

The Cosmological Aesthetics of Tomás Saraceno's Atmospheric Experiments

Sasha Hildegard Engelmann

DPhil Candidate

School of Geography and the Environment

St. Hilda's College | University of Oxford

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Abstract

This dissertation proposes *cosmological aesthetics* as a critique of and contribution to geologic, geomorphic and geographical aesthetics. This argument is developed in the context of human geographers' growing interests in the dark, imperceptible and unknown forces and fields of Earth and the cosmos. Attention to such cosmic phenomena amplifies the porosity of distinctions between humans, nonhumans and matter; therefore we require an aesthetic theory at the limits of sensing. In developing this aesthetics, this dissertation draws conceptual support in particular from the non-anthropocentric philosophy of Alfred North Whitehead and from Isabelle Stengers' "ecologies of practice". At the same time, the elaboration of cosmological aesthetics emerges from a site-based creative ethnography of Studio Tomás Saraceno in Berlin, and more specifically, from a series of experiments in transdisciplinary collaboration, writing and teaching with Tomás Saraceno. This dissertation interrogates how the *surfaces, webs, envelopes* and *interstices* populating and propagating in Saraceno's artwork affect the transmission and distribution of sensation across spaces and scales: in short, how these forms become technologies of cosmo-aesthetic adventure. By engaging with Saraceno's art projects, from *On Space Time Foam* to *hybrid webs* and the *Aerocene*, and by participating in the atmospheric experiments of *aerosolar sculptures*, this dissertation articulates two core propositions of cosmological aesthetics: first, that aesthetic experience can create tangible, sensible relations with contexts that are far removed, or much wider than, the particular conditions in which we experiment. And second: such adventures in aesthetics emerge from practices bound together by the forces of obligation, attachment and crucially, imagination. Employing foremost the device of the *web*, cosmological aesthetics explores propositions for bodies to be creatively extended in a vast and vibrating cosmos.

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Acknowledgments

I still want to finish this the way that I started, says Alvin Straight in David Lynch's *The Straight Story* (1999). Alvin, a World War II veteran of 73 years, has ridden a John Deere lawn mower hundreds of miles from Iowa to Wisconsin in order to see his 80-year-old brother. *You need to tell the straight story*, Derek McCormack said to me, referencing Lynch's film, in one of our last PhD supervision sessions in Berlin on a hot summer afternoon. If there is one attunement and skill I have learned from Derek over so many years of research and writing, it is the enduring art of telling stories – atmospheric ones, circumstantial ones, elemental ones – and straight ones. For these and many other teachings in geography and life, I am eternally grateful.

Like so many spiders weaving sails into the wind: in the realm of webbed stories, my thanks go to Tomás Saraceno. Never in my life have I had such a cosmic opportunity – to enter a practice, a community, a discourse, indeed a cosmos – one that traverses art, science and geography as elegantly as threads of iridescent silk. The past years have radically transformed my thinking, given me courage, and fostered friendship – the last of which I hope will never fade.

To detect the whispers of a blackhole-Shiva: this is the beginning of a story with Jol Thomson. On that first Berlin morning, we started working together, writing together, dreaming together. It could not have been otherwise. My own words failing, I turn to Ursula K. LeGuin's *The Left Hand of Darkness*: *As we ran the sledge across the snow-bridges over narrow crevasses we could look down to left or right into blue shafts and abysses in which bits of ice dislodged by the runners fell with a vast, faint, delicate music, as if silver wires touched thin crystal planes, falling.*

In myriad ways, this dissertation has been enlightened by members of Studio Saraceno, especially Adrian Krell, Lars Berendt, Daniel Schulz, Kotryna Šlapšinskaitė, Sarah Ferrar, Desire Valdez, Tato Chavez, Tobias Lange, Martina Pelacchi, Veronica Lugaro, Sebastian Steinboeck, Claudia Melendez, Javier Rosenberg, Canice Grant, as well as Emek Ulusay, Stefano Arrighi, Vasily Sitnikov, Julia Hajnal, Edgar Diaz and Dorota Gaweda, who are formerly studio members.

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To Mom and Dad, for teaching me how to sense the spirits in the olive and oak trees and letting these carry me far away, and to my brother Elliott, for shelter, tea, and existing.

Together with the dark curving letters forming the words on these pages, I thank the willow trees with whom I breathed, the Berlin Spree, the “good machine” (as Alvin Straight would say) on which this thesis was written (never failing once!), and the photons of sunlight dancing and cascading at this very moment into the quercetin molecules of living things, those that sustain the atmospheres of this planet.

How then can space function differently from the ways in which it has always functioned? What are the possibilities of inhabiting otherwise? Of being extended otherwise? Of living relations of nearness and farness differently? – Grosz and Eisenman, 2001: 129

You are all vibrating in the same web. – Tomás Saraceno, 2016

An Introduction to the Practice of Cosmological Aesthetics

I. Surface

I step down on a short rope staircase, my feet wobbling as the knots stretch. At the bottom of the ladder there is no other choice but to step, or rather to slide, onto the slippery, pliant surface. An anticipatory tension, drawing the stomach in. A split-second closing of the eyes. Outstretched. Arms. Gray. Light.

The drop. A half sinking, half sliding struggle, and the immediate sense of a force beneath. I make a crease as I crawl into the middle; it closes behind me. I don't move, I fold. Peering down I see other bodies, folding too.

II. Web

A female Nephila rests on her web, legs delicately tensed on a radial axis. She is blind and deaf, although she has one of the most sensitive bodies of any living being. Air is to her what water is to a human: she feels the atmosphere as a dense, stirring pool. When she spins, she uses her back legs to draw out silk from her abdomen, sensing gusts of air to cast long threads to far-away points. Sometimes she secretes thread with special glue on the ends. Often she eats part of her web and weaves it anew. For her, the cosmos is a vibratory one: she feels zones of perturbation and tension traveling from distant regions of the web to her receptive body.

III. Envelope

Air traffic control (via Sven) says OK. Tomas and Adrian motion to release. We retreat from the black membrane and let it rise. It levitates. As it floats over the grass, Tomas and Adrian and I jog with it. It is moving quickly, lifting upward, expanding. I can feel the pull of the thing in my whole body. It is several times my height. The mouth of the balloon yawns. I look upward, directly inside. The colors are golden, gray, brown and blue. It moves, creature-like, with complicated folds and twists.

Amplifying eddies and vortices in the air, lines waving and bending through the medium and membrane, joining and spinning away.

IV. Interstice

The structure has become quite large, towering over the human participants, folding back over itself like a curling, cresting wave...

One person crawls through the opening, then another; then Dr. Chris Field, chairman of the IPCC, follows suit, along with Pablo Suarez. The camera's view points toward the floor as the person who is filming also enters. Inside, a handful of people are standing, arms at oblique angles to the floor, palms up in gestures of disbelief, not trying to repress their smiles as they gaze around at the rippling, multi-colored dome. Dr. Field is wearing an uncharacteristically wide grin. Scattered words are heard. Then there is a ringing exclamation, from somewhere behind the camera:

"This is the best thing that has ever happened to politics!"

Sensing practices matter. They matter because the practice of sensing, especially sensing the faint or far away, is a matter of extending. It is a matter of extending through materials, materials that absorb and transmit the phenomena of sense.¹ The insight that sensation travels through surfaces, webs and atmospheres, indeed that it travels from distant cosmic entities, is an ancient one.² But a project that doesn't stop there, that *experiments* with this insight, is different and novel. Such a project requires working with media, materials and attachments much like our *Nephila* spider weaves her web. The

¹ In this passage, the meaning of “sense” approximates that of vibration or intensity: for example as developed in the work of philosopher Alfred North Whitehead (1929) on “vibratory nexus”; or in the work of Gilles Deleuze (2003) and Elizabeth Grosz (2008) on “pure intensity” or “the intensification of the resonance” (Grosz, 2008: 24).

² For example, this statement is implied in the “sylvan amplification” of the Ecuadorian Amazon rainforest as elaborated by the Runa Puma people and anthropologist Eduardo Kohn (Kohn, 2013); or the holographic cosmology of the Kogi people as explored by François Bucher (Bucher, 2016); such an aesthetic claim has been developed by many philosophers, among them Luce Irigaray (on air), Michel Serres (on turbulence and media) and Alfred North Whitehead; it is given also in the assumptions of scientific experiments, for example in sensing neutrinos, cosmic rays, and gravitational waves.

intervention of this dissertation is to elaborate an aesthetics in practices that attune with the world and the cosmos in concrete and alluring ways.

This aesthetics – or what I call *cosmological aesthetics* – is an aesthetics of webs.³ Following the work of Alfred North Whitehead and Isabelle Stengers, the term *cosmological* refers to the world-making function of “ecologies of practice” that cohere and endure.⁴ In light of this, *aesthetics* is understood as the play of sensation across such ecologies of practice and the matters and media they enroll. In this way aesthetics approaches *aesthesia*: a notion of sensitivity and feeling that is neither circumscribed by the human perceptual apparatus, nor by the cognitive faculties of perceiving subjects. The core propositions of cosmological aesthetics are twofold: first, that aesthetic experience can create tangible, sensible relations with contexts that are far removed, or much wider than, the particular conditions in which we experiment. And second: such adventures in aesthetics emerge from practices bound together by the forces of obligation, attachment and crucially, imagination. Employing foremost the device of the web, cosmological aesthetics attends to the play of sensation in recognizable, resilient and imaginative practices.

What do a surface, a web, an envelope and an interstice have in common? These are forms – not conceptual frames, or Platonic ideals – rather, “lived abstractions” (Manning and Massumi, 2014) that pattern and propagate through materials and bodies. In this dissertation, I am interested in how form and form-finding participate in the generation, transmission and distribution of sensation: how forms become technologies of aesthetics. This requires understanding surfaces, webs, envelopes and interstices not as discrete objects, rather as sensors and amplifiers. I am also interested in these particular four forms as

³ The term “cosmological aesthetics” was used by art historian Barbara Stafford to describe the work of 18th century draughtsman and art theorist Pierre Giotin Humbert de Superville, who studied comparative mythography and mythology to argue that certain specific directional lines and colours elicit a universal response in people of all times and places (Stafford, 1972). Although it resonates with Humbert’s and Stafford’s appeals to the resonance of certain forms, the cosmological aesthetics of this dissertation differs from this work in its focus on events, practices, atmospheres, gestures, refrains, affects and more broadly, the non-representational textures of experience.

⁴ In her article “Introductory Notes on an Ecology of Practices” Isabelle Stengers defines “ecology of practices” as “a tool for thinking” and enlarges in the following way: “The problem for each practice is how to foster its own force, make present what causes practitioners to think and feel and act. But it is a problem which may also produce an experimental togetherness among practices, a dynamics of pragmatic learning of what works and how” (Stengers, 2013: 195).

they engender and cohere practices of moving, relating and sensing that have a qualitative consistency across space-times and scales. The properties of forms, and the media in which they are immersed, compel four different styles of cosmological experiment, four different modes of becoming cosmological explored in this dissertation's empirical chapters.

I am making an argument about the relevance of a *cosmological* approach to *aesthetics* for geographic thought and experiment. In this dissertation, I do this through encounters with the artwork of Tomás Saraceno. Through an active engagement with surfaces, webs, envelopes and interstices as they proliferate within and beyond the work of Tomás Saraceno, I pose several questions about geographic notions of aesthetics, scale, the more-than-human, and the social. These are primarily: how does a surface transmit a post-scalar relation between intensity and extensity? What is more-than-human sympoiesis with a multitude of creatures, and with dark or “exotic” matters? What would the social look and feel like if it was woven through a sense of the cosmological that operates with an aesthetic, ethical and political force transversal to scales, species and spheres? Exploring these questions mutually informs cosmological aesthetics and the discipline of geography. Yet these questions have emerged from years of ethnographic engagement with the artwork of Tomás Saraceno: an engagement with artworks that make aesthetic, ethical and political propositions of their own.

You are all vibrating in the same web: this statement, made by Saraceno in an interview with Caroline Jones (Saraceno and Jones, 2016) is an observation, an instruction, and a politics. It is an observation of the way bodies weave into worlds of filamentary design and communication – those assemblages of matter, information and energy crisscrossing our small blue planet. *You are all vibrating in the same web* is also a user’s guide for Saraceno’s large-scale installations. As you enter the scaled-up, re-constructed web of a black widow spider, traverse one layer of a flexible, transparent membrane, or connect one seam of a solar-powered sculpture, *you* are exploiting vibration as primary sensory resource. And lastly, these seven words summon a community: one of participants immersed in a medium in which to think, to speak, and to act. To be vibrating in the same web – albeit not in the same way, or at the same frequency – is to have a particular collective politics.

Tomás Saraceno is a Berlin-based artist who has met with international success in the last fifteen years, in large part due to his abilities to think and work with webs: including those of a wide range of spider species, those modeled by scientists attempting to understand patterns of dark matter in the universe, and those of twenty-first century technologies of sensing and communication.⁵ As any visitor to one of Saraceno's exhibitions will attest, Saraceno himself is an expert at weaving: gathering and knotting entities together. But his genius is of equal relevance for geographers as for art historians and cultural critics, for several reasons. Over the length of his career, Saraceno has experimented with the aesthetic, social and political textures of more-than-human encounters. In particular, Saraceno has proposed diverse typologies of webs as figures we can think with to understand multispecies communities and a spectrum of social harmony and dissonance. His work is therefore pioneering of the important shift in the social sciences to take more-than-human entanglement seriously, and through experimentation, to position human practices as belonging to a spectrum of more-than-human practices.

Furthermore, Saraceno's work envisions different styles of atmospheric dwelling and moving, sensing and communicating that transcend and transact scales, articulated in the body of work he terms *Cloud Cities*. In the two years during which I worked closely with the artist, this body of work also became associated with two other titles: *Becoming Aerosolar*, and more recently, the *Aerocene*. The *Aerocene* refers to a series of buoyant, sun and air-powered sculptures as well as a new planetary epoch: one in which collective investment in atmosphere is widely performed. The questions posed by Grosz and Eisenman: "What are the possibilities... Of being extended otherwise? Of living relations of nearness and farness differently?" are at the innermost circle of Saraceno's modular practice as well as the cosmological aesthetics elaborated in this dissertation (Grosz and Eisenman, 2001: 129). They also

⁵ Tomás Saraceno has collaborated extensively with scientists and academic institutions. It is impossible to overstate the value of such collaboration for Saraceno's practice. Two important examples are: the invention of a laser-supported tomography method to scan and digitize spider webs, carried out in collaboration with engineers at TU Darmstadt, and presented at the 18th International Congress of Arachnology; an ongoing collaboration with Dr. Leila Kinney, Dr. Lodovica Illari and Bill McKenna at MIT's Department of Earth, Atmospheric and Planetary Sciences on developing more nuanced models of atmospheric fluid dynamics, applications for monitoring of airborne pollution via aerosolar sculptures, and more sophisticated flight prediction for aerosolar vehicles.

recall the history of geography as a science interested in forces and media that produce different concepts of scale and space-time.

Although this dissertation emerges from an ongoing relationship with Tomás Saraceno, it also reads Saraceno's work together with other creative and philosophical practitioners. These are practitioners who, like Saraceno, peer around the corner of anthropocentric discourses at other onto-epistemological horizons: for example, futures of "airship to orbital" programs (Powell, 2008), Earth's "critical zones" (Latour, 2014), inter-species communication and politics (Barth, 2014; Massumi, 2014), "social insects" and "biotremology" (Mühlethaler and Hoch, 2014; Mühlethaler, 2016) new "thermodynamic imaginaries" (Moe, 2014; Turpin, 2015), cosmo-poetic narratives (Ait-Touati, 2011; 2014) and metabolic regimes (Szerszynski, 2015). In the spirit of Saraceno's various vibratory communications with spiders and other species, a large number of nonhuman collaborators make contributions to these horizons.

Given Saraceno's rhythms of practice and experiment, a dissertation engaging with his work must also be a webbed, polyphonic and multi-rhythmic affair. Throughout this dissertation, ethnographic material in the form of images, anecdotes, conversations, poems, films, diagrams and description will help to make these pages a palimpsest of my collaborative engagement with Saraceno and his studio. This dissertation is the shimmer of a "para-ethnography" (Holmes and Marcus, 2008b) in which Saraceno's work will not be interpreted as much as entangled with multiple histories of collaboration, making, teaching and writing. As we weave this web together, we will cast radial threads (those running through all of the chapters) and sticky-ended threads (those triggers designed to catch new entities and pull them inward). There will be meshed threads and surfaces (where arguments gain concreteness) and freestyle threads (those that reach and gesture outward to other spaces and ideas, or cross between nodes in this text). The radial threads are cast here, now. Rather than discussing the four empirical chapters as distinct units, each of the following sections elaborates a theme of this project's atmosphere of practice, experiment and reflection that significantly informs all of the empirical chapters. These following propositions for aesthetics, scale, the more-than-human and the social contribute to

geographical thought and experiment in the “cosmic epoch” of the Anthropocene (Whitehead, 1978[1929]). The following section first enlarges the stakes and scope of cosmological aesthetics for geography and the ethnographic story that follows.

Cosmological Aesthetics

Just as we see little spiders or certain insect larvae hidden like precious stones in their cotton and satin pouches,

In the same way, I was shown an entire nestful of still embarrassed suns in the cold folds of the nebula.

- Paul Claudel cited in Bachelard (1958/1964: 172)

Cosmological aesthetics is inspired by propositions for sensing the cosmos. Such propositions are not made by single beings or entities (let alone humans), but in the performance of cosmological experiments. However, this is not to suggest that the concept of cosmological aesthetics is primarily inspired by sensing beyond Earth. Attentions to cosmos and geos are mutually constitutive. As many, including Hartshorne (1958), Cosgrove (2000; 2012) and Cormack (1994) have explored in detail, geography emerged as a “cosmographic science” (Fröbel cited in Hartshorne, 1958: 102). From the 1st century cosmographic studies of Claudius Ptolemy (especially *Almagast* and *Geography*) re-printed in Latin in 1410, to the *Kosmos* (1845) of Alexander von Humboldt, to James Lovelock’s Gaia hypothesis, studies of the cosmos were not opposed to studies of the geomorphic or geographic (Cosgrove, 2012: 31). In the 17th century, for example, cosmology and geography were linked in attempts to understand the formation of the Earth and the complex changes of its surface. One example is Thomas Burnet’s *Telluris theoria sacra* (1681), a text that narrated Earth’s evolution from chaos to its current state in “six cosmic phases” (Kragh, 2007: 72). More than a century later, astronomers like Friederich Wilhelm

Bessel were close correspondents of Alexander von Humboldt, and were influenced by Humboldt's widely circulated ideas of mineralogy, climate, and tectonic plasticity. A myriad other stories and conversations could be detailed here, in which a diagramming of the Earth informed that of the cosmos, and vice versa. Cosmological aesthetics, therefore, is not a non-geographical aesthetics; rather it is a different *lure* for aesthetics that is informed by the cosmic and cosmological, and more specifically, the practical and aesthetic webs that bind creaturely, cosmic and conceptual entities.

The aesthetics developed in this dissertation is informed by a sense of the cosmological as construction of worlds that is inseparable from practices of sensing-at-the-limit. A brief anecdote is useful here. At the end of the 18th century, the famed self-taught German astronomer William Herschel, having reached great success from his discovery of Uranus, pieced together the architecture of the Milky Way using a twenty-foot reflector telescope (Kragh, 2007). He assumed that he could see all of the stars in our home star-system with this telescope. He boasted, "I have looked further into space than ever human being did before me" (Kragh, 2007: 87). However, when he later constructed a 40-foot reflector telescope, he found that he had been mistaken – there were many more stars visible. The aging Herschel admitted that perhaps the Milky Way was truly "unfathomable" (Kargh, 2007: 87). For Herschel, and for his contemporaries, the practices of observation bound up with the telescope constructed and reconstructed the cosmos, while gesturing also to what was just beyond reach: *unfathomable*. The practice of peering further and further into interstellar space is one that actively continues today, although the modalities of sensing have shifted from photons to gamma rays to neutrinos and most recently, to gravitational waves. Interestingly, Herschel met with Alexander von Humboldt during the testing of the 40-foot reflector; these two thinkers found resonance in a concept of the cosmos that was not mechanistic but malleable: "a living thing that changed, grew and fluctuated" (Wulf, 2015: 166). Cosmological aesthetics is informed by such practices of sensing-at-the-limit that are also, simultaneously, world-making practices. These include practices of speculating with diagrams, with technologies of observation, and with instruments of sensing and description.

What is the relation between the vibratory cosmos of the *Nephila* spider in this chapter’s opening vignette, and that in which our home galaxy moves, among superclusters of celestial filaments and nebulae? Is it possible to consider an insect and an astronomical entity in the same web of relations: a web that does not produce hierarchies of space or scale, but zones of proximity and synthesis? As in the case of the cosmological questions that populated the theories of Einstein, Planck and Heisenberg, in which matter’s (im)materialities came to the fore (Rycroft, 2012), the concepts with which we might respond to these questions are both philosophical and experimental. They summon the notion that, “...tiny and immense are compatible... If a poet looks through a microscope or a telescope, he always sees the same thing” (Bachelard, 1958/1964: 172). In the verse from Claudel that begins this section, and Bachelard’s theorization, the very large and very small are not two poles on a continuum of scale, but directly bound up in each other. The fold of this “intimate immensity” is the opposite of the zoom. For, as Bachelard asserts, we do not zoom in our imaginations; we have a “relaxed participation in images of immensity” (Bachelard, 1958/1964: 191). Moving from the very large to the very small is more about synthesis: “the transactions between two kinds of [cosmic] grandeur” (Bachelard, 1958/1964: 193).

The web is one entity that allows us to materialize the cosmological transactions that Bachelard, and the many poets he cites, evoke in verse. The meaning of “cosmological” here resonates with Alfred North Whitehead’s *Process and Reality: An Essay in Cosmology* (1929) as it informs the work of Isabelle Stengers. In Whitehead’s text, cosmos and cosmological refer to universes, or ensembles, from the minute to the vast, characterized by their co-extensive capacities for vibration (Hansen, 2015; Whitehead, 1978[1929]).⁶ Importantly, this notion differs from that of Humboldt, whose idea of the

⁶ Trained as a mathematician, Whitehead was familiar with Einstein’s theories of relativity and often references such achievements in his philosophical work. A lesser-known fact is that in 1922 Whitehead actually presented an alternative theory of gravitation that led to the same predictions as Einstein’s field equations, although it was based on very different mathematical formulae (Kragh, 2007: 138). While Whitehead’s ‘non-covariant, action at a distance’ model was largely ignored by cosmologists at the time, his proposal, also articulated in *Process and Reality*, that our universe is ephemeral and might be replaced with another one with different laws of nature and different dimensions of the space-time continuum, laid the ground for the theories of “many universes” popularized in the 1980s (Kragh, 2007; Barrow and Tipler, 1986: 191). Since Whitehead’s agile mathematics and metaphysics created the conceptual foundation for the proposal of a multiplicity of worlds, and worlds-in-formation, his work is

cosmological denoted a perfectly harmonious Earth-Cosmos relation. Stengers' contribution, in part, is to articulate what a Whiteheadian notion of cosmological coherence means for ecologies of practice: in short, cosmological practices are those that gather together in recognizable form, motivated by obligations and attachments between practitioners (Stengers, 2011; 2013). Such ecologies of practice are cosmological achievements. And such achievements have particular aesthetic consequences.

For Whitehead, subjectivity emerges when “actual occasions” – temporal inflections of experience analogous to Deleuze’s events or “singularities” (Shaviro, 2009) – inherit, respond to, or *prehend* each other across vibratory continua. In Whitehead’s non-anthropomorphic, non-anthropocentric account of the world and its relational media, aesthetic feeling emerges not only in human subject-formation, but also that of entities (or *societies*) like plants, rocks and electrons (Shaviro, 2009; Whitehead, 1978[1929]). Following Whitehead, an aesthetics of cosmological practices is not circumscribed by the human sensory apparatus: sensation travels through media and materials, creatures and devices, participating in the blurring of ontological boundaries. This blurring is evidenced when Jakob von Uexküll writes that a spider web exhibits characteristics of the “fly archetype” so that a spider is “fly-like” (Von Uexküll, 1982: 66).⁷ In its adoption of the “fly’s melody,” the web is part spider, and part fly (Von Uexküll, 1982: 66). Sensible vibrations transmitted by the medium of the web amplify such ontological and trans-species blurring. Saraceno’s ongoing research on biotremology and seismic communication is another case in point: through detecting and recording the perturbations made by insects with and through webs, Saraceno and Roland Mühlethaler investigate how sense and sensing emerges (and has meaning) beyond the human. In the vein of important contributions to anthropology

an excellent resource for an aesthetic theory of cosmological experiment. It is also metaphysics adequate to the work of an artist whose studio cares for around three hundred living, weaving spiders.

⁷ A note on the ontological blurring of spider and fly is useful here. Jakob von Uexküll writes:

The spider's web is certainly formed in a 'fly-like' manner, because the spider itself is 'fly-like'. To be 'fly-like' means that the body structure of the spider has taken on certain of the fly's characteristics — not from a specific fly, but rather from the fly's archetype. To express it more accurately, the spider's 'fly-likeness' comes about when its body structure has adopted certain themes from the fly's melody. (von Uexküll, 1982: 66)

This “likeness” through the “adoption of themes” between spider and fly blurs their status as distinct beings or life-forms. This topic is also cited in an essay by David Toop, “Filament Drums: the Endless Instrument” in T. Saraceno and G. Pezzato (Eds.) *Cosmic Jive: Tomás Saraceno: The Spider Sessions*.

beyond the human, especially Eduardo Kohn's (2013) *How Forests Think*, Saraceno and Mühlethaler are exploring *how insects feel*.

In the context of such cosmological achievements, where do we locate the imagination, or the role of artistic practice? In Whitehead's cosmological coherence and Stengers' ecologies of practice, the role of the imagination is acknowledged, but under-emphasized to the extent that it acts as a real cosmic "force" for practices. The numerous arachnologists and bioacousticians with whom Saraceno collaborates are compelled to the collaboration not only because it is useful for their own research; in addition, they are imaginatively lured by the dream-like prospects (still largely shunned in scientific research) of inter-specific communication, even that between humans and insects.⁸ Furthermore, the collaborations between materials scientists, atmospheric scientists, social scientists and architects on Saraceno's *Aerocene* project is not justified or validated by institutional or professional cooperation alone, but is genuinely motivated by a "germinal collective dreaming" of an alluring, post-Anthropocenic future (Shapiro, 2015). A number of thinkers and philosophers aid me in conveying the *imaginative urgency* of *Aerocene* practices. In particular, Bachelard's (1958/1964) "cosmicity" and "poetic reverberation" and Irigaray's (1999) porous poetics recuperate the force of imaginaries in motivating these ongoing collaborative practices.

Inspired by Whitehead's philosophy of organism and cosmos, and especially this philosophy's insistence on aesthetics as fundamental to the spectrum of more-than-human experience, this dissertation articulates how certain creative, cosmological practices amplify aesthetic experiences not only of the other-than-human, but of the dark, the solar and the cosmic. This dissertation asserts that these creative experiments, of which Saraceno's work is a wonderful example, mobilize a cosmological aesthetics. The central distinction between Saraceno's work and that of many other artists is the following: through a collective posing of problems and an engagement with modular forms and concepts, Saraceno

⁸ Indeed, the first international symposium on Biotremology that occurred in July 2016 was jointly organized by Peggy Hill, a behavioural ecologist who has contributed pieces to Saraceno's *Arachnid Orchestra* discourse, and included a series of panels on "Social Insects," organized by Roland Mühlethaler, a specialist in bio-acoustics who is now a resident and collaborator of Studio Tomás Saraceno.

cultivates ecologies of practice that cohere in time and space. This distinction has purchase for understanding the *work* these experiments do in multispecies world making, in blurring disciplinary divisions, and in contributing to the conversations on aesthetics in human geography.

This dissertation does not apply the theory and philosophy of Whitehead and Stengers, or recent discourses in human and cultural geography, to “read” or “interpret” Saraceno’s artworks. This is a gesture that would seek “to capture” the artworks in the terms of a specific disciplinary language (Stengers, 1989/1997). As Born and Barry (2010) elaborate, such an imposition of one disciplinary frame on another leaves disciplines and practitioners unchanged. Instead, this thesis understands Saraceno’s artworks as philosophical-aesthetic propositions in their own right. To carry out geographical research in the folds of a membrane, while waiting to launch a sculpture at dawn, or by feeding a colony of social spiders, as I did throughout my ethnography, is to feel and follow the world of practice at Studio Tomás Saraceno, and to allow questions to emerge from this world. Cosmological aesthetics emerged in this way, as an attempt to solve the problem of articulating the kinds of aesthetic adventures proliferating in practices at Studio Saraceno. Yet in doing so, cosmological aesthetics extends beyond the work of Tomás Saraceno, making contributions to concepts of scale, the more-than-human and the social.

In the first empirical chapter, Luce Irigaray’s porous philosophy, Bruno Latour’s commentary and Saraceno’s *On Space Time Foam* (2012-13) aid us in understanding the atmospheric exposure and conditioning of bodies as they pass through membranous surfaces. The chapter develops a notion of surface as a membrane, a vehicle of movement, and a gathering force that animates the cosmological qualities of space-time. In the subsequent chapter on Saraceno’s *hybrid webs*, cosmological aesthetics emerges from the disjunctive synthesis of highly irregular, incongruous entities across epochal or cosmic scales; and in the visceral experience of *lures* and *patterned contrasts* (Shaviro, 2009: 79; Whitehead, 1978[1929]). In the final two chapters, we meet with the participatory, collective practices of *aerosolar sculptures*: entities that place assemblages of humans, nonhumans and technological devices in contingency with “weather-worlds” and “force-fields” (Ingold, 2010) born of the choreography between

our planet and its nearest star. The last chapter in particular draws these aesthetic infrastructures and “aerosolar polities” (Turpin, 2015) into a notion of *interstitial politics* for the *Aerocene* (Pignarre and Stengers, 2005/2011). Each of these chapters and their frames of attention ask how a surface, a web, an envelope or interstices invite cosmological experiments that extend bodies and imaginations, troubling static notions of scale.



Figure 1: Tomás Saraceno
Aerocene, launches at White Sands (NM, United States), 2015

The launches in White Sands and the symposium “Space without Rockets”, initiated by Tomás Saraceno, were organized together with the curators Rob La Frenais and Kerry Doyle for the exhibition “Territory of the Imagination” at the Rubin Center for the Visual Arts. The sculpture D-O AEC is made possible due to the generous support of Christian Just Linde. The artistic experiment achieved two world records of the first and the longest solely solar flight by a lighter-than-air vehicle. Courtesy the artist; Pinksummer contemporary art, Genoa; Tanya Bonakdar, New York; Andersen's Contemporary, Copenhagen; Esther Schipper, Berlin.

© Photography by Studio Tomás Saraceno, 2015

Scale

In this dissertation, as for the *Nephila* spider, webs gather and transmit sensation in ways that transcend and transact scales. The webs at work here are not only spider webs; nor are webs the only entities that blur scalar divisions. In the work of Tomás Saraceno, surfaces, envelopes and interstices are modular, shifting forms that also transmit sensory information between and among scalar registers. This doesn't mean that we cannot speak of the dimensions of these forms. Nor is scale irrelevant as a term. Rather, this dissertation clarifies that the aesthetic, ethical and political potency of these four forms is related to their ability to modulate, aggregate, assemble, and shift across scales and sites of practice. As they assemble and re-assemble, they often retain a qualitative consistency, generating "enunciative territories through their diagrammatic and sensory functions" (Gerlach, 2015: 10; Guattari, 1992/1995). This is also a major part of their appeal to Saraceno as the components of *Cloud Cities* or the *Aerocene*.

Geographers have a long history of engagement with notions of scale, especially in relation to capital (for example Harvey, 1985; Smith, 1984; Brenner, 1998), the region (for example Sayer, 1989) and the local (for example Massey, 1991). The conversations on scale that more directly inform this dissertation are those in which scale is troubled as a workable concept in favor of attentions to site-based ontologies. Recent interventions by Marston et al. (2005) and Swyngedouw (2004), argue that the presupposition of hierarchical scale – usually allied with a relatively small number of 'grains' (such as the body, neighborhood, urban, regional, national and global) – create difficulties in thinking relations that exist outside, within, or intra- to, these terms. As Marston et al. (2005) assert, "...hierarchical scale is a classic case of *form determining content*, whereby objects, events, and processes come pre-sorted, ready to be inserted into the scalar apparatus at hand" (emphasis in original; Marston et al., 2005: 422; see also Thomson and Engelmann, forthcoming). In short, 'solving for scale' closes down the potential for unusual or surprising insights. Moreover, the authors assert that an analysis that relies on scale flirts with 'methodological perspectivalism, a God's Eye view' (*ibid*), which requires significant conceptual acrobatics to maintain.

These are adept and heavy critiques that suggest that scale should be abandoned in favor of a “flat” or “site ontology” (Marston et al., 2005). Such an ontology would, “invent – perhaps endlessly – new spatial concepts” that start from within the messy middle of more-than-human sites (Marston et al., 2005: 424). However, this dissertation makes the case that there are occasions for *forms determining experiment* or *forms determining practice* that create novel aesthetic, ethical and political stakes. As I will explore in chapter five, the recognizable form of a three dimensional black widow spider web is brought into relation with a three dimensional simulation of dark matter in the universe through the means of visualizing, re-construction and the creation of a “recording surface”. Although the spider web and the “cosmic web” are far removed in space and scale, and lack the same organizing structure, a process of experimentation with their resonances illuminates shared qualities of emergence: or, *filaments becoming visible*. This experiment creates a “disjunctive synthesis” between the scale of the spider web and that of the simulation (Deleuze and Guattari, 1991/1994). An attention to scale becomes useful not for circumscribing the subjects of analysis (e.g. spider web, simulation or experiment), but for highlighting the hollows, the “betweens” of scales in which unusual moments of synthesis are seen and felt. This argument resonates with those of Jonas (2006) that scale must remain a part of human geography, not least for its hollows, and the novel narratives these make possible.

If a web is a web is a web, another form of scalar transaction occurs in the ecologies motivating Saraceno’s *Aerocene* concept. The *Aerocene* finds its expression in the solar-powered aerostats that Saraceno constructs and launches with his studio, various publics, and university collaborators around the world. Yet the *Aerocene* is also a post-Anthropocenic future, one in which floating, aerial, self-aggregating aerostatic sculptures join and disperse depending on the mutually interacting forces of economy, society and climate. The *Aerocene* epoch is invoked, much like a spell is cast, each time a single sculpture is launched. Therefore the epoch is not debated or delineated in stone: it is announced each time one such sculpture takes flight. And through the affective intensity of such *aerosolar* announcements, which have a qualitative consistency whether they are carried out in Peru or Germany or Turkey, the epoch is performed in a refrain of practices designed to be shared further. In another sense,

the sculptures that embody the *Aerocene* project range vastly in size from only a few cubic meters in volume to many hundreds of cubic meters. Each incremental change in surface-area to volume ratio has different consequences for the buoyancy and flight of such sculptures, as will be elaborated in Chapter 6. Once again, scale remains a workable term for delineating the physical relations between such sculptures and their atmospheric conditions. Still, as Tsing (2015) has argued in relation to forestry practices, *Aerocene* practices cannot be simply “scaled up”; rather, each spell of enactment acts as a political and ethical interstice enfolding, at once, the intimate and the epochal, present and future.

A third related intervention into the geographic conversations on scale lies in the capacity of cosmological experiments to create tangible, sensible relations with conditions that are far removed from the particular conditions of the experiment. Such relations emerge, for example, in the sensing of energetic cascades in event of an aerosolar sculpture launch. The *cascade* of a photon into a black membrane is a, “*waterfall of causality* in which one event triggers and affects the next” (italics ours; Fulton cited in Rooney, 2004: 176). The qualities of energetic cascades, as they express quickly or slowly (or not at all) in launching an aerosolar sculpture, create different affective atmospheres sensed and acted upon by practitioners. In this way, subatomic, human and cosmological entities are intimately entangled in the aerosolar performance (Chapter 6). They cannot be separated into distinct or nested scales. These qualities can lead us to understand the cascade as the expression of entanglement in the interstitial, liminal spaces between subatomic particles, sculptural membranes, the Sun and other radiant bodies, GPS trackers, digital sensors and ecologies of creative practice. Sending waves across such assemblages, cascade phenomena collapse static, singular notions of scale(s) and amplify human, more-than-human as well as technical agencies.

Ultimately, it is through a shared quality of formation that we can think of a *Nephila* spider and a galaxy in the same web of relations, one not predicated on scale, but on the terms of attraction, lure and synthesis. It is through the coherence and imaginative urgency of modes of practice that a group of students on a hill in Germany can have tangible experiences of the cascades of photons entering Earth’s atmosphere and warming a plastic membrane. And it is through the crafty spells of ecologies of practice

that an event of sculptural inflation at a climate conference in Lima, Peru is immediately interstitial with numerous others happening elsewhere around the world. These experiments, and the cosmological aesthetics they convey, do not question the use of scalar analysis as much as they offer forms and figures to open and develop the interstices of scalar concepts.

More-than-human

What is more-than-human sympoiesis performed with a multitude of creatures? How does one “co-author with the alien” (Last, 2013) or, “co-author [with] the cosmos” (Yusoff, 2015)? These are questions that increasingly arise in geographic and ethnographic literature. As part of a varied engagement with the “more-than-human” (Whatmore, 2006), social scientists have begun to give more attention to creatures that are not ‘big like us’, and that are microscopic, strange or monstrous (Bingham, 2006; Ginn, 2013; Dixon, 2009; Lorimer, 2016). In contrast to geographic literature that has attended to companionship or attunement between animals and humans (Haraway, 2008; Hinchliffe, 2010; Lorimer, 2010), and their bio-geographical traces (Lorimer, 2006; Barua, 2014), Davies (2012) for example has studied mice and glowfish in laboratories, speaking not only of individuals but of populations: creatures which are, “not only multiple, but a multitude” (Davies, 2012: 626). Lorimer (2016) has recently engaged with helminths or worm species that have been successfully diminished in humans through infrastructures and practices of modern hygiene; these “friends without a face” are now hopefully hosted by humans convinced of their benefits to health, especially with respect to the immune system (Lorimer, 2016: 72).

The ethnography presented in this dissertation considers “embodied empathy” between humans and populations of spiders (Despret, 2013). Spiders are creaturely (and some say monstrous) friends who express themselves primarily in the (inter)faces of webs. The processual and patterned production of *hybrid webs* at Studio Saraceno forces thought on the axes of more-than-human sympoiesis, on collaboration between and across multitudes of creatures, and on the possibilities of inventing encounters with matters and entities that are foreign to us. In thinking with such hybrid entities, this dissertation

also contributes to rich conversations in multi-species ethnography and anthropology, for example as exemplified in a recent special issue of *Environmental Humanities* journal on Multispecies Studies (2016). In particular, ethnographers of the more-than-human such as Despret and Meuret (2016) have proposed that specific relations and obligations of practice render multispecies communities *cosmoecological*.⁹ Other scholars including Yusoff (2015), Bosworth (2016) and Reinert (2016) question ethnographic attentions to the biotic or creaturely, inviting a subversion of the modern “geontologies” that render inorganic matter passive. Cosmological aesthetics intersects with these cosmoecological and regolithic research imaginaries in its practical attentions to the world-making of creaturely multitudes and their inorganic compositions and secretions.

This dissertation also contributes to geographies of the more-than-human and the inorganic by engaging experiments with the energetic, the elemental and the solar made possible in artistic practices. The propositions here are twofold: on one hand to articulate the cosmological aesthetics of experiments with the solar and the elemental that emerge from the creative practice of Saraceno, and on the other hand to convey the force of envelopes as amplifiers or attractors in such experiments. In Saraceno’s aerosolar sculpture workshops, the process of sensing and working with the sun and the atmosphere becomes a distributed one: it takes places across bodies, devices, conditions and practices, and the lines, tethers, and relations that hold them together (Engelmann and McCormack, under review). The aerosolar sculpture amplifies the textures of an elemental field whose affects are felt on earth but whose provenance is solar and cosmic.¹⁰

For these reasons and others, Saraceno could be considered a “climate artist” (Engelmann and Saraceno, 2014; Galaragga and Szerszynski, 2012). As Galaragga and Szerszynski (2012) set out, a

⁹ Despret and Meuret write of cosmoecology and sheep herding practices: “Bodies, souls, pastures, steppes, cosmos, humans, sheep, dogs, horses, gazelles, and wolves are entangled in a net that connects the sky and the earth: ecology and cosmology are knotted in a common story, forming a cosmoecology of multiple beings, gods, animals, humans, living, and dead, each bearing the consequences of the others’ ways of living and dying” (Despret and Meuret, 2016: 25-26).

¹⁰ A crucial consideration in the development of more-than-human methodologies as set out by Dowling et al. (2016) is attentiveness to the limitations of prose / text in communicating research that explicitly reaches beyond the human; in this dissertation, imagery, film and poetic verse are used to better convey the qualities of solar-cosmic conditions and cascades.

climate artist is one who creatively and poetically collaborates with Earth's fluid envelope of gases, iso-surfaces, orbiting objects and zones of restriction and freedom. Indeed, as others have commented, the future that Saraceno's work enlists is one in which contemporary life and its architectures are exposed to, rather than sheltered from, the excess of solar energy flowing through molecules of fluid matter (Moe, 2015). This summons an architecture that is purposefully open, dissipative and exuberant (Moe 2014; 2015); one that engages "flow" not merely as an "aesthetic marker" but as part of an epistemological project (Kwinter, 2006; 2015). Indeed, the notion of collaborating with an entire planetary climate takes more-than-human symposia to another stage.

But Saraceno's ambition is even more cosmic than this. In 2015 and 2016, Saraceno launched the world's first fully certified human-carrying solar balloon, the *D-OAEC-Aerocene*, over the White Sands of New Mexico (Figure 1) and in Istria, Croatia. As will be elaborated in detail throughout this thesis, a solar balloon, or an *aerosolar sculpture* (as Saraceno prefers) is an aerostatic envelope that gains buoyancy by creating a difference in pressure between inside and outside its membrane using solar radiation. As the *D-OAEC Aerocene* ventures demonstrate, Saraceno's work engages solar-cosmic energy as a material and medium. Aerosolar sculptures are alive to cosmic energy in the way that the molecules of the Earth are alive to the 2000 amps of negative charge that propagate, at any given moment, in atmospheric storm-systems. Kirby (2011) elaborates that when a lightning bolt strikes, it is not simply the product of a charged tendril reaching down from a cloud, but rather: "a stuttering chatter between the ground and the sky" (Kirby, 2011: 10). Objects on the ground can initiate lightning strikes by producing upward moving "leaders" of invitation. In this way, lightning is "a stroke in which an entire field of energy rewrites itself" (Kirby, 2011: 12). As Clark (2010a; 2012b) following George Bataille has also pointed out, most contemporary architecture, design and society are passive to the excesses of radiation from our nearest star. Indeed such passivity is a dangerous stance in an epoch of increasing climatic volatility (Clark, 2010b). Saraceno's aerosolar sculptures are like "leaders" of invitation activated by light, heat and convection, *re-writing an entire field of energy* (see Thomson and Engelmann, 2015). As scholars including Szerszynski (2015) have noted, Saraceno's work is distinctly

Earthly, but it brings space and its energies closer to Earthly life. It is therefore a resource for engaging solar and cosmic energy, radiation and atmosphere as explicit concerns, rather than as mere background conditions, in more-than-human ethnography and geography.

Jol Thomson, a long-term collaborator of Saraceno's, once told me that the real material for Saraceno's artistic practice is energy (Thomson, personal interview, 2014c). Indeed Saraceno's frequent references to "synergy" echo the synergistic design pioneered by Buckminster Fuller, and are therefore reminiscent of technological utopianism (Epstein, 2012). But if Fuller's *Dymaxion* houses offered semi-autonomous and replicable units for fixed ecological dwelling spaces, Saraceno's pneumatic installations, aerosolar sculptures and hybrid webs are event-oriented. They are fundamentally weather and climate-dependent. And they are performed in daily intra-actions, all-day / all-night workshops and/or early morning launches. Therefore they also highlight an important feature of more-than-human as well as creative geographical methodologies: that is, attentions to events, atmospheres and processes.

As Tsing (2015) has explored in research concerning the largely hidden worlds of matsutake mushrooms, Choy (2011) on "air's substantiations" and Hird (2010) on microbial biomes, approaching inaccessible or ephemeral worlds necessitates inventive methods and a willingness to be lured by the propositions of half-glimpsed phenomena.¹¹ Thinking and experimenting with the phenomena emergent in Saraceno's diverse experiments, this dissertation enlarges more-than-human geographies of the multitude, the dark, the solar and the cosmic.

The Social

For Saraceno, and for this dissertation, the social is woven together with the cosmological. As such, the social is understood to operate with an aesthetic, ethical and political force transversal to notions of scale, species, or particular social spheres. Such a notion of the social is informed by developments in the social sciences that question the social as a sole provenance of the human, that

¹¹ See also Stengers (1997) on the work of Barbara McClintock, who was lured on conceptual and scientific adventures by the corn cells in her laboratory.

consider human-material cooperation and association as social achievements, and in this way challenge the presupposition of a sociality-materiality divide (Latour and Woolgar, 1986; Latour; 1999; Henkel, 2016; Marres, 2016). Latour's (2005) extensive work on a "sociology of associations" as part of the core arguments of Actor Network Theory ripples through geographical studies of wild(er)ness (Whatmore and Thorne, 1998), disease (Hinchliffe, 2001), infrastructure (Amin, 2014), and the "happening" of the social (Lury and Wakeford, 2012) to name only a few. This dissertation experiments with the assertion made variously by both Alfred North Whitehead and Gabriel Tarde that, "every thing is a society and all things are societies" (Tarde, 1999: 58 cited in Latour, 2005: 14). Yet it also proposes that not all societies are equally relevant, or equally alluring as companions for thinking and feeling the cosmos. Therefore this dissertation maps a spectrum of sociality and sociability that extends into the nonliving and inorganic, and is rendered explicit in the play of specific forms, namely surfaces, webs, envelopes and interstices.

How can we think of the social and the cosmological in aesthetic terms? The aesthetic technologies of surfaces, webs, envelopes and interstices are also, and importantly, social technologies. This is better expressed in a story Saraceno tells about one species of ballooning spider: *Stegodyphus dumicola*:¹²

... [for] this single spider to be able to fly, [the length of the thread] needed was seven hundred kilometers... and this meant nobody could understand how she will be able to fly. That was in two thousand and one. And after a while they find that many many spiders... thousands come all together on the top of a tree. And they start to release all [of] the threads. Remember they are blind. They are blind, they are deaf, and they release all [of] these threads into the air. Now the air starts to blow. And there are thousands of them. But somehow the air currents start to weave these threads, which are quite long right? They connect one thread to another. All at the

¹² Saraceno repeats this story often in interviews, presentations and studio visits. It is a way for him to link his "webbed" or knotted artworks with the aerial, floating sculptures of the *Aerocene*. This particular telling of the story occurred during a joint presentation with Bronislaw Szerszynski at the Haus der Kulturen der Welt in Berlin in October 2014.

same time. This means the atmosphere, or the air currents, the thermics, are the currents which weave this carpet. And at one moment this carpet is [woven], and all of [the spiders] feel it. They are not social spiders in this case but they become social by being in the air... the air might help them to become social. This means they take off all at the same time. And the atmosphere weaves this web. I thought this was a nice transition to the [concept of] Becoming Solar, which is something we are trying to weave out between Bron [Szerszynski] and Sasha [Engelmann] and Bruno [Latour] and many other friends. (Saraceno and Szerszynski, personal recording, 2014)

Although they are blind and deaf, the spiders sense atmospheric turbulence and thermic properties through the silken extensions of their bodies. It is also these sensory and bodily extensions, woven into a “carpet,” that allow them to become airborne together, to achieve what alone would be impossible. As Saraceno emphasizes, these spiders do not normally socialize: that is, they don’t build and maintain webs together like species of “social spiders”.¹³ Nevertheless, the air helps *Stegodyphus* weave a collective, sensitive web: to become social. And as their silken threads fly and connect to each other, sensing and socializing become practically the same thing.

Yet this is not without peril. As the thousands of spiders collectively lift off from the tips of the leaves on which they are holding, they undoubtedly feel something they have never felt before: the force of solar-cosmic energy pulling them skyward. As Saraceno commented after he piloted the *D-OAEC Aerocene* in White Sands, NM: “it felt like skydiving, but away from Earth’s surface” (Saraceno, personal communication, 2015b; Engelmann, 2016; Figure 1). The style of aesthetic and social experiment conjured by Saraceno is one of weaving-into forces and fields that are far more distributed and complex than ordinary human or spider bodies can immediately intuit. As Lorimer (2006) stated beautifully in his study of humans and reindeer: “in the conjoined, sinewy lines... we find other matter, other properties, and other forces drawn into the realm of ‘the social’” (Lorimer, 2006: 516). For Tomás

¹³ The specific webs of social spiders will be considered in more detail in the following chapter and in the empirical chapter on hybrid webs.

Saraceno, *Stegodyphus* spiders, and for the experiment of this dissertation, an account of the social draws in lines, matters and forces of solar, atmospheric and cosmic origin.

In a publication produced on the occasion of Saraceno's exhibition *Cosmic Jive* at Museo d'Arte Contemporanea di Villa Croce, Genova, Joseph Grima (following Cedric Price) wrote that in an age of accelerated innovation, we have constructed answers to questions that we haven't yet learned to ask (Grima in Saraceno and Pezzato, 2014: 98). The Internet, for example, is a technology for socializing, and it is in some ways the answer to the question of how to be social. But it may be that we have not yet asked the right question, or got our heads around what the social really is, what it means to share an *Umwelt*. Saraceno's installation *On Space Time Foam* (2012-3), his *hybrid webs*, and his *aerosolar sculptures* are experiments in the social. In particular, what is produced in the middle of each *hybrid web*, what is excessive and overflowing, is a sense of the complexity of social being: of maintaining one's shape while giving structure to another. Being social requires sensitivity, orientation, tension, and flexibility. It is less a matter of mingling, mixing or associating, than of an entering into disjunctions, transactions and syntheses.

What would be the right question? Maybe it would be: what is a social technology? Or maybe it would be how the qualities of the connections we experience facilitate our awareness of them. Saraceno purports that his installations produce patterns of sociality that transcend human, nonhuman and material registers. He states the following about the large-scale installation *In Orbit* (2013):

This is what I enjoy the most—seeing this new language emerge, speechless, instinctive bodily basics that are common to all living humans, animals, and inanimate objects, where movement drives one towards a certain synchronicity with others in this socially, mentally, physically dynamic environment until a common pattern emerges. We begin to share responsibility; we witness how our behavior affects the behavior of others. How this network of interrelatedness stems from a single string perpetuated along a whole network of strings, forming the net you are walking on ... (Saraceno in Ackerman et al., 2011: 45)

For Saraceno, the potential of spaces and forms to provoke bodies, movement and thought into new social configurations cannot be underestimated. A net that encourages and cultivates such configurations is for Saraceno the ultimate social technology. He begins: “This is what I enjoy the most – seeing this new language emerge”; my experience can attest that this is undoubtedly true. During an excursion to *In Orbit* at the K21 Ständehaus Museum in Düsseldorf in Winter 2015, I witnessed Saraceno lying on the nets of his five-story-high sculpture, cradling a film camera for several consecutive hours, as one after another two hundred architecture students in our jointly-taught class stepped shakily onto the new surface (Figure 2).



Figure 2: Tomás Saraceno filming IAK Students in December 2015 traversing the installation *In Orbit* (2013-) at Kunstsammlung Nordrhein-Westfalen, K21 Ständehaus, Düsseldorf.
Photography by Sasha Engelmann.

Saraceno recounted afterward how each person's facial expression changed dramatically once they stepped onto the net – many closed their eyes or looked horrified or surprised. To be sure, in traversing the installation the students were feeling each other's vibrations and movements. However, in the

exhibition rooms lower down in the gallery there were open wire frames with colonies of *Cyrtophora* (social spiders) who had established themselves in the museum. The proximity of these other beings whose webs so closely resembled those of *In Orbit* provoked many of the students to ask questions of their own instincts on the installation surface. Were they spiderlike? Were they communicative? Did they shift and change the space? Did the vibration affect the way they breathed? The overwhelming consensus was that the space had challenged them to suspend their habits and reference points, their speeds and modes of balance, in order to become sensitive to a communicating medium with flexible, topological contours.

The multi-species societies cultivated by Studio Saraceno are numerous, from *Spider Salons* (2015-) to *hybrid webs* to the *Arachnid Orchestra* (2015). In a *Spider Salon*, for instance, one learns about spider communication by actually playing frequencies to a spider and listening to what it “plays” back. This occurred in one instance in a public performance at the Haus der Kulturen der Welt in Berlin, when Saraceno gave a public lecture while several *Nephila* and *Tegenaria* spiders plucked a shared web; the vibrations of the spiders were amplified into the auditorium, making insertions into Saraceno’s lecture. On several occasions, noteworthy musicians (including Evan Ziporyn and David Rothenberg) visited Studio Saraceno in order to play different instruments together with the spiders. In such experiments, there is a degree of multispecies sociability and reciprocity that is rare in spheres of art, natural science and geography. The critical point is that the social is worked through cosmological practices that place human and nonhuman practitioners in relation to a common medium that transmits sensation, articulated most often in frequency and vibration. Such practices, and the social propositions they make, are not only relevant for the scientific fields of inter-species communication and group behavioural dynamics (Saraceno has contributed to scientific work in both of these fields).¹⁴ They are

¹⁴ Saraceno has contributed to new research on bio-acoustics and seismic communication, working primarily with Dr. Roland Mühlethaler in Berlin. Saraceno has also recently begun an exciting collaboration with the Department of Collective Behaviour at the Max Planck Institute in Germany, especially with Dr. Ian Couzin, and Dr. Alex Jordan. Couzin and Jordan are scientists studying complex and coordinated behaviours that result from social interactions among individual creatures: from fish schools to animal migrations to social spider colonies.

also relevant for practical and imaginative extensions of horizons of the social informed by a dramatic spectrum of multispecies encounters.

To Cast Away

The cosmological aesthetics elaborated in this dissertation and rendered explicit in Saraceno's atmospheric experiments can inform geography and the present geographic "cosmic epoch" (Whitehead, 1978[1929]). Cosmological aesthetics is articulated in a short speech given by Saraceno when, late at night, after many hours constructing aerosolar sculptures in the Institut für Architekturbezogene Kunst (hereafter IAK) in Germany's Querumer Forest, a group of students, teachers, artists and technologists gathered in the tiny kitchen for some food and conversation. Saraceno stood over a table of crowded objects and plates, pens and notebooks. He told one of his favorite stories about flying in the gondola of an aerosolar sculpture. While flying, he says, he is talking to someone else in the gondola, but also noticing that their hair does not move at all – it is perfectly still. Such is the experience of "stillness in motion" also articulated by famed balloonist and aviator Alberto Santos Dumont and theorized for geography by Derek McCormack (2009). Saraceno recounts how he looked down from the gondola and, to his surprise, sees trees shaking violently below. Then he says:

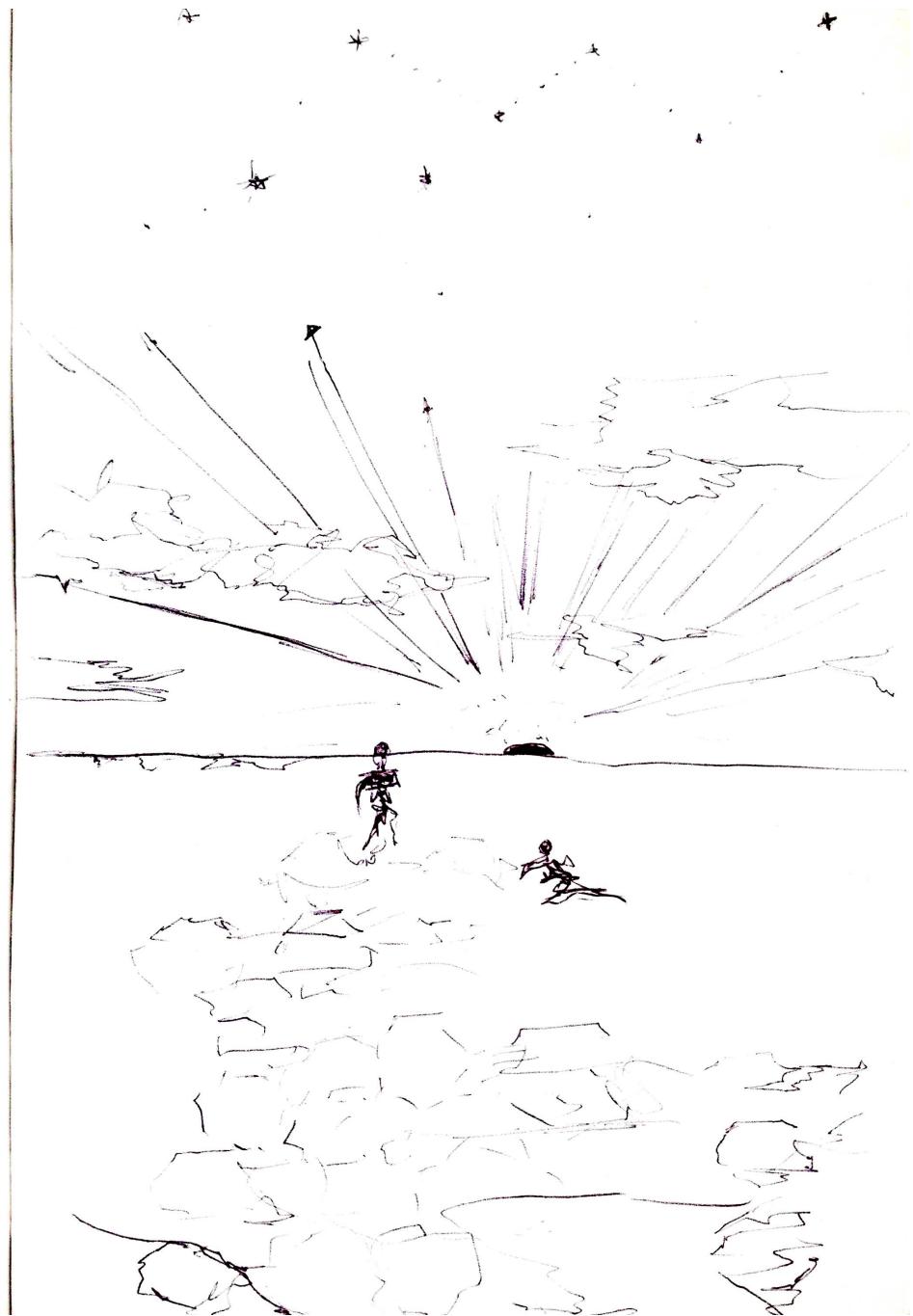
So, how can we describe the wind, as something that we don't feel anymore in our faces, we don't see our hair moving, but we see in the distance that the wind is producing something we don't feel anymore, you know? That's something that could help us to understand the Anthropocene... we can start to see there will be a big change, and we explain it in graphs, the heat is rising, and we can see it, but we cannot feel it. What we are trying to do here, somehow, is to feel it. (Saraceno, personal communication, 2014)

What I believe Saraceno related in this statement is the notion that a physical and aesthetic experience can create tangible, sensible relations with contexts that are far removed, or much wider than, the particular conditions in which we experiment. In other words, how can we sense something at a distance? Or phrased slightly differently, how can we devise ways of thinking and working that make us

sensitive and responsive to phenomena far removed across spaces or scales? These are some of the fundamental questions that animate the particular aesthetics of Saraceno's practice. They are also questions that surface in various guises in discourse on the epoch of the Anthropocene.

Saraceno hints at the notion that it is possible to invent circumstances and experiments that produce real, concrete evidence of otherwise imperceptible entities and conditions. This possibility, as Saraceno asserts, has relevance for how we think and theorize the Anthropocene, and indeed, the degree to which certain predictions about the Anthropocenic age are inevitable or not. Saraceno's repeated insistence on re-naming the Anthropocene as the *Solarcene* or *Aerocene* reflects his conviction that the graphical constructions of warming temperatures, rising sea levels and ecological collapse offered by experts are only *one form of possible evidence* of what a new age – a new thermodynamic age – might hold. Another form of evidence might be purely sensual, and its very enactment might make different futures possible.

The bringing together of cosmic, elemental, ecological, social, vibratory and poetic phenomena in collaborative ventures is the project of Saraceno's webs and the achievement of the cosmological aesthetics he cultivates. It is also a project that wishes the world to become otherwise. It asks where art can create interventions in the eco-political textures of the present. In contrast to the vast majority of other writing on Saraceno's work, which frames his oeuvre in the terms of utopia, sheer innovation, or environmental and ecological art, I will discuss Saraceno's artworks as propositions for bodies to be sensually, socially and politically extended. Such propositions are not utopic or fantastical; they offer a spectrum along which sensation and participation is attracted and congealed, a spectrum along which worlds are made and unmade. This does not mean that such propositions are always successful, equally generous, or unproblematic. However, they force thought on questions that are also at the heart of the cosmological discipline of geography: questions that address the liveliness of more-than-human societies in a vast and vibrating cosmos.



Interstice I: Drawing of two figures in the sunrise in the Salar de Uyuni, Bolivia, January 2016. For two weeks Tomás Saraceno, Tato Chavez, Daniel Schulz, Tobias Lange, Bernd Pröschold, Jan Hattenbach, Jol Thomson, Maximiliano Laina and Sasha Engelmann made films, watched stars, launched sculptures and got lost in the Salar de Uyuni. It was in the context of this site and expedition that cosmological aesthetics was formulated. Expedition commissioned by MARCO, Museum of Contemporary Art of Monterrey.

Drawing by Sasha Engelmann.

Literature Review: From Geographical to Cosmological Aesthetics

Cyrtophora

A colony of Cyrtophora spiders huddle in the center of a finely meshed surface. They are small creatures, with tiny round abdomens and legs that curl against their bodies. When they move, they sprint and rest, sprint and rest. They inhabit several platforms of horizontal mesh “tents,” which they built together, and have repaired over time.¹⁵ White sacks are embedded in vertical strands that connect the platforms: prey that have been desiccated and wrapped in silk. As egg sacks hatch and the colony grows there may be dozens of spiders inhabiting the platform-like webs, co-producing, co-inhabiting and sensing a shared world.¹⁶

Introduction

This colony of *Cyrtophora* spiders are the creaturely guides with which I have come to understand the process of writing a literature review for this dissertation. In an oblique sense, geographers are not unlike the *Cyrtophora* spiders in the passage above: creatures engaged in relations of tension between surfaces and depths, planes and folds, and the myriad ecological and social encounters entangled in them. In another sense, the process of writing a literature review is akin to that of spinning a web in a three dimensional space together with a group of willing collaborators. This literature review, like the tent-web of the *Cyrtophora*, is the strata onto which my work is “lodged” (to paraphrase Deleuze-Guattari), or a surface on which this dissertation holds. Indeed, any literature review, like the colony of *Cyrtophora* spiders, is a social affair.

¹⁵ Of the 40,000 known species in the *Aranae* order, *Cyrtophora* spiders are one of only 40 known social spider species. Unlike the vast majority of other arachnids, *Cyrtophora* collaboratively build, maintain and inhabit their webs, which have an appearance somewhat like a tent or mesh-surface poised in the middle of an open space. *Cyrtophora* will reappear in Chapter 5.

¹⁶ Excerpt adapted from field notes made by author at Studio Tomás Saraceno, 28 March 2014.

In the pages that follow I will collect the thinkers and concepts with which I collaborated in formulating a resource for addressing the artwork of Tomás Saraceno as it provokes notions of scale, the more-than-human and the social for geography. This resource is cosmological aesthetics: a concept that already shimmers across geography in research and writing that “listens” to the imperceptible (Kanngieser, 2015: 82), identifies “non-local” forces (Yusoff, 2015) and, “seek[s] to reach... toward the constitutive unknown forces of the Earth” (Bosworth, 2016: 5). The first proposition of cosmological aesthetics in relation to these rich discussions is the following: if we are able, indeed if we *must*, allow geographic thought to be affected by the unknowable or imperceptible “forces of the Earth,” then we are already primed for thinking-with webs of dark matter, solar-energetic cascades, and the various in/audible vibrations of our atmosphere and our cosmos in practical and creative ways. As a discipline, geography is already inviting the kinds of aesthetic experiments that place a *Nephila* and a galaxy in the same sensitive web. The second important proposition is that the capacity to be lured by “unknown forces”, or to be affected by sensation that travels beyond the limits of human sensation, always depends on concrete practices held together by what Stengers terms “obligations” (Stengers, 2005; 2013). Such obligations performed in diverse modes of practice enable the cosmological experiments in which aesthetic adventures occur.

This chapter begins by weaving together assertions of the role of artistic “world-making” practices in geographical history and thought. It moves then to air and atmosphere as contexts for cosmological aesthetics, engaging with academic scholarship on atmosphere in human geography, as well as examples of contemporary artworks contributing to notions of atmosphere. For the purposes of this dissertation, an atmosphere is an entity whose affective and meteorological qualities cannot be dissociated. An atmosphere is a cosmological entity since it has (and is) a gathering force for diverse sensory experience. The chapter briefly details the creative story of Tomás Saraceno as an atmospheric artist. The chapter then concludes with an articulation of the qualities of non-human, post-human, geologic or geomorphic aesthetics that resonate with the project of cosmological aesthetics, while also elaborating how the latter productively extends conversations on aesthetics in human geography.

Weaving Geographies of Atmosphere, Art and Aesthetics

Alexander von Humboldt is an obvious figure with which we can begin a geographical foray into atmosphere, art, aesthetics and the cosmological that support the arguments in this dissertation. The young Humboldt learned to apply “new organs” of poetic attention from working with the poet Johann von Goethe (Wulf, 2015). As cited in work on “Humboldtian aesthetics” and geopolitics (Dixon et. al., 2012; Marston and de Leeuw, 2013; Hawkins, 2013b), Humboldt advocated for both artistic and scientific methods in knowing, sensing and depicting the world. Phrased differently, Humboldt invented a new form of attention to what Despret and Meuret (2016) call “cosmoecological” worlds. For Humboldt, Goethe’s poetic verses were as great an epistemological achievement as the theories of biologists (Wulf, 2015). The two by three foot map named *Ein Naturgemälde*, produced by Humboldt after his first journey across South America, and collecting information on species-regimes and climatological zones of the Chimborazo Volcano, was a work of art as much as a work of science. It was a work of art not only because the *Naturgemälde* employed stylistic, aesthetic and descriptive techniques, but also because it created a “rupture” (Deleuze, 1981/2003; Guattari, 1992/1995) in common notions and significations of environment and ecology. I will further explore the concept of artwork as “rupture” in the sections that follow.

Humboldt’s sentiments echo more than a century later in Sir Francis Younghusband’s comments that a geographer should possess, “*something* of the poet and the painter” (emphasis mine; Younghusband, 1920 cited in Hawkins, 2013b: 30). But what is this “something” of poetic and painterly work that a geographer should cultivate? The answer came initially in the notion of an optical discernment, or a, “seeing eye” that formed the core of the “new cultural geography” emergent in the 1980s and 90s.¹⁷ This period witnessed geographers turning toward literary description and painting to negotiate culture’s co-production of landscape. Still, it was from within the exuberance of the

¹⁷ Although, as Gillian Rose (2003) has argued, geography has become a “visual discipline” without the healthy critiques of such visuality prominent in the other “visual” fields of anthropology and art history.

“humanistic” geography of the 1980s that Donald Meinig soberly stated: “Geography will deserve to be called an art *only* when a substantial number of geographers become artists” (emphasis mine; Meinig, 1983: 325). According to Meinig, geographers had yet to truly “explore” the humanities, “handicapped” by the lack of “skills and tools” of art practice (Meinig, 1983: 325). Although many have interpreted Meinig’s comments as an encouragement of arts practice within geography, it is also, and I believe primarily, a precision on the difference between the analytical, the interpretive and the creative / experimental. These different approaches separate humanistic geography from the production of art in the humanities. They also distinguish creative production based on predefined cultural categories such as figuration and abstraction, from the far-from-equilibrium, “unframing” practices that constitute arts of rupture (Guattari, 1992/1995).

The radicality of Meinig’s precision on what a geographic art practice would entail, is better grasped when we consider the relation between art, rupture and knowledge. According to Grosz (2008) following Deleuze, art is a *force* that makes space for new kinds of thinking and experiment in the world, and which is generative of different intensities and forms of affective encounter. In other words, artworks generate “shocks to thought” (Massumi, 2002): they agitate the atmospheres of everyday life. Deleuze (1981/2003) and Guattari (1992/1995) elaborate that we exist in a sea of clichés or cultural uniformities – stitched in the fabric of late capitalism and its tools of marketing, our surroundings are composed of forms, objects, symbols that we learn to categorize and interpret. Artworks, Deleuze writes, create “glitches” in this system of clichés, unsettling interpretations, heightening feelings, and altering the fabric of space-times (Deleuze, 1981/2003). For Guattari: “The work of art... is an activity of unframing, of rupturing sense, of baroque proliferation or extreme impoverishment, which leads to a recreation and a reinvention of the subject itself” (Guattari, 1992/1995: 131). Art unsettles our daily habits of “making sense”; it operates to produce an “affective-event” (O’Sullivan, 2009). Geographers who turn to the arts must become open to events of unsettling, even those that destabilize the disciplinary frameworks we learn and hold dear.

Artworks don't only unsettle and rupture our associations to images, symbols, signs and other referents of disciplinary knowledge systems: they do the same to culturally and historically ingrained dispositions toward matter, energy and the living world. As expressed poetically in the work of Dewsbury and Bissell (2015), Anna Tsing (2015) and Vincianne Despret (2013), dispositions toward environment and nonhuman creatures are passed on tacitly in bodily postures, in inflections of language, in habits of thought and action, and in differential practices of care and violence. Artworks offer productive sites for (re)mapping and (re)orienting such implicit or explicit dispositions. Moreover, artworks can accomplish this by producing and acting as *lures*, drawing bodies toward phenomena that are at the edge, or beyond, their normal capacities for interpreting the world. The cosmological aesthetics set forth in this thesis articulates how particular artistic encounters with air and atmosphere, dark or "exotic" matter, and solar-cosmic energies shift bodies into different modes of sensitivity toward materials and phenomena far removed across spaces and scales. In this way, artworks have particular purchase for geographical and cosmological knowledge practices.

There is an immense variety of scholarship that we might enroll in defining the axes of geography-art relations. Human and cultural geographers including Sallie Marston, Sarah De Leeuw, Felix Driver, Deborah Dixon, Matthew Gandy, Divya Tolia-Kelly, Jennifer Gabrys, Kathryn Yusoff, Elizabeth Straughan and Harriet Hawkins have all in various ways mapped the inter-permeabilities of geography and the arts. Hawkins in particular has identified a few evolving problematics for geography-art engagements. For Hawkins, it is important that artwork is understood to mean more than a finished or discrete object. Rather:

Art is explored here as an ensemble of practices, performances, experiences and artefacts rather than as a singular 'object' (a painting or a sculpture) (Dixon, 2008; Hawkins, 2010c). This attentiveness to art practices in addition to the 'finished' object points to understandings of 'art' as a site where 'new multi-dimensional knowledge and identities are constantly in the process of being formed' (Rogoff, 2000). As such art has much to contribute to the development of geographical knowledge and to the formation of geographical subjects. (Hawkins, 2011: 465)

In *For Creative Geographies: Geography, Visual Arts and the Making of Worlds* (2013b) Hawkins explores themes through which geographers have worked with art. Her emphasis on artistic practices as practices of world-making resonate with the cosmological approach of this dissertation. Hawkins' themes are divided along the terms of landscape, critical spatialities and participation, and within them what she identifies as, "dialogues" and "doings" (Hawkins, 2011; 2013b). It is possible to diagram geography-art intersections in a myriad of ways, but here I will highlight a few key threads that resonate and run transversal to those cast by Hawkins. These transversal coordinates are not exhaustive but are simply those that have most informed my own research and writing.

The first resonating thread is art as a worldly dataset. The propositions of artworks have been widely understood as "proxy data sets" (Dixon et al., 2012b: 229), as "packet[s] of information" (Harriet, 2013b: 26) or, "nugget[s] of experience" (Meinig cited in Hawkins, 2013b: 25). This is likely the most common way that geographers have engaged with art. It involves turning towards art as source material, as a perspective or reflection on the world, and is exemplified in much of literary geography's use of fiction or historical writing to grasp dispositions toward landscape (Marson and De Leeuw, 2013). While this style of engagement with art was prominent in geography's "humanist renaissance", especially in the work of Cosgrove and Daniels (1988), Cosgrove (1985; 1989; 1994), Rees (1973; 1982) and Tuan (1976; 1990) among others, it continues into the present. It is safe to say that the majority of articles addressing the work of artists in the social sciences, whether the artwork addressed is of a more representative nature as in Thorne's (1999) study of climatology in the paintings of Constable and Turner, or whether it bends and troubles the zones of art, science and experiment as in the case of bio-art or nano-art (for example in Dixon et al., 2009), we find art employed as material or lens through which scholars elaborate on a geographical aspect of the world. What is at stake here is that art continues to be a site where geographers turn *momentarily* in order to re-turn to the discipline to make more serious, enlightened comments. This is not the same as artistic work actually being *intrinsic to* the field, as Meinig suggested over thirty years ago.

Within this thread's trajectory, we can point to several ways geographers have turned to art, and especially performance art, as an important source of conceptual provocation. First, geographers have explored what artworks offer for expanded and performative notions of touch or the haptic. Here we can think of Crouch and Toogood's (1999) study of the "everyday knowledge" of abstract artist Peter Lanyon. Lanyon's expressive painting technique suggests a "tactile knowledge" of the world rather than, "an explicit topography constituted through surveillance, perspective and detachment" (Crouch and Toogood, 1999: 72). More recently geographies of touch as outlined by Paterson (2009) have included the reading of bodies' dynamic intimacies in Jenny Saville's large-format paintings (Colls, 2012) and the development of tactile "nano-imaginaries," as explored by Hawkins and Straughn (2014). To be precise, Hawkins and Straughn (2014) destabilize the "art as dataset" style of engagement by presenting rich description adapted from the experience of the art exhibition to blur the boundary between creative practitioner, researcher and reader. More generally, geographies of the non-visual have drawn insights from the work of performing artists, for example in the case of Straughn's (2014) research on the olfactory performance by Hagen Betzwieser and Sue Corke. Highly significant here are the growing attentions to music, for example in a special issue edited by Ben Anderson, Frances Morton and George Revill including articles on the spatiality of vernacular music (Revill, 2005) and on the trance music in Goa's rave scene (Saldanha, 2005). Various scholars, myself among them, have advocated for a wider attention to sound or "affinitive listening" (Adey, 2015) as elaborated and performed in contemporary art works (Engelmann, 2015a; Gallagher et al., 2016; Kanngieser, 2015). Such scholarship is allied with a methodological focus on rhythm (McCormack, 2004) and rhythmanalysis (Simpson, 2008; 2012). Each of these various geographic engagements with artistic performance take the artwork or site as a kind of worldly dataset, albeit one that is not static, but ripples through both geography and art.

Furthermore, geographers have amplified feminist approaches to the aesthetics and politics of the "seeing eye" through the resources of artworks. In this space Gillian Rose is an eminent figure. Although her work is more firmly located in feminist critiques of visuality, image-making and image-circulation in geography (Rose, 2000; 2003) she has arguably done more than any other geographer to

elaborate visual methodologies (importantly, *audiencing*) that ripple into geographic attentions to artworks (e.g. Warren (2013) on James Turrell's *Skyrooms*). Nash (1996) also echoes Rose in her critiques of the gendered politics of the gaze through a consideration of the male body in the work of two female artists. In the sphere of narrative Sarah De Leeuw (2012) has elaborated contemporary geographies of colonialism through poetic and sensual attention to the archives of early twentieth century settler women. Dixon (2011) has explored the sounds, and specifically the screams, of the monstrous through a feminist lens on dramatic performance and media. The aforementioned Colls (2012) article on Jenny Saville's paintings mobilizes Luce Irigaray's concept of the mucous to rethink portrayals of intimacy and proximity. Likewise, in recent work Hawkins' (2015) re-maps the roles of light, sight and the visual by employing Irigaray's engagement with Merleau-Ponty and the installations of Pipilotti Rist. Non-geographers have made important interventions in this conversation. Here we might recall Irit Rogoff's geographically informed study of Anna Mendieta's earth-printing performances, posed against the work of male-dominated earth-art (Rogoff, 2000); or the work of Kathleen Stewart (2011; 2014) and Sara Ahmed (2016) on affective architectures of feminine voices. The series of sessions termed "Feminist Geophilosophies" at the 2015 American Association of Geographer's meeting in Chicago, convened by Kathryn Yusoff, Angela Last, Mary Smith, Sarah de Leeuw and Nigel Clark, made a variety of subtle and more explicit gestures to the work of poets, storytellers and multi-media artists as opening up alternative, feminist, or non-visual capacities to sensing the geologic and the cosmic.

In another important sense, geography's engagements with art have implicated the researcher's as well as the reader's sensory abilities, emotions, and affective states. This style of work is similar to the aforementioned scholarship concerned with art as material or data, but places emphasis on the researcher's body and/or mind as altered by the experience of art. In this style of work, the researcher's and sometimes the reader's body is understood to be an instrument of creative research. Tolia-Kelly (2007), for example, finds participatory drawings and paintings composed by migrant workers in the Lake District as, "representing the values, sensory meanings and embodied relationships that exist for

migrant communities with this [very English] landscape” (Tolia-Kelly, 2007: 330). Gibbs (2014) advocates for embodied research methods as particularly valuable in site-based art-science collaboration. In my empirical work on Dryden Goodwin’s urban art installation *Breathe* (Engelmann, 2015b), I engaged with the artwork as a force on physical, affective pre- and unconscious sensory registers by writing and drawing-with the urban artwork. What differentiates this body of work from that of “art as worldly dataset” is its attentiveness to the sensual and embodied “shocks” generated by art encounters, and the willingness to make these intensities of experience explicit in writing (even in journal articles). Of course, all geography-art engagements implicate the researcher and reader’s physical, affective and emotional condition; the distinction is to what degree such implications are registered and permitted to enter the space of reflection and publication.

A third zone of geography-art relations that I hinted to at in the beginning of this chapter is the engagement with art as a model of knowledge production that is not opposed to those of the natural and physical sciences, but permeates such disciplinary spaces to co-constitute knowledge on environment, energy and atmosphere. Born and Barry (2010) delineate several “logics of interdisciplinarity” through which artists and scientists share practices; they privilege “public experiments” where both disciplines allow their knowledge systems to be reframed by their encounter (Born and Barry, 2010). Yusoff and Gabrys (2011) argue that imaginative practices – in which they collect images, installation and land-art – enfold valuable insights on environmental change and can meaningfully contribute to the modeling of scenarios in different climatic futures. The blurring of disciplinary boundaries in knowledge production is particularly expressed through a body of work on *making as a way of knowing*. For example, the act of composing and capturing photographic images and films, alone or with others, is imbued with countless decisions that can be unpacked in intervallic or processual terms (Williams, 2016). In this vein, Garrett (2011) and Garrett and Dekeyser (2015) have employed videos to address artworks that are sited in urban margins and/ or subject to immanent destruction. In their work, the videos function not only as evidence of the process of research, but as animate archives of their collaboration with urban-

artistic ephemera. In cultural anthropology, Tim Ingold has written beautifully about making kites as a way of learning a tactile phenomenology and meteorology of “things in the air” (Ingold, 2009).

Hawkins defines “creative geographies” as those instances, “where geographers collaborate with artists or curators to make-work, carry out research, develop exhibitions or practice various different creative techniques” (Hawkins, 2011: 465). In contrast to artistic research in which art offers information, inspiration, awareness of feeling and emotion, or new approaches to knowledge production, creative geographies place researchers in the very messy middle of arts practice. In the process, the “handicaps” mentioned by Meinig can become instructive sites for attachments and obligations between geographers and artists (see Parr, 2007; and this dissertation). Some of the most interesting work in creative geographies has explored, “rhythms, cycles, events, encounters, movements and flows, instincts, affects, atmospheres and auras, relations, knots and assemblages” (Hawkins, 2013b: 34). In other words, creative geographies attend to the non- or more-than-representational elements and textures of art practice, the interstitial zones and affects from which creative process emerges. I situate my own work within creative geographies since, as I will outline further in my methodology, I joined in the everyday practice and experiments of Studio Tomás Saraceno over two years, and participated in the invention of practices, especially relating to teaching and fabricating aerostats. Moreover, a large portion of the work I will present in this dissertation is a creative geographical experiment in which I practice art as much as Tomás Saraceno and his studio team practice geographical research. Before further developing the resources for geographical and cosmological aesthetics mobilized in this dissertation, here I will review some geographical and artistic work that engages the atmospheric, and trace a personal creative history of Tomás Saraceno.

Atmospheric Art

The artwork of Tomás Saraceno is decidedly atmospheric. But what exactly is an atmosphere? As stated briefly earlier, an atmosphere is a conditioned and conditioning entity whose many affective, meteorological and physical qualities cannot be disentangled. An atmosphere performs suspension,

condensation, weight and lightness, density and flow, traveling between affective and physical registers. I cannot claim such a definition of atmosphere as my own, since it has been taken in various directions by Adey et al., (2013), Anderson (2009), Anderson and Ash (2015), Bissell (2010), Choy and Zee (2015), Edensor (2012), McCormack (2008; 2009), Shapiro (2015) and Stewart (2011) among others. As Choy and Zee (2015) argue, the recent surge of interest in the notion of the atmospheric in the social sciences might have something to do with the distinctly atmospheric predicament posed by the Anthropocene. Their argument, like mine, closely links “air” with “atmosphere,” but uses “air” most often for physical description, while “atmosphere” has more abstract, affective and aesthetic connotations. In this dissertation, atmosphere holds together the aesthetic, ethical and political qualities of mobility, immersion, and the alluring experiment of becoming-buoyant.

There are different philosophical and creative ways to think with air and atmosphere in human geography, outlined in a special issue on “aerographies” (Jackson and Fannin, 2011; Olwig, 2011). The special issue (edited by Mark Jackson and Maria Fannin) included texts on the phenomenology of fog (Martin, 2011a), the ghostly poetry of Paul Celan (Groves, 2011), and the aesthetics of emptiness in James Turrell’s “Skyrooms” (Saito, 2011). Jackson and Fannin also cite Robert Barry’s *Ideal Gas Series* (1969), Yves Klein’s “air architecture” (1958) and HeHe’s *Nuage Vert* (2013) among other creative experiments with air (Jackson and Fannin, 2011). Thus, in attempts to articulate and organize geographic thinking on air and atmosphere, and to propose “aerography” as a necessary complement to studies of the “geo”, artworks are productively enrolled. One reason for this may be that artworks can generate new (and hybrid) situations, terms and metaphors for thinking through the (im)materialities of air and the elemental (Gabrys and Yusoff, 2012; Stengers, 2005; Whatmore, 2013). Another might be that artists enlist metaphor, simile and other figurative devices to convey the, “complex somatic sensations” of airy experience (Paterson, 2009). While much scholarship has focused on air’s status as a technically or politically enrolled material, much less attention has been paid to its aesthetic resonances (Adey, 2013; Barry, 2001; Williams, 2007). A project attentive to the poetic and aesthetic dimensions of air does not turn away from questions of the social and political, but explores the ways air and

atmosphere gather and organize capacities for feeling (Dixon et al., 2012a; Serres, 2008). Artworks that explicitly collaborate with air, opening up spaces of atmospheric attunement and sensibility, offer rich conceptual resources for geographers interested in aesthetic intensities born by air and atmosphere.

There are many ways of approaching atmosphere, as evidenced in the “atmospheric methods” of Anderson and Ash (2015) or “atmospheric things” of McCormack (2014b). Art practice is one way to attend to the simultaneous visible and invisible, affective and physical qualities held together in atmospheric experience. In the geographically important tradition of landscape painting, from Turner to Constable to Freidrich to Thérèse Oulton, gestures of marking produce strikingly different renderings of weather, climate and airy events.¹⁸ Such a history is too long and varied to attend to deeply here, and has been detailed by others, particularly Thornes (2008). Many contemporary artists work with the atmospheric and the meteorological through processes of drawing, printing and animation. Cynthia Lin, for example, creates enlarged, highly detailed pencil drawings of dust and microscopic entities. In contrast, Julie Mehretu’s *Gray Area* (2007-2009) series is a meditation on the history of conflict and occupation of space in Berlin; each piece incorporates myriad swarms and flight paths, indicating the palpable atmospheres of transition in places like Berliner Platz. Installation artists Lola Guerrera and Berndaut Smilde capture ephemeral, ghostly photographs of clouds that they produce using contraptions of mist, smoke and dust. Olafur Eliasson employs fog and light to generate the spectral conditions of weather events in *The Weather Project* (2008), a moving, miniature rainbow in *Beauty* (1993), or cultivates a wall of Icelandic moss to diffuse a room with a specific scent and humidity (Eliasson, 2007). The materiality of air was conveyed in the large-scale animation *Breathe* (2013) by Dryden Goodwin; this animated work, illustrating a child’s body in a visceral rhythm of respiration on a twelve minute

¹⁸ Turner’s paintings record the chromatic splendor of the 19th century London Smog events in strokes of cadmium red with a palette knife; in contrast, Kaspar David Friedrich’s *The Monk By the Sea* (1808-1810) is an almost formless gradation of atmospheric hues, placing the viewer herself, “on the threshold of those shapeless infinities” (Rosenblum, 1961: np). From Turner and Freidrich one can trace a line to Rothko, whose 1954 painting *Light, Earth and Blue* is missing a human figure precisely because the viewer herself has become the monk before the sea, absorbed by the “shapeless infinities” (Rosenblum, 1961). From Rothko we might leap to the *Territory* (2009) paintings of contemporary landscape artist Thérèse Oulton, paintings that depict shorelines and fog-drawn hills, terrains that have a quality of being almost anywhere. The precise rendering of surface texture in Oulton’s works reveal different patterns of organization, so that the viewer is no longer standing before a shapeless atmosphere, but hovering, or in a state of permanent vertigo, or in free-fall.

video loop, was projected onto a scaffolding eight meters high on the roof of Gassiot House at St. Thomas' Hospital in London in October 2013.

Through encounters with artworks, viewer-participants sense the texture of the particles that make up airy-atmospheric bodies, despite the fact that these are invisible to the human eye. Saraceno's artworks invite people to walk, slide and climb across semi-permeable, transparent, shifting surfaces; or to participate in the fabrication of a sculpture that will become lighter-than-air. Such artistic experiences formed from the compositional attachments of practitioners, sculptures, organisms, energies, forces and media, necessitate the vocabulary of cosmological aesthetics that I develop in this dissertation.¹⁹ A different kind of cosmological aesthetics of the atmospheric is found in the work of Amy Balkin. Balkin's long-term project to generate a "Clean Air Park" over the Los Angeles Basin using retired carbon emissions credits from California's carbon market was also performed in 90,000 postcards written to the German Chancellor of the Environment on the occasion of the Documenta Art Fair in 2013, urging the minister to submit the Earth's atmosphere to UNESCO on an emergency basis as a world heritage site. Such participatory practices interrogate the legal and coded relations between living beings and the volume of Earth's atmosphere. Such work reflects cosmological aesthetics since it proposes techniques and tools (those of legal administration and policy) through which to compose and relate to atmospheres far beyond participants' sensing capacities.

Although this dissertation emerges from discussions on art, atmosphere and aesthetics in human and cultural geography, it is also inspired by work on atmosphere in art history and theory. Art history scholars like Monika Bakke, Brian Dillon and Steven Connor point to the increasing engagement of

¹⁹ In addition to Saraceno's work, we also witness cosmological aesthetics in the work of Pierre Huyghe, who composes films of lakebed ecologies, tsunami-blown landscapes and arctic luminal phenomena. The artist employs characters like a dog with a bright pink hind leg or a chimp trained to act the part of a waitress in a ruined restaurant, as well as rich sound accompaniment in incredibly detailed scenery, to create elemental atmospheres in which the viewer-participant is made to feel like a beetle on the wall or a microbe in an estuary. Still, there is a difference between the "sublime aesthetics" (Dixon et al., 2012) of Huyghe's work and that of romantic painters like Caspar David Friedrich: in the former, the artist composes a world in which certain characters, including the viewer, are permeated and perturbed by cosmic forces, rather than positioned in awe or amazement to them. The cosmological aesthetics of Huyghe's works resonates with the "post-natural sublime" as developed by Martin (2011b) or the "dark ecology" of Timothy Morton (2007) to the extent that the artist crafts mythologies and parafictions that are not of a Kantian tenor, instead animated by the weird Anthropocene ecologies of the present.

contemporary artists with tropes of air and atmosphere. An interest in air is certainly not new to the realm of art, however: “Air is no longer an ideal image for art, but an object for it to work on, and by which to be itself worked out, worked loose even from its self-identity” (Connor, 2007: 12).²⁰ In other words, the airy and atmospheric are challenging matters for creative practice to think and work with. While Connor goes so far as to describe a contemporary “air-art” movement, the examples detailed earlier at least evidence contemporary artists’ fertile experimentations with the airy and atmospheric (Bakke, 2007; Connor, 2007).

In my creative ethnography with Tomás Saraceno, I collaborated in the production of artworks and performances that specifically engaged air and atmosphere. The following passage is an excerpt from a performance artwork: the *Dust Séance*.

*And as the eddies form, and cascade down in scale, lowly aerial spirits known to the Greeks may presence themselves to our eyes and then to our ears in the auditorium one by one: the Anemoi, the Aurai, the Harpyiai – and the Daimones, the abrupt shifts in atmosphere that we feel as unbidden affect, as hope, dread, sorrow or joy.*²¹

Tomás Saraceno, Bronislaw Szerszynski, and I performed this artwork to an audience of approximately one thousand visitors at the Haus der Kulturen der Welt, Berlin. In the completely darkened auditorium, Szerszynski and I alternated in reciting a prose-poem (partially cited above) while Saraceno tuned the dials on his delicate instrument-sculpture, titled *Cosmic Dust and the Breathing Ensemble* (2016) (Figure 1). Over the course of the performance, we conjured aerial spirits, chanted dimensionless numbers, and invoked cosmic rays and particles. Meanwhile, a camera recorded illuminated dust particles in the path of a small spotlight, and transmitted the visual data to a computer with particle tracking software that

²⁰ Peter Sloterdijk and Steven Connor cite Marcel Duchamp’s *Air de Paris* as one of the first artworks to take an airy volume as its medium and conceptual experiment. Duchamp famously bottled 50cc of air in Le Havre, labeled it *Air de Paris* and brought it to the Arendbergs in New York.

²¹ Excerpt from “Dust Séance” co-authored by Bronislaw Szerszynski and Sasha Engelmann. This is a prose-poem that was performed with Tomás Saraceno and his instrument and artwork, *Cosmic Dust and the Breathing Ensemble* at the *Wisdom Techniques* evening event, in the series *Technosphere x Knowledge*, at the Haus der Kulturen der Welt, Berlin, on April 16th 2016.

digitized and converted each dust particle into a sound. The sound was “played back” to the dust via two speakers placed directly under the beam of light. This was a feedback loop in which the airborne dust, composed of the very breath of the performers and audience members, was rendered sonic and vibratory. The untraceable and inaudible spirits of the air were, for the space of the performance, rendered sensible and explicit, and given names.



Figure 1: *The Dust Séance* by Tomás Saraceno, Bronislaw Szerszynski and Sasha Engelmann. Haus der Kulturen der Welt, Berlin, April 2016.
Photography by Haus der Kulturen der Welt.

In such a performance, atmosphere is made explicit as a material that enfolds appearances and apparitions, objects and traces, bodies, ephemera and spirits alike. It is a medium that gathers and intensifies transactions of the chemical and the pneumatic, the cosmic and the ordinary. The project of making air explicit has philosophical significance. According to Luce Irigaray, air has largely been “forgotten” in the annals of philosophy and social theory. She writes, “Air does not show itself. As such,

it escapes appearing as (a) being.” (Irigaray, 1999: 14).²² Attending to air as a medium of voice, thought and expression is to make an ethico-aesthetic proposition (Guattari, 1992/1995) about what kinds of entities may come to light, and to matter in public experiments. Such investments in Irigaray’s writing will be employed as exemplary of practical and philosophical collaboration with air.

Inspiring notions of aura (Böhme, 2006 cited in Anderson, 2009) halo (Thrift, 2008) and affective transmission (Brennan, 2004) atmospheres have played a central role in mobilizing aesthetics. Another prescient example is Jill Bennett’s (2012) study of the impact of the 9/11 event on global cultural expression, and especially how the event propagated through gestures, hues and qualities of cultural performance in what she terms “practical aesthetics”. Thought together with atmosphere, aesthetics achieves a *suspension* in which myriad atmospheric experiences – including those of wind, odour, heat, friction, force, breathing and breathlessness, anticipation, speculation, elation, foreboding, among many others – are possible modes of extending and becoming sensitive.²³ This form of extension in aesthetic experience is cosmological in the sense I elaborated earlier, since it creates universes or ensembles of attention and relation. Extending oneself cosmologically is to form attachments with entities and phenomena that transmit sensation, much like a spider forms attachments by spinning silk between distant points and surfaces. Understanding atmosphere as an “heuristic” in which to encompass a spectrum of physical and affective sensation (as detailed ethnographically by Choy, 2011) is one way to become sensitive to the sheer gathering forces of atmospheric media. It is also to become aware of the liminal, the fleeting and the ephemeral not as peripheral to experience, but as sensible trajectories to be followed onward. The trajectory to which we turn is a brief elaboration of Tomás Saraceno’s life and artistic development, resources that will be addressed implicitly in the remainder of this dissertation.

²² But for Irigaray, air establishes the very possibility of thought, speech and action, let alone expression: Of what [is] this is? Diaphanous, translucent, transparent. Transcendent? Mediation, fluid medium, unhindered in relating the whole to itself, and certain of its parts to each other, according to their properties: real properties or ones decreed “true”. (Irigaray, 1999: 4)

²³ This assertion is greatly inspired by Choy and Zee’s treatment of suspension as an orientation for fieldwork and ethnography. They write: “Inquiry into suspension is to wonder what it is, in changed times, to be in this air, held and distributed differentially through it as particulate in a medium, thrown into the mix of its compositions” (Choy and Zee, 2015: 211).

The Universe in 40 Jumps

This dissertation is not an art historical one, but it is essential to know more of Saraceno's upbringing and influences to proceed further. As Saraceno related to me numerous times, and stated in an interview with Marion Ackerman, Daniel Birnbaum, Hans Ulrich Obrist and Udo Kittelman, his grandfather had a large collection of artifacts: "each wall, shelf, and so on was covered with stuff: instruments, stone arrows, beautiful colourful woven ponchos, and aboriginal art from South America ..." (Saraceno in Ackerman et al., 2011: 45). He gave the young Tomás two books in particular that have shaped the artist ever since. These were *Architecture Without Architects*, by Bernard Rudofsky, and *Cosmic View: The Universe in 40 Jumps*, by Kees Boeke. The first is an examination of various indigenous and vernacular practices of habitation: architectural styles passed down over generations that attune to climate. The second is, "a truly cosmic view of the universe and our place in it" (Boeke, 1957: 4). Boeke's descriptions and graphic imagery, shifting degrees of perspective from the galactic to the atomic, directly inspired the famous film *Powers of 10* (1977) by Ray and Charles Eames.

Saraceno's family was forced to immigrate to Italy for political reasons while he was a boy. He describes returning to his homeland, Argentina, after living for several of his young adult years in Italy: at that point, "I was an *Italian* boy," (Saraceno in *Creator's Project*, 2014: np). To be brought back to Argentina felt unfair, strange. Years later, Saraceno would attend Universidad Nacional de Buenos Aires to study architecture, and went on to complete postgraduate degrees in Art and Architecture at the Escuela Superior de Bellas Artes de la Nación Ernesto de la Carcova, Buenos Aires. He won a scholarship to pursue a degree at the Städelschule, Frankfurt am Main in architecture, but found himself increasingly making art. One of his first art exhibitions was held in an elevator, after he convinced the gallery where he had been working to let him use the only remaining space. In these years, he also met the Icelandic installation artist Olafur Eliasson at a workshop in Italy. Eliasson then invited Saraceno to join his large studio in Berlin.



Figure 2: *Galaxies Forming along Filaments, like Droplets along the Strands of a Spider's Web*, 2009. Installation view, 53. Biennale di Venezia, 2009, with the support of Fondazione Garrone, Genoa, Italy and Fondazione Sambuca, Palermo, Italy, special thanks to pinksummer contemporary art. Courtesy the artist; Tanya Bonakdar Gallery, New York; Andersen's Contemporary, Copenhagen; Pinksummer contemporary art, Genoa; Esther Schipper, Berlin. Photography © 2009 Alessandro Coco

In 2009, Saraceno attended the International Space Studies Program at NASA Ames Center, where he experienced parabolic flight: an aircraft carries passengers up and down at 45 degree angles, producing around twenty seconds of weightlessness at the top of every curve. The feeling of weightlessness hasn't left him since, he (half) jokes. Later that year, Saraceno presented a major installation called *Galaxies forming along filaments like droplets on a spiders' web* (hereafter, *Galaxies*) at the 53rd Venice Biennale (Figure 2). This artwork, with an extended metaphor for its title, manifested the beginning of what would become a long-term research project in comparing a three-dimensional black widow web to new simulations of the structure of the universe. The installation at the Venice Biennale, which is pictured above, would be later interpreted by Bruno Latour as an illustration of the networked hierarchies of spheres of social being. Latour found Saraceno's artwork diagrammatic of Sloterdijk's "spheres of intimacy" meshed harmoniously with Actor Network Theory (Latour, 2012).

Saraceno's artwork proved that both social-spatial theories of spheres and networks were compatible, and in fact, inseparable (Latour, 2012).

Since this success in 2009, Saraceno's work has grown dramatically. On his newly redesigned website, his work is described in this way:

Saraceno's oeuvre could be seen as an ongoing research, informed by the worlds of art, architecture, natural sciences and engineering; his floating sculptures and interactive installations propose and explore new, sustainable ways of inhabiting and sensing the environment towards an aerosolar becoming. (Studio Tomás Saraceno, 2015)

Critically important works in his oeuvre are *Galaxies forming along filaments like droplets on a spider's web* (2009) at the 53rd Biennale Di Venezia, Venice; *14 Billions* (2010) at Bonniers Konsthall, Stockholm; *On Space Time Foam* (2012-13) at the Hangar Bicocca in Milan; *On the Roof: Cloud Cities* (2012) at the Metropolitan Museum of Art in New York; *In Orbit* (2013-) at the K21 Ständehaus Museum in Düsseldorf; and most recently, the *Aerocene* (2015), at the Grand Palais in Paris, on the occasion of the COP21 Climate Conference. The phrases "ongoing research" and "towards an aerosolar becoming" gesture to the processual nature of Saraceno's work. As part of the research for this dissertation, I have had some part in articulating the trans-scalar, modular aspects of these works:

Solar, lighter-than-air sculptures could provide new nomadic ways of dwelling on the Earth, as macroscopic forms of aeroplankton set themselves adrift on the winds, containing diverse and hybrid forms of life. New, shifting assemblies would appear in the air—cumulo-cities, cirrus-cities, stratocumulo-cities—as aerosolar structures cohere one day and dissipate another, according to the interacting dynamics of atmospherics, economics, politics, and culture.

(Saraceno, Engelmann and Szerszynski, 2015: 36)

The notions of modularity, of shifts in multiple scales, of nomadic traveling and collective endeavor are core tropes in Saraceno's work. They manifest a reaction against most architectural logic in the twentieth century: logic that foregrounds stasis, insulation, individualism. They also resonate with certain styles of modernist utopia from the work of Le Corbusier to Achigram's *Drop City*. As Nicolaus

Epstein (2012) has written in his master's thesis on Saraceno's work, these projects flirt with an abstract idealism that lacks the capacities to motivate real sustainable, political or ecological actions. This dissertation will hold a critical lens to Saraceno's ambitious visions and large-scale installations, but will find that in contrast to the techno-utopian quality of the artist's earlier statements about *Cloud Cities*, the tenor and trajectory of more recent initiatives, especially *Becoming Aerosolar* and the *Aerocene*, bring focus to collective "interstitial" politics and grassroots action. In contrast to Saraceno's earlier emphasis on visionary utopias, these recent gestures summon novel investments in atmosphere that extend far beyond Studio Saraceno. As I will explore in the final empirical chapter on aerosolar polities, the development of the *Aerocene* as an open-source community-driven project, one that transcends traditional art or studio spaces over which Saraceno holds clear authorship, is what is simultaneously thrilling and challenging about this project for Saraceno and his studio.

Another pivotal moment so far in Saraceno's career was his studio's move from Frankfurt to Berlin in 2012 to occupy the space formerly inhabited by the studio of Olafur Eliasson. Two years later Saraceno moved the studio to its current location in Rummelsburg, East Berlin. In interviews at Studio Saraceno in early 2014, many studio members spoke of the rapid increase in size of the studio (from 10 to 35 people) and the way this had shifted the studio's professional and social atmospheres. Saraceno's new building even has a shallow pool of water on the roof, "to bring the clouds to the studio" (Saraceno, personal communication, 2015). It borders East Berlin's *Spree*, where in summer studio members eat lunch, launch boats or test the most recent models of flying sculptures.

To be sure, human fascination with life in the skies is ancient; the notion of *Cloud Cities* conjures a field of experiments with floating forms across architecture, art and literature. In the 1960s Buckminster Fuller collaborated with architect Shoji Sadao on *Floating Cloud Structures (Cloud Nine)* (ca. 1960) (Figure 3). A photo-collage of this project shows large, smooth spheres hovering above a mesa-like mountain range. Although it is an important reference for Saraceno's work, the atmosphere, unlike that in architectural collages produced by Studio Saraceno, appears strikingly vacant and still.



Figure 3: Buckminster Fuller and Shoji Sadao, Project for “Floating Cloud Structures (Cloud Nine)”, ca. 1960. Black-and-white photography mounted on board, 40.3 x 50.2 cm
Photography by Whitney Museum

In the realm of literature, we might think of Jonathan Swift’s *Laputa* in *Gulliver’s Travels* (1735), Jules Verne’s *A Voyage in a Balloon* (1852) or Italo Calvino’s *Invisible Cities* (1972/1974) in particular the cities of *Octavia* and *Baura*, in which inhabitants walk on carefully woven webs suspended high in the sky, never sure how long they will last. While he was at the Städelschule, Saraceno studied under Peter Cook, one of the founders of the avant-garde, futurist group, Archigram, which had published designs for radically different, metabolically structured cities such as *Drop City* (Ackerman et al., 2011; Epstein, 2012). In the U.S. the group known as Ant Farm, co-led by architect turned conceptual artist Chip Lord, were well known in the 1970s for their autonomous, inflatable, pneumatic and nomadic spaces. Between 1969 and 1972 Ant Farm constructed and performed several *50x50 foot pillows*. Indeed, although the structures and the narratives informing them do bear important differences, the view from underneath an Ant Farm pillow (Figure 4) might (except for the nudity of human bodies) be mistaken from a view from within Saraceno’s *On Space Time Foam* (2012-13). Such histories and resonances came to bear in my

period of fieldwork. In late 2014 Chip Lord came to Berlin to participate in the Anthropocene Campus at the Haus der Kulturen der Welt, and I had the pleasure of meeting and working with him in a seminar. Later that week I found myself on Tempelhofer Feld on a sunny winter morning, flying new kite models with Saraceno, some studio members, and Lord himself. It was thrilling to witness the meeting of Lord and Saraceno, two generations of artists whose works explore pneumatic spaces for human dwelling.



Figure 4: Ant Farm, 50x50' pillow, 1970, Installation in Freestone, California.
Source: Lewallen and Seid (eds). *Ant Farm*, 2004, pp: 52-53.

Still, it is in the work of architect Frei Otto that we might find a greater part of Saraceno's inheritance. Otto studied the geometries of spider webs, membranes, bubbles, foams, and crystals. He founded the institute for Lightweight Structures at the University of Stuttgart and completed major commissions for the West German Pavilion at the 1967 Montreal Expo as well as the roof of the Olympic Stadium in Munich. Saraceno knew Otto in his lifetime, and paid visits to him before his sudden death in March 2015. During the two years of collaborative teaching I did with Saraceno at IAK,

at the Technical University of Braunschweig, Otto's long-term publishing director Professor Berthold Burkhardt was invited to give a lecture (Figure 5). Burkhardt brought with him several original models from Otto's former studio, and performed a foam experiment for our students. The lineage from Otto (via Burckhardt) to Saraceno was thus made explicit to the new generation of architects and artists who are now first-hand students of Saraceno's work.



Figure 5: Tomás Saraceno and Professor Berthold Burkhardt lecturing on the legacy of Frei Otto and form-finding architecture at IAK, Technical University of Braunschweig, Spring 2015.
Photography by Sasha Engelmann

But it is also incorrect to attribute Saraceno's inspirational resources to the realms of architecture or art, let alone several individuals or studios. Saraceno draws inspiration from astrophysics and cosmology, music, ecology, biology, materials science, social science, evolutionary theory and politics. In an interview with Mario Ackerman, Daniel Birnbaum, Hans Ulrich Obrist and Udo Kittelman, he cites the following artistic influences:

...the great artists Gyula Kosice, Gordon Matta-Clark, Claudio Caveri, Ciudad Abierta in Chile, Xul Solar's beautiful paintings, Amancio Williams, Bruno Taut, Wenzel Hablik, Yona Friedman, Constant [Nieuwenhuis'] "New Babylon," and... Mark Wigley (Saraceno in Ackerman et al., 2011: 43)

These are figures who pioneered kinetic and luminescent art (Kosice), drifting cities (Nieuwenhuis) Argentine modern architecture (Williams) German expressionism (Hablik) and astrology-informed painting (Solar; Figure 6).

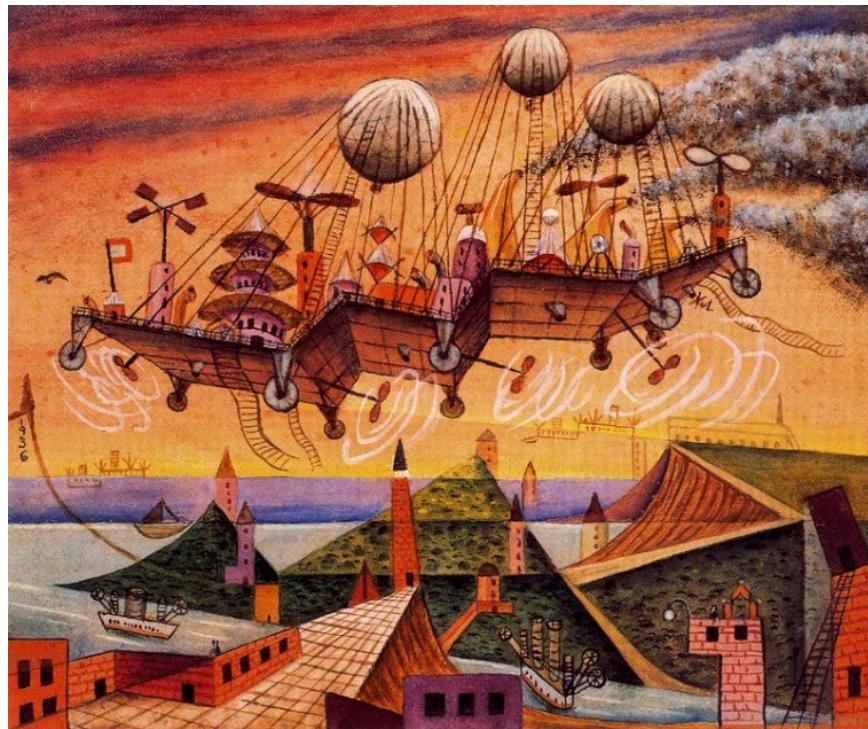


Figure 6: Xul Solar, Vuelvillas, 1936.
Source: Museo Xul Solar.

In the same interview, Saraceno recounts that when he gave presentations at the Städelschule, he would start with at least 100 images of work made by others (Saraceno in Ackerman et al., 2011: 42-47). He continues:

Santos Dumont, the incredible German Zeppelins... Tsiolkovskii (pioneering ideas of greenhouse and space elevators)... ISS International Space Station, Krutikov, “flying cities,” J. J. Grandville, Jules Verne, the cenotaph of Étienne-Louis Boullée, Stanley Kubrick’s “A Space Odyssey,” Dominic Michaelis, Carl Sagan, Don Davis, Rick Guidice, Arthur C. Clarke, Gerard K. O’Neill, Olafur Eliasson, Sadao, Oscar Niemeyer, Carlo Scarpa, Jantar Mantar (an observatory in Jaipur), the Nazca Lines ... (Saraceno in Ackerman et al., 2011: 44)

In such interviews, Saraceno often answers by citing the words and achievements of diverse practitioners, including those listed here, as if insisting that they speak directly rather than enter obliquely into his own answers. He is willing to actually perform the gathering of source material that is so important to his practice. Often he enrolls the voices (or vibrations) of nonhumans, retelling stories of spiders in the studio. Sometimes this can produce discord in an interview or presentation. According to Saraceno: “the answer doesn’t need to be understood, but should resonate” (Saraceno in Ackerman et al., 2011: 45).

In any given pile of books on Saraceno’s desk, there might be *The Movement-image* by Gilles Deleuze, *The Web of Life* by Fritjof Capra, *How to Live on Mars* by Robert Zubrin, *Hacia la Utopia* (trans.) by R. Buckminster Fuller, *Esculpir en el Tiempo* (trans.) by Andrei Tarkovsky and *The Ashley Book of Knots* by Clifford W. Ashley. One might find Jussi Parika’s *Insectology*, Brian Massumi’s *What Animals Can Teach us About Politics*, or Naomi Klein’s *This Changes Everything*. One will surely find, *Floating to Space: the Airship to Orbital Program* by John Powell and *Biomateriomics* by Steven W. Cranford and Markus J. Buehler. A great part of Saraceno’s practice, as he readily admits, is generated through conversation. As I will explore further in my methodology chapter, it is the gathering of myriad literatures and concepts together in an elemental cloud of associations, and the rendering explicit of key patterns in such associations, that constitutes a primary process of Saraceno and his studio.

A commitment to air and atmosphere as cosmic and cosmological entities is evident in Saraceno's installations.²⁴ These artworks are diagrams for extending airy and atmospheric poetics beyond the gestural and writerly resources invoked by Tim Choy, Steven Connor, Kathleen Stewart, Tim Creswell, Cynthia Lin, Julie Mehretu and others. For Saraceno, air is a medium that always already enfolds cosmic phenomena and forces, phenomena that can be amplified given certain conditions and forms. The link between a poetics of air (as elaborated by Choy, 2011; Engelmann, 2015b) and cosmological aesthetics will be further elucidated in Chapter Four through the experience of Saraceno's *On Space Time Foam* and in Chapter Six on aerosolar sculpture workshops. In the section that follows I will place cosmological aesthetics in dialogue with the styles of post-human, inhuman, geographical and geomorphic aesthetics that have surfaced in human and cultural geographies, in order to outline the unique contribution made by cosmological aesthetics to these geographical spaces of thought.

From Geographical to Cosmological Aesthetics

In this dissertation, I am proposing an orientation for aesthetics that is inspired by multispecies webs (Chapter 5), atmospheric media (Chapter 4), cosmic-energetic cascades (Chapters 6 and 7), and scientific abstractions of the dark and the (im)perceptible (Chapter 5). I am also proposing that these adventures in aesthetics are inseparable from cosmological practices: concrete performances of attachment and obligation enrolling human, nonhuman and material practitioners (Stengers, 2013). Stengers claims that new concepts, "will have no meaning unless they succeed in bringing to existence those dimensions of experience that usual statements can ignore" (Stengers, 2011: 248). Cosmological aesthetics is therefore tested throughout this dissertation to the extent that it actually transforms aesthetic experience. However, cosmological aesthetics is a discovery that is also founded on a critique of recent conversations on aesthetics in human geography. These conversations and critiques are outlined here.

²⁴ Born and Barry (2010) (following Hannah Arendt) would likely interpret the gestures in Saraceno's work as "*epideixis*:" "the transformative power of speech and art, a *power to move*" entities, objects, thoughts, and affects (italics mine, 116). The movement here is towards a conception of air and atmosphere as creatively, emotionally and affectively generative of different modes of sensing.

The development of an aesthetic theory of matter(s) sensed across epochal temporalities, and of both animate and inanimate entities, is already a project in geography. In these endeavors, as in this dissertation, the very capacity to write and theorize aesthetics is indebted to Kant, who asserted that aesthetics was autonomous from epistemology (see Zagala, 2002). In Kant's *Critique of Judgment* (1790/1914) taste, beauty and the sublime are born of the free association of mental "faculties" (such as sensibility, understanding, reason and imagination) (Shaviro, 2002; Zagala, 2002). Scholars like McMahon (2002) have highlighted convincing resonances between Kant's notion of beauty and Deleuze and Guattari's notions of difference and singularity. An important qualification here is that no matter how important Kant's contribution to theorizing aesthetics, Kantian aesthetics presupposes a cognizing subject – a human subject²⁵ – held separate from the world of matters, objects and organisms. As I have already indicated in drawing from the philosophy of Whitehead, the cosmological aesthetics developed in this dissertation is incompatible with a Kantian "bifurcated" notion of the world and aesthetic experience. The experiments explored in this dissertation do not locate aesthetics in thinking subjects, but in pulses, vibrations, perturbations, auras, atmospheres, cascades and various other stimuli.²⁶

In human geography the terms of aesthetics resonate strongly with the language of Deleuze and Guattari. Aesthetics is defined broadly as the dynamics of sensual assemblages, or "multi-sensuous encounters between body and world" (Dixon et al., 2012b: 229). Important philosophical influences on aesthetics in human geography are Jacques Rancière's (2004/2006) "politics of aesthetics," on the ways in which aesthetics subtends modes of investment in labor and political life; and Deleuze's notions of becoming and multiplicity as theorized by Grosz (2008), Colebrook (2009; 2011) and O'Sullivan (2009). However, as Jackson (2016) has argued, in order to truly challenge Kantian dualities in thinking and

²⁵ In a recent article, Mark Jackson (2016) explores the ways in which any politics of aesthetics is undercut by implicit enrollment of Kant's theories of aesthetic judgment and taste – theories which not only presuppose a human subject separate from the world, but a particular model of human subject - namely, a white human of European descent.

²⁶ In this respect and others, the cosmological aesthetics developed here resonates with Bertrand Prévost's theory of "cosmique cosmétique" in which aesthetics is re-invested with a notion of world (Prévost, 2012). However, Prévost's argument is more particularly interested in adornment, colour and order / disorder; this dissertation, in contrast, mobilizes a different meaning of the term "cosmic" which has less debt to notions of cosmetics and order.

theorizing aesthetics as well as make good on the claim that aesthetics operates in assemblages beyond the human, geographers must explicitly decolonize and provincialize aesthetics. This could occur through an engagement with more-than-human semiosis as in Kohn's (2013) *How Forests Think*, or in accommodating *aesthesia* and *epideixis* via styles of enunciation, presentation and performance that trouble tropes of the cognizing subject.

In a review of two recent “geoaesthetics” texts – *Space, politics and aesthetics* (2015) by Mustafa Dikeç, and *Geographical aesthetics: imagining space, staging encounters* (2015) co-edited by Harriet Hawkins and Elizabeth Straughan – Jellis (2016) insightfully observed that a broad, Deleuze-Guattarian definition of aesthetics in these texts is nevertheless enacted primarily in relation to examples from “high art”. This difficulty embodies the intrinsic “duality” of aesthetics.²⁷ For Jellis (2016), the stakes for geoaesthetics scholarship lie in shaking institutional art’s monopoly on aesthetics, so that wider and more pervasive “proto-aesthetic” tendencies (Guattari, 1992/1995) can be registered. This would require actually “doing” and “locating” aesthetics outside of institutionalized, gallery-based and fine-art contexts.²⁸

In this dissertation, I locate art and aesthetics both within and beyond institutional and “high art” frameworks. For this project, art is broadly understood as a cosmic force made explicit in the channeling of intensity (see Grosz, 2008) the power to move, (see Borne and Barry, 2010), and/or the creation of opportunities for “rupture” and “glitch” that bring about different patterns of subjectivity and enunciation (Guattari, 1992/1995). Although he is certainly an institutionalized artist, and his studio is supported by the production of marketed art-objects, Saraceno situates his artwork in the vein of these latter, Deleuze-

²⁷ This assertion of a “duality” in aesthetics is articulated in Deleuze’s claim in *The Logic of Sense*: “Aesthetics suffers from a wrenching duality. On the one hand, it designates the theory of sensibility as the form of possible experience; on the other hand, it designates the theory of art as the reflection of real experience” (Deleuze, 1990: 260).

²⁸ I have great respect and sympathy for Jellis’ (2016) comment on the fact that geographers overwhelmingly turn to the work of artists in order to “do” aesthetics. The wider project of cosmological aesthetics, of which this dissertation is one part, includes additional ethnographic research and writing I have completed on the sensing practices of neutrino telescopes and dark matter experiments (see Thomson and Engelmann, 2015; Thomson and Engelmann, forthcoming).

Guattarian modalities.²⁹ An important distinction between the aforementioned geoaesthetic scholarship that turns to art, and this dissertation, is the degree to which I participated and contributed to artistic practices which, although situated alongside the work of Studio Saraceno, emerged largely beyond institutional frameworks and the realms of “high art”.

Turning further to the rich conversations on aesthetics in geography, then, we must acknowledge several contributions to post-human aesthetics (Dixon et al., 2012a), geologic and geomorphological aesthetics (Dixon et. al., 2012b) geographical aesthetics (Hawkins and Straughan, 2015) and geomorphic aesthetics (Yusoff, 2015). Each of these projects in some way mobilizes the “strange-scales” (Bosworth, 2016) of earthly and geological life to situate aesthetics in terms that do not reproduce human sensory exceptionalism. But there are further relevant affinities in the ways that inhuman, posthuman, geographical and geomorphic aesthetics have been heretofore developed. As articulated by Yusoff (2012; 2015), Hawkins (2013), Hawkins and Straughan (2015) and Deborah Dixon (2009; Dixon et al., 2012a), one of the defining qualities of a geomorphic, geologic or inhuman aesthetics is its attention to discontinuities: leaps, breaks, spacings, and, “nonlocal elements” as intrinsic to subject-formation (Yusoff, 2015). For example, addressing the *Gwion Gwion* rock artworks in Australia, Yusoff writes:

The subject is the holding together of that gap that is stretched between the discontinuities of these [bio-geomorphic] ecologies; it is the gathering up of these communities into an entity that is discontinuous with itself because it contains nonlocal elements (Yusoff, 2015: 398).

This geomorphic subject is not a singular entity but a multitude, held together. The hybrid, geologic entity of the *Gwion Gwion* surface is “discontinuous with itself” because it contains within it the vastly different temporal and material elements of geology, biology and human gesture, of surfaces that move and agitate with different speeds and slownesses. Yusoff continues:

²⁹ In numerous conversations over the two years I worked with Saraceno, he variously described his artistic practice as emerging from conversations, questions, collaborations and experiments. On more than one occasion, I witnessed Saraceno resisting the urging of major institutions to produce a large commissioned sculpture, in favor of carrying out further research and collaboration with studio members, scholars, students and activists.

What is given is *the forces between entities, the energy and contagion of those forces* that cement identities as entities in the on-going constellation of forces and relations. The slippage of subjectivity is an indeterminacy, a between, that is not a pivot point on which terms turn to infect one another (as in hybridization) in a symmetrical arrangement, but it is a discontinuity, always missing itself, in radical asymmetry (italics mine; Yusoff, 2015: 399).

What Yusoff describes in the *Gwion Gwion* rock paintings is not an assimilation or mixing of different components but a *holding together* that refracts the asymmetric human, nonhuman and inhuman entities.

What is produced by these multiple contact-points on the “recording surface” of sedimentary rock are “forces between entities” and, “the energy and contagion of those forces” (Yusoff, 2015: 399).

However, rather than “nonlocal,” which suggests that entities are “outside” or “elsewhere,” the various geologic, cosmic, living, nonliving, metazoic and bacterial perturbations of the *Gwion Gwion* paintings might also be articulated through “disjunctive synthesis,” a Deleuzeo-Guattarian term that I develop in relation to Saraceno’s *hybrid webs* in my second empirical chapter. Briefly here, disjunctive synthesis is a conceptual tool to think about aesthetic relations formed across differences in media, material and scale. Furthermore, the kinds of syntheses evoked in Yusoff’s passage enroll not only tangible entities like rock, water and pigment, but also the “cosmic” forces of gravity, electro-magnetism and radiation that shift, decay and alter matter and surface over different timescales.

A few words on the *cosmic* are useful here. From the “cosmic vertigo” of Felix Guattari’s *Chaosmosis* (1992/1995) and Elizabeth Grosz’s (2008) “frames” on cosmic chaos, the “cosmic” has multiple valences that refer to forces that lie beneath or above the thresholds of human awareness. Certain connotations of the cosmic are allied with the cataclysmic: in particular Nigel Clark’s writing on “ex-orbitant globality” (2005) and climatic volatility (2010) enlists paleoclimatology, (in)calculability and George Bataille’s physics and philosophy of accumulation to bring cosmic-catastrophic cycles to social theory. Others resonate with the poetic and geopolitic: Last (2015) reads the cosmic in the “creative attention” to intangible materialisms of Simone Weil and Aimé Cesaire. Attuning to the cosmic echoes in recent work on the elemental (Adey, 2015; Engelmann and McCormack, under

review), in which forces anterior to human perception are nevertheless accommodated in cosmic-elemental “force-fields” (Ingold, 2010). Various conceptual techniques have arisen for attending to such elemental forces and fields: I have employed Ash’s (2013) device of perturbation to think with Adey’s (2015) concept of “affinitive listening” in the flights of solar balloons (Engelmann, 2015a); Bissell’s (2010) and Henriques’ (2010) focus on vibration addresses body-technology relations in the terms of absorption, transmission and turbulence in the former, and a distinctly vibratory-rhythmic account of atmospheric affect in the latter. The play of the term “cosmic” and its role in recent theories of geographical aesthetics is one point of departure for the cosmological aesthetics extended in this text. What cosmological aesthetics offers scholarship on such hybrid, striking entities like the *Gwion Gwion* rock paintings is to better articulate the aesthetic force of more-than-human societies as emergent from irreconcilable, heterarchical differences. These are differences played out on radically different scales and temporalities of organism, material and cosmos. They do not collaborate, join, or homogenize, as much as they push, pull, prey and even cannibalize each other (see Yusoff, 2015).

The aforementioned work enrolling the cosmic-energetic across sociology, geography and cultural studies makes a strong argument for the entanglement of imperceptible forces in life on Earth’s surface. But as Yusoff (2013) astutely observes, in the literature that has addressed co-enactment and relationality, “there has been little place for the dark spaces of nonrelation” (Yusoff, 2013: 221). Harrison writes of the hollows, holes, and ellipses of experience as being fundamental to relation: the situation of “being-held-toward-another” (Gasché, 1999: 9 cited in Harrison, 2007: 591). Clark (2010) astutely recognizes the scarcity of, “ventures into domains where the dominant force is genuinely other-than-human, let alone where humans are not present in any significant sense” (Clark, 2010b: 40). An important evidence for this is that scholarship on co-production and relation in the social sciences has not addressed the kinds of forces and materials that Einstein prefigured with his “cosmological constant” and that astronomer Fritz Zwicky as early as 1933 postulated as the “missing mass” that makes up the majority (over 80%) of the observable universe. Such mass and energy is far from passive, causing, “the clustering of stars into galaxies and galaxies into connecting strings of galaxies” (Wilford, 1992). What

would it mean to account for “dark,” non-baryonic matter and its attendant (largely unmeasured) forces in social scientific theory and research? Such a project has been newly launched by anthropologist Rebecca Ellis and artist Sarah Casey, who have collaborated with physicist Kostas Dimopoulos to develop a notion of the “radically (im)perceptible” as part of a theory on the role of mathematics in navigating the thresholds of technically extended perception (Ellis and Casey, 2015).³⁰ Cosmological aesthetics builds on the work of Ellis and Casey, but also aligns with attentions to in-human (Last, 2013; Yusoff, 2015) or post-human aesthetics (Dixon, 2009; Dixon et al., 2012a) in order to further open up questions of aesthetics for the non-animal, non-baryonic and/or the wholly insensible. Indeed one primary motivation in doing so is to meet the provocations made by Clark (2012) and Saldanha (2012) among others to outline what an aesthetic theory of un-graspable, un-charismatic, but alluring entities might be.

More precisely, what is particular about the cosmological societies described by Yusoff (2015) among others? Yusoff writes:

...in acknowledging that which is discontinuous, there is also the capacity to notice that which ‘jumps’ between states in an untimely fashion without a causal logic, rather than just that which crosses between, that which is proximate or partial to relation. *Aesthetics shows up this leap.*
(italics mine; Yusoff, 2015: 402)

In other words, there is a certain quality to aesthetic experiences that transact spaces, sensory registers and timescales without following causal logic. It is not only that aesthetics “jumps” or “shows up” in the discontinuities, but also that this aesthetics is differently thought-felt: it has intensities, speeds and velocities that are difficult to assimilate into terms like “beautiful,” “logical,” or “timely”. This is not only an aesthetics of the geo, the morphic, and thus of the Earth, as much as it is also emergent from a more eclectic mix of force-fields, spectral bodies, and the influence of phenomena that warp and weft

³⁰ I was fortunate enough to have the opportunity to participate in the Dark Matters Symposium organized by Ellis and Casey at the Lancaster Environment Center in December 2015, where I co-presented a paper on neutrino detection with the video artist Jol Thomson. A version of the paper I presented with Thomson is now forthcoming in *The Anthropocene Review*.

matter and space-time. Whether we can understand or articulate exactly what these many other dimensions and forces are is less relevant than acknowledging the possibility that aesthetics may include differences and contrasts that are more vast, or more extreme, than we can readily intuit: differences between the nano and the macro, between visual and non-visual forces, or even between the tangible and intangible. Cosmological aesthetics interrogates not only what is affirmed when we bring relations to the fore, but also, “what is denied when we act ‘as if’ this is all there is; as if there are no other worlds worlding away, insensible to our (scientifically extended) perceptual field” (Yusoff, 2013: 215).

Given the provocations made by research in quantum field theory and relativity in the early twentieth century, Whitehead wondered why philosophies of aesthetics return to Plato’s “gray stone” as primary sensory resource and thought-metaphor: “The Greeks were ignorant of modern physics; but modern philosophers discuss perception in terms of categories derived from the Greeks” (Whitehead, 1978[1929]: 117). Cosmological aesthetics is one that is informed by contemporary theoretical and particle physics and the scholars that have written about these fields (including Karen Barad (2007) and Vicky Kirby (2010)), that the sensible world is composed of vast amounts of matter and energy that are certainly part of our “cosmic epoch” even though we cannot directly sense or describe them (Whitehead, 1978[1929]). It is an aesthetic attunement that in speculative and practical ways challenges us to transcend the “double edged habits” that orient aesthetic feeling in relation to the human sensory apparatus (Whitehead, 1978[1929]: 119). Having positioned cosmological aesthetics in these salient conversations in human geography and beyond, it remains to close the loop (the orb of the web): to consider what these insights offer creative geographies.

Cosmological Aesthetics and Creative Geographies

In this dissertation’s development of cosmological aesthetics, artistic practices provide the practical and creative encounters that allow relations between the tangible and intangible, geologic and cosmic, or the human and non-human to be opened, sensed and theorized. The Deleuzeo-Guattarian device of disjunctive synthesis is useful in this regard. Disjunctive synthesis articulates and theorizes the

ways radically different entities can meet in “non-sensuous similarity,” (Deleuze and Guattari, 1972/1984). Like Deleuze and Guattari, I understand disjunctive synthesis to be ubiquitous, but rendered explicit in artistic encounters that create shock-fronts, perturbations, recording surfaces, or performances enlisting diverse non-human collaborators.³¹

The notion of cosmological aesthetics pays significant debt to Elizabeth Grosz’s engagement of Deleuze’s philosophy. In *Chaos, Territory, Art: Deleuze and the Framing of the Earth* (2008) Grosz addresses the relation between “cosmological imponderables” and creative practices:

Cosmological imponderables – among the most obvious, the forces of temporality, gravity, magnetism – equally the objects of scientific, philosophical, and artistic exploration, are among the invisible, unheard, imperceptible forces of the earth, forces beyond the control of life that animate and extend life beyond itself. Art engenders becomings, not imaginative becomings – the elaboration of images and narratives in which a subject might recognize itself, not self-representations, narratives, confessions, testimonies of what is and has been – but material becomings, in which these imponderable universal forces touch and become enveloped in life, in which life folds over itself to embrace its contact with materiality, in which each exchanges some elements or particles with the other to become more and other. (Grosz, 2008: 23)

For Grosz, art is an agent, a field of force itself, that engenders such touch-points, enfoldings and becomings, in which exchanges of “elements or particles” are made between the visible and invisible, the audible and inaudible, the concrete and cosmic. For this reason, Grosz continues:

...art is not frivolous... it is the most vital and direct form of impact on and through the body, the generation of vibratory waves, rhythms, that traverse the body and make of the body a link with forces it cannot otherwise perceive and act upon... (Grosz, 2008: 23)

³¹ Another resource for thinking such ‘nonlocal’ junctures might be Karen Barad’s concept of “intra-action,” insofar as this term accommodates the “congealing of agency” from within matter’s ongoing materialization (Barad, 2007) and has been useful to scholars like Yusoff (2013) to think about the insensible. However, Deleuze and Guattari’s emphasis on the particularity of synthesis has more purchase, both for cosmological aesthetics and for the spider webs to be met throughout this thesis.

The impact of artistic practice is in the generation of waves, rhythms, forces, and vibrations: art is a form of creative extension and amplification analogous to that produced by webbed filaments extending from the body of the spider.³² To return to the material at the beginning of this chapter, this is precisely why the poetry of Goethe, Balkin's atmospheric re-codings, or Saraceno's *aerosolar sculptures* and *hybrid webs* are achievements in earthly and cosmic knowledge: they generate an intensification of material forces, holding space open for sensitivity and attunement to such forces. This is also why Meinig's comments remain relevant and radical decades after he asserted the differences between the analytic interpretation of art and the actual doing of art. The *doing* of art in geography means not only thinking and theorizing the unknown forces of the earth, as scholars are increasingly attempting to do, but also inventing practices that practically and imaginatively *move* bodies and matters in relation to such forces.

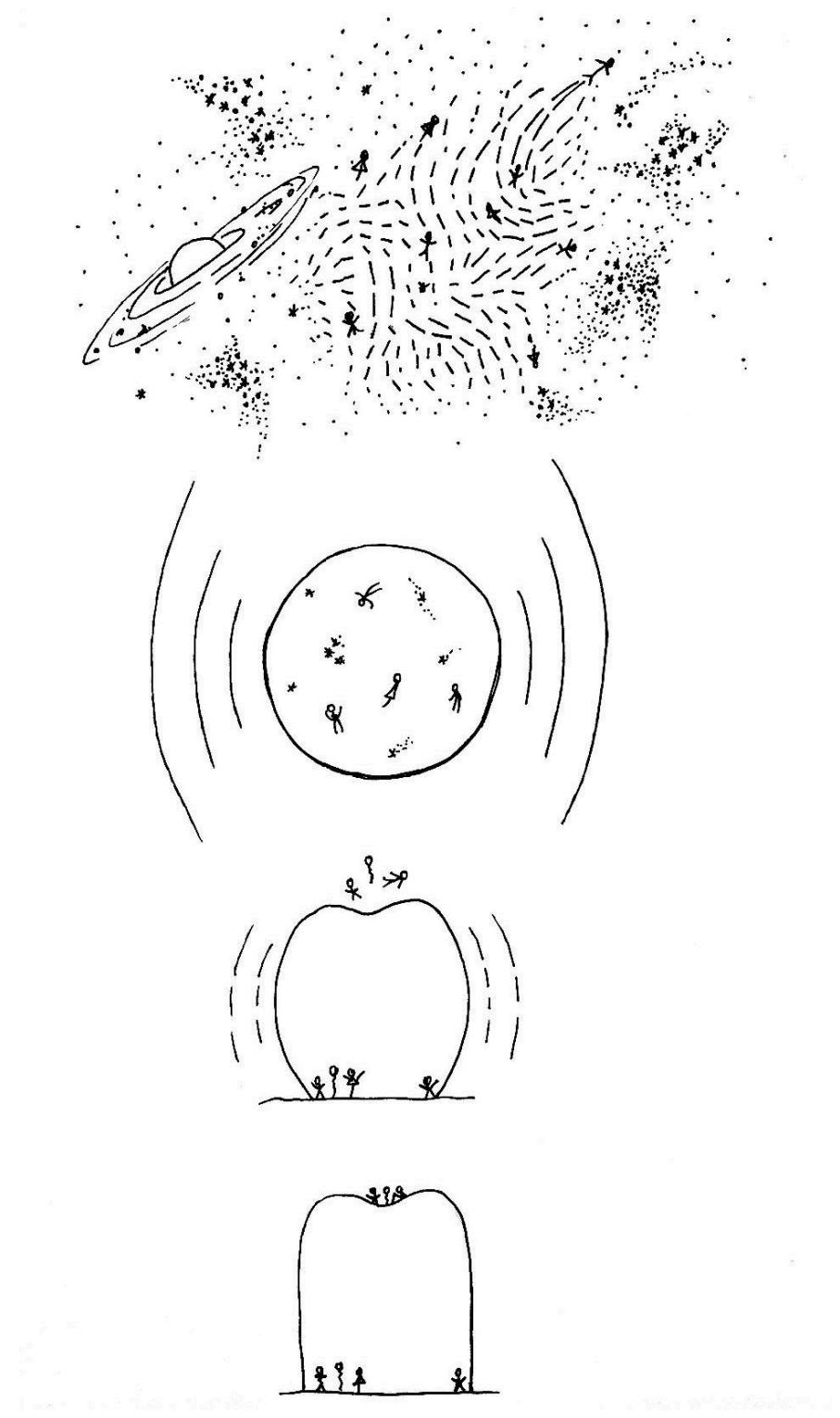
In the spirit of a geographical arts practice, and in the ethos of a humanistic geography worthy of its name, cosmological aesthetics becomes useful in articulating the threads, “links” and vibrations between creative practitioners, and nonhuman, inhuman and cosmic collaborators. More succinctly, cosmological aesthetics is a vocabulary for art as material and imaginative becoming – art as a geographical force. In doing so, cosmological aesthetics lends support to creative geographies’ attentions to the auras, atmosphere, rhythms and waves: to the promiscuous, non-representational and cosmic materials out of which creative practice emerges.

From ancient cosmographic depictions to present day geo-ontologies and geographical aesthetics, geographic scholarship has been lured by inorganic, imperceptible and inhuman fields and forces. In light of these rich engagements, one contribution I am making is to articulate that there are creative and material practices that cooperate in amplifying such fields and forces of geos, bios and

³² In this line of thought, I am reminded of an essay by Frédérique Aït-Touati produced on the occasion of Saraceno’s exhibition *Cosmic Jive* at the Museo d’Arte Contemporanea di Villa Croce, Genova (2014). Here, Aït-Touati cites a passage from Diderot’s text *D’Alembert’s Dream*, in a young lady speaks with a doctor on the concept of a body at the center of an extended web, one that transmits impressions from the world, even as far away as the star Sirius (Aït-Touati, 2014). Aït-Touati elaborates:

The relationship between matter and sensation is clearly stated here: the spider is the sensitive soul at the centre of its vibrating web. In Saraceno’s works, we are the spiders. We are the sensitive souls whose perceptual capacities are extended beyond our bodies through vibrating strings. (Aït-Touati, 2014: np)

cosmos. Such amplifications are not trivial or frivolous, but engender both imaginative and material becomings that change how practitioners practice, relate, invent and dream with the world. These becomings are produced and manifested in art; as such, they have consequences for practices of knowledge production, for subjectivity and enunciation, and for the ethics and politics of research. Rather than turning to thought-objects and metaphors to think and theorize the aesthetics of more-than-human societies, we might better practice aesthetics by inventing cosmological experiments: those that combine practical and material collaborations with imaginative lures in endeavors to become sensitive and response-able to the Earth and the cosmos.



Interstice II: A drawing of the transformation of a membranous, participatory art installation into the Cosmic Microwave Background. Completed at Studio Tomás Saraceno in April 2014, with the help of Edgar Diaz, Jol Thomson and inspiration from Tomás Saraceno. Drawing by Sasha Engelmann.

Feeling-into a Method: Creative Ethnography and Collaboration

at Studio Tomás Saraceno

A prevailing characteristic among spiders is the ability to “hear,” not through a timbal-like organ as in humans, but rather through trichobothria, thin hairs emerging from their legs. These individual hairs once exposed to air currents act as movement detectors and respond to airborne stimuli. So-called slit sensilla, tiny slits in the exoskeleton, inform the spider about vibrations through the substrate. (Jäger, 2015: np)

It would then be better to try to conceive this history as a complex surface, conveying wormholes of sheer acceleration, bottlenecks of stoppage or equilibrium, zones of stationary values, several fragmentations... (Serres, 2001: 377)

Introduction:

A wolf spider is a kind of spider that does not weave webs. The spider travels at night, encountering other spiders and capturing prey. If a male spider encounters a female spider, he drums his abdomen on a surface, and uses his legs to produce micro-turbulences in the air that the female can detect. The threads woven and sensed by this kind of spider are not silken ones, but spirals and waves extending in air. This creature is feeling toward quasi-invisible impressions in a dense milieu, and is sending information back. It is both solitary and social at the same time. The techniques of this spider guide my reflections here.

This dissertation emerges from a creative ethnography of Studio Tomás Saraceno. Over two years of site-specific fieldwork, my research encompassed a sustained commitment, not without risk, to a group of practitioners, and a series of experimental events and projects (Stengers, 2005). While the primary space of my research was Studio Tomás Saraceno in Berlin, the events with which I became

‘mixed up’ took place in other parts of Germany, and in France, the US, the UK, Bolivia and Turkey. They included a diverse range of activities including, but not limited to, exhibition conception and production, collaborative writing and presentation, photographic documentation, sketching, interviewing, teaching (including curriculum design), traveling, significant amounts of editing and generally participating in all aspects of life and work at Saraceno’s contemporary art studio. In the process, I came to understand my methodology partly through a concept of “tracking” or “feeling-into”: an ongoing commitment to unfolding collaborations, conversations and practices embedded in a series of cultural spaces. My concept of feeling/ following as an orientation for research is inspired by Isabelle Stengers’ extended metaphor of the research scientist as tracker (Stengers, 1989/1997). In contrast to the “hunting in a pack” that is practiced by many scientists who seek to identify, narrow and capture the research-problem from every direction, the tracker practices “empathy”, allowing the research itself to suggest different and novel directions (Stengers, 1989/1997: 128; Bhangu et al., 2016). The German word for “empathy” – *einfühlung* – translates directly as “feeling into”. Without taking too many liberties with Stengers’ writing, I read “the art of [feeling into]” practiced by Stengers’ tracker-scientist as a negotiation between the pull of the questions of research, and the acuity of the scientist(s) tracing and following them (Stengers, 1989/1997: 128).

I see a resonance in these ideas with the gradual pace at which I was allowed access into the work of Studio Saraceno and especially the series of experiments gathered around the concepts of *Becoming Aerosolar* and the *Aerocene*. In the process, like many ethnographers, I formed intellectual and personal relationships with people and the things that inspire them. To be sure, the metaphor of tracking can only go so far; in other connotations it may suggest stalking, annoyance, or even a form of predation that is incompatible with my experience. In the way I have developed it here, tracking or feeling-into is similar to what Latham (2003: 2000) calls “feeling-toward a method” in which the methods of research are not predetermined, but emerge over the twisting story of investigation, trial, and error. This process required a shift in what I understood to be my role as a researcher, and what was possible in this role. Finding myself thoroughly immersed in a space of dense relations at once concrete

and enigmatic, not unlike that of Baudelaire’s forest of *Correspondances*, I traced a sequence of impressions that added up to an intimate understanding of the work of an artist whose practice is among the most novel and transdisciplinary today. In doing so, I formulated the notion of cosmological aesthetics that is both expressed and complicated by the work of Tomás Saraceno.

In holding to a concept of following, tracking, or being pulled along, my methodology resonates with the series of projects in, “non-representational theories” (Lorimer, 2008; Thrift, 2008), insofar as, “a non-representational method involves an intensification of problems *and requires staying with those problems for a while*” (emphasis added; Ash and Anderson, 2015: 48). As in the metaphor of the track, “staying with” is not passive, but an athletic and agile practice. However, just as “problem” and “field” cannot be dissociated, “staying with problems” is also, “to explicate the background of life and thought without presuming that the background is simply an inert “context” or that the background is a mysterious, inaccessible, substance outside of all mediation” (Ash and Anderson, 2015: 48). In my project, explicating the “background” of the work of Studio Saraceno meant taking part in experiments that extended far outside of the studio space – indeed into spaces that would not normally be considered part of the art world. My attempt to convey the qualities of this “expanded field” (see Hawkins, 2013a) of artistic work is achieved through a range of methods including participant interviews and observation, creative writing, image-making and diagramming, all of which transmit the many stories of creative projects realized and unrealized, concepts tested and abandoned, and the personal histories caught up in them. The diversity of methods in my approach is not meant to obscure, but to better attend to Saraceno’s work as it is carried out in myriad collaborations with people inside and outside the studio, and to grasp its relation to a wider context of thinking and experimentation with the atmospheric, the elemental and the cosmic. The more I worked with Saraceno, the more I also understood that a plurality of tools are necessary to discern the ways in which the artist’s projects are lured by the intangible and the imperceptible.

The inheritance I draw from non-representational theory is also that this body of work, “takes the energy of the sense-catching forms of things seriously” (Thrift, 2008: 9), and it acknowledges, “how the

whole business of praxis and poeisis is wrapped up in the stubborn plainness of a field of things” (Thrift, 2008: 8). The ‘energy of the sense-catching forms of things,’ will play important organizing roles in this dissertation. I will show that a degree of abstraction is necessary to capture the attachments between and among surfaces, spheres, webs, and interstices in the multi-sited work of Studio Saraceno. Drawing from human and cultural geography as well as philosophy and aesthetics, my work is supported by claims that a degree of abstraction does not reduce, but allows us to better “grasp” the patterning and propagation of forms as physical and conceptual tools (Massumi, 2002; McCormack, 2012). Still, an attention to the agency of specific forms is as important as questioning, “the solidity of the world, since so much of it is ultimately mutable” (Thrift, 2008: 8). The thingness of a form-in-the-air, as Tim Ingold has beautifully illustrated, includes the lines, vortices and eddies that extend from what we would normally define as its boundary (Ingold, 2009). Furthermore, a method of *feeling-into* the practice of Studio Tomás Saraceno (Figure 1) required specific skills and vocabularies: for example, an ability to recognize the different webs of solitary and social spider species, to reference thinkers like Guattari, Rudofsky and Latour, and to use the various templates of aerosolar sculpture design.



Figure 1: A frame / model of a tetra-kai-decahedron standing in shallow water on the roof of Studio Tomás Saraceno during a cloudy day in spring / summer 2014. Photography by Sasha Engelmann.

Furthermore, I understand atmospheres as simultaneous affective and meteorological entities that are useful for exploring the lived experiences, experiments and production of Studio Saraceno. For example, the meteorological conditions of a field in Berlin, and the way these generate or close down possibilities for the flight of air-catching things, enfold and catalyze affective conditions that are sensed and transmitted by practitioners (explored further in Chapter 6). Equally, the particular atmospheres of Studio Saraceno are engendered and influenced by certain kinds and rhythms of work: these are atmospheres composed of half-finished ideas circulating through hands and bodies, the repetition of familiar tetrahedrons and dodecahedrons, kites hanging from beams in the ceiling, the stirring presence of Saraceno himself dressed in many shades of blue, the collective elation around commissions won and executed, heavy doors opening and closing, the cool half-light streaming through large industrial windows, and the periodic vibrations of Balearic techno, the 3D-printer or espresso machine. According to Anderson and Ash (2015) an “atmospheric method” is one that apprehends the ways atmospheres selectively affect and “weigh” on each other, radically changing the textures of experience. Atmospheric

method is a science of attention and attunement to atmosphere. Becoming attuned to the qualities of atmosphere figured prominently in my understanding of life and work in Studio Saraceno.

Before moving to further accounts of my methodology, one more point is apposite. This has to do with the “cosmicity” of the practices at Studio Saraceno. In the essay, “Introductory Notes on an Ecology of Practices” Isabelle Stengers writes:

...each achievement in the ecology of practice, that is, each (always partial) relation between practices as such, as they diverge, must be celebrated as a ‘cosmic event,’ a mutation which does not depend on humans only, but on humans as belonging, which means they are obliged and exposed by their obligations. (Stengers, 2013: 192)

Stengers argues that humans *belong* to events by virtue of their *obligations*, which involve attachments to nonhumans, devices, relations and materials. However what is always missing for me when I read accounts of Stenger’s “cosmic events” and their attendant “cosmopolitics” is an adequate account of the imagination: the creative ability to invent and form associations. The imagination obliges human practitioners to practices, and also catalyzes the, “experimental togetherness among practices” which Stengers calls “endurance” (Stengers, 2010). Stengers attributes this gathering tendency primarily to the fact that each practice fosters its own force, resulting in, “a dynamics of pragmatic learning of what works and how” (Stengers, 2005: 195). As Latour has also shown, the work of scientific practitioners is animated by “experimental factishes” or fictions – specific (often visual) notions of theory or method that makes practices interesting (Latour, 1999). Still, less has been made of the “imaginative urgency” of such practices and their visual-sensorial allure: for example, the attractions of diagrams, images and descriptions and their roles in creating experimental inertia.

No less present in the ecology of practices at Studio Saraceno, and I suspect in the labs of physicists and natural scientists too, is what Gaston Bachelard calls “cosmicity” (Bachelard, 1958/1964). Cosmicity refers to “poetic reverberation” – sensual and psychic resonances – or, “an abstract-concrete

daydream” (Bachelard, 1958/1964: 28).³³ Cosmicity is performed by the sleepless philosopher who trains his mind to hear the ebb and flow of a vast ocean in the hubbub of the chaotic, nighttime city (Bachelard, 1958/1964). Likewise, it is found in the quest to compare the web of a black widow with the “cosmic web” of the universe (see Chapter Five) or the extrapolation of futures of “cumulo-cities,” and “cirrus-cities” from a balloon-sculpture made of reused plastic bags (Chapter Seven). My point is that speaking of an ecology of practices at Studio Saraceno in terms of attachment and obligation leaves out a crucial part – namely, the specific kinds of imagination, cosmicity and poetics which lend intensity, enchantment and attraction to these experiments and which differentiate Tomás Saraceno’s work from that of other artists or architects. Production and practice at Studio Saraceno is not only cosmopolitan but also cosmo-poetic (Ait-Touati, 2011) and cosmo-aesthetic.

An *aerial transponder* is a tool for measuring the velocity of aerial objects. It works by sending pulses at specific intervals that define the transponder’s *interrogative mode*. It functions in a way analogous to the wolf spider who sends out pulses of turbulence in ambient air, feeling the environment’s returning vibrations. In the sections that follow, I will detail three methodological devices, or moving transponders, which animated and organized my research practice. These are: tracing the space of percolation (Serres, 2001), working knowledges together (Verran cited in Wakeford and Lury, 2012: 17; Holmes and Marcus, 2006), and collaborative writing. I like to think of these as transponders for my research because they each represent different modes of communication and interrogation that punctuated my fieldwork at different intervals and spaces. They emerged from the ongoing experiment of feeling-into a method. And they are not all equal in importance or in amplitude: I have written them into this chapter in a sequence that conveys periodic staging and re-staging of my research project. They blend and weave with the more concrete materials generated from interviews,

³³ This is not to mean that Stengers leaves no place for the imagination. Indeed in her writing with Ilya Prigogine, the force of the notion of the Big Bang as a “narrative element” equal in imaginative allure to ancient and indigenous cosmologies is well noted, especially by Felix Guattari (Prigogine and Stengers (1988) cited in Guattari, 1992/1995: 132). However, in my engagement with the work of Saraceno, and indeed with many of his non-artist collaborators, I found that art and imagination had to be better acknowledged in order to account for the quality of the practices at hand.

photographs, participation, observations and other kinds of recording. I believe these three devices are ‘inventive’ in that, “they [do] not leave [the] problem untouched” (Lury and Wakeford, 2012): each created and maintained a different relation in my role on various projects, and also made impressions on the work of Studio Saraceno. Like Dewsbury’s (2003) description of concepts, these transponders are, “props for the act of witnessing” (2003: 1912). They may be, “costly in the exchange of certainty, but they assure creativity... and allow openness” (*ibid*). I will elucidate how each of these recurrent modes of engagement leaves room for the cosmic and cosmological to breathe and reassemble, and to inspire ongoing collaborative work that cannot possibly be contained by the chapters in this thesis.

Percolation

By entering the world of Studio Tomás Saraceno, I was introduced to a lively ecology of practices involving the research, experiment and production of artworks, exhibitions, publications, and university curricula. I witnessed the range of spaces in which Tomás Saraceno and members of the studio carried out experiments with everything from South American spider species to Riemannian geometries to stratospheric balloons. My goal was not to remain an observer, but to enter into this field of practice, to get “mixed up” in it, and to “[experiment] with questions which practitioners may accept as relevant” (Stengers, 2005: 184). This meant entering into the milieu of the studio, at first daily and then approximately once a week, to participate when matters and forms were “stuck” as much as when they seemed “to flow” (Figure 2; Serres, 2001).

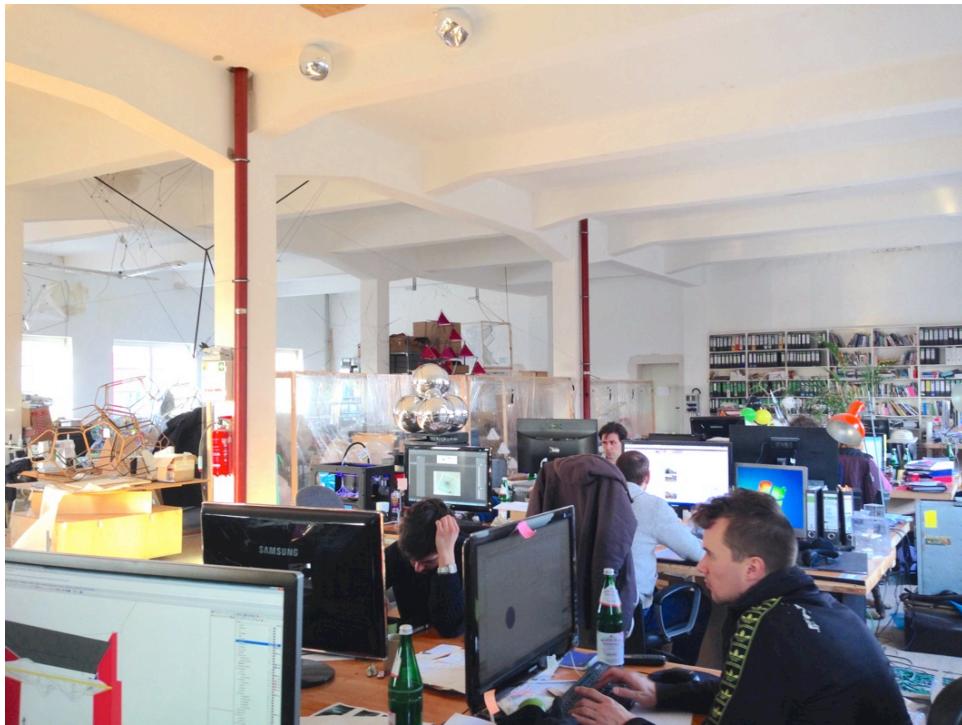


Figure 2: A working day at Studio Tomás Saraceno, March 2014.
Photography by Sasha Engelmann

Before moving further into the description of percolation at Studio Saraceno, I want to give some detail to the routine methods I practiced throughout my fieldwork. I kept a series of field notebooks in which I noted observations from days at the studio, wrote down questions for interviews, made small drawings of installations and sculptures, and kept a running log of ideas for writing. I also took close to 8,000 photographs within the studio and at the many other events that occurred around it. Some of these photographs are found throughout this thesis.³⁴ I found drawing and diagramming very useful for engaging with studio conversations. Like most trained architects, Saraceno sketches constantly, on almost anything he can find. When we had meetings together in the studio, he often drew out what he meant by a certain model or idea, and I often photographed or kept these fragmentary drawings to refer to later. I also made my own drawings to understand concepts, or added to those

³⁴ I was informed by studio members at an early stage that publishing my photographs online or in other public forums would be undesirable unless previously agreed upon. Therefore members of Studio Saraceno have approved (and offered advice on captioning) on all of the images in this dissertation.

Saraceno had made. I found these to be important reference points. In fact, this practice was much more useful to the progress of my research than the series of photographs or videos I produced.

My method of drawing and diagramming was informed by geographers' attentions to such techniques. Latham's (2003) use of the Diary Photograph, Diary Interview Method (DPDIM) identifies diagrammatic associations sketched by participants who are asked to detail their daily schedules. In particular, my engagement with Saraceno's sketchbook in Chapter 4 takes cues from Latham's work: the qualities of exaggeration and caricature of Saraceno's figures convey the drama of an installation's atmospheric states. McCormack's explorations of drawing and diagramming also significantly inspire my work, from his diagrams of rhythm (McCormack, 2002) to those elaborating spaces of movement, performance and experiment (McCormack, 2003; 2004). As McCormack writes in an author's response to a series of commentaries on his book *Refrains for Moving Bodies* (2014a):

Diagramming is a way of drawing together concepts for making this kind of spacetimes travel possible. Diagramming is a holding in tension, in which some kind of constraint gives something shape while holding it open. (McCormack, 2016: 226)

The drawings and diagrams I produced during my fieldwork "held open" spaces of thinking and experiment to which I returned. I understand these diagrams' relation to spacetime-travel as one of sustaining the play of specific concepts over time.

I conducted a series of interviews with almost all of the core members of the studio, as well as some tangential members (for example interns), and in some cases repeated interviews. On one occasion I conducted a group interview with three members of the production team. However I found that formal interviews were not the best way to understand the roles of studio members, for several reasons. First, it proved difficult to schedule formal interviews in the studio, as most individuals had absolutely no time to spare during the day, and if they did, they felt uncomfortable speaking about some aspects of studio life while in the studio itself. I was able to arrange to meet several people for formal interviews outside the studio space and working hours. While these interactions were useful, they were sometimes strained. However, as I became more familiar with the life of the studio, I found that I could have interesting

conversations while talking about a model, a try-out, a drawing or an exhibition. Having some physical basis for the conversation encouraged insights that would not have emerged in an alternative space (Figure 3). Therefore I began writing down notes and phrases from conversations I had in this second way, and used them to supplement what I learned from participant interviews. I could not record these latter exchanges. However I feel that the notes I recorded from these conversations are detailed and abundant enough to function as equal to interviews in terms of the expression of ideas, concepts, associations and affects.



Figure 3: A few models at Studio Tomas Saraceno in March 2014.
Photography by Sasha Engelmann

I would like to emphasize the unfolding history of my work and engagement with Tomás Saraceno and his studio. Upon arriving at the studio in Berlin in early March 2014, I immediately noticed the diversity of experimental work undertaken by the studio team. In the context of much of the current work in cultural and creative geographies, which evidences scholars studying and “audiencing” site-specific artworks (Warren, 2013; Yusoff and Gabrys, 2006) spending time in artists’ studios

(Hawkins, 2010; 2013b; 2015a; Lapworth, 2015; Sjoholom, 2014), curating with artists (DeSilvey, 2003, 2006; Hawkins, 2013b), “animating archives” (Lorimer, 2009; DeSilvey, 2007; Mills, 2013) and co-producing work with artists (Barry and Kimbell, 2005; Foster and Lorimer, 2007), my work could be described as an in-depth, long-term collaborative and co-productive relationship with Saraceno and his studio. I believe that the degree to which I became a part of the creative space of Studio Saraceno, contributing not only to components of exhibitions but also to the major new projects *Becoming Aerosolar* and the *Aerocene* is an example of creative-geographical co-production that is unique in the field. It is unique because my extended collaboration with Saraceno went far beyond the researcher / research subject, ethnographer / field, or critic / artist relationship; rather, Saraceno and I found *common lures* that animated several mutually engaging research questions and fed directly into both of our practices, however different our disciplinary foundations. This work is still ongoing. As I write this paragraph, I am 4,000 meters in altitude at the Salar de Uyuni in the Bolivian Andes on an expedition with Saraceno, Jol Thomson, Daniel Schulz, Tato Chavez, Martina Pelacchi, Tobias Lange, Maxi Laina, Bernd Proschold and Jan Hattenbach to launch several aerosolar sculptures over the world’s largest salt lake and record timelapse images of the cosmos reflected in the lake surface (Interstice I; Figure 4). Therefore this dissertation is written entirely within the space of continued collaboration. It is not an ‘objective’ overview of this work, but an attempt in writing through the intricate, messy weave of research-creation (DeLyser and Hawkins, 2014; Manning and Massumi, 2014).



Figure 4: A tent on the bank of the Salar de Uyuni where I spent many hours in January 2016 watching two timelapse cameras taking composite images of astronomical entities. The tent was inhabited in shifts by other members of the small team from Studio Saraceno. It became, for me, an important site of quiet reflection.

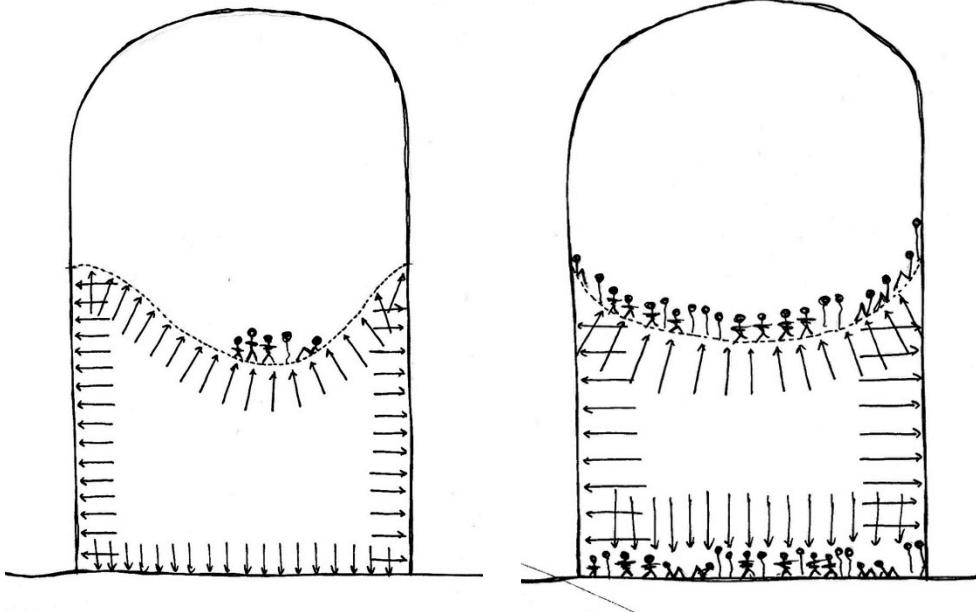
Photography by Sasha Engelmann

The process of staying with problems becomes more difficult when there appear to be multiple paths to take, or when in fact there is so much material and so many competing options one can't move at all. In my experience at Studio Saraceno, part of the capacity to track a project's development means understanding its space of "percolation" (Serres, 2001; Stengers, 2010: 236). The notion of "percolation" was articulated by Michel Serres for the history of geometry (2001), and adapted by Stengers to a reading of the meandering histories of thermodynamics, in which a number of descriptions of equilibria and the importance of entropy converged and competed. Stengers contends that it is impossible to predict, from the actors and the field of interaction, why a single research trajectory prevails. She writes, "connections between [concepts, theories and actors] may become locally denser until, at some point, a threshold is reached and things begin to "flow"" (Stengers, 2010: 237). Further she adds, "it is all those absent histories, all the questions that weren't asked or were left unanswered, that delineate the true space of percolation" (Stengers, 2010: 238). The most visible trajectory may not,

after percolating, resolve all the questions that were there in the first place. However those questions and uncertainties do not disappear. Thinking through the space of percolation reveals that there are many false starts, ideas, and directions that may temporarily ‘dry up’ but return again and again.

My first experience of Studio Saraceno was one of percolation. On the very first day I visited Studio Saraceno in March 2014, I worked with Saraceno, Jol Thomson and Edgar Diaz on a series of drawings to conceptualize a new artwork for an upcoming exhibition in Toulouse. We produced drawings of various potential “atmospheric states” of the artwork, including one in which the breathing of viewers underneath a membranous surface caused the pressure to increase and the volume of the membrane to expand, pushing those on top of the membrane higher. Others articulated the relative pressure levels felt by viewers above and below (Figures 5 and 6). Another scenario involved the artwork launching from the museum and becoming a balloon (or the cosmic microwave background, see Interstice II). Still another represented the membranous artwork spanning the height of the troposphere, with a depth reaching to the core of the Earth. At the time, I was fascinated by the practice of drawing out these sometimes plausible, and often absurd “atmospheric states” of an artwork. As the planning and conversation for this exhibition continued over the summer, the single-membrane installation idea was set aside in favor of *Museo Aero Solar*, a collectively constructed aerosolar sculpture made from re-used plastic bags. The initial drawings spent months untouched, in my notebook. Looking back at this series, however, I read these as a palimpsest of the concepts circulating in the studio during a specific period of time. The trajectories contained within them “dried up” only temporarily (or not at all). The device of a membrane that inflates through the respiration of inhabitants appeared in the aerosolar sculptures constructed by Saraceno with students in Germany and Peru in November and December 2014 and in Germany and Austria in 2015. The drawings I made with Diaz would return in slide presentations for future artworks, in one instance illustrating the afterlife of another installation. The “true space of percolation” is not reducible to the story of the artwork that was exhibited, but also the range of conceptual play and experiment in the diagrams I have described, diagrams that “hold open” specific

concepts and experiments. It is the space of percolation, as much as the ultimate direction of flow, which I aim to make present in these chapters.



Figures 5 and 6: Atmospheric states of the installation proposal for Tomás Saraceno's submission to "Pour un monument à l'Anthropocène" curated by Bruno Latour and Bronislaw Szerszynski at Les Abattoirs, Toulouse.
Studio Tomás Saraceno, March 2014.
Drawing by Sasha Engelmann

But “percolation” has further meaning for Tomás Saraceno’s practice. Saraceno’s projects are animated by a remarkable consistency of play with certain key concepts. As Thomson explains:

You could think about [Tomás Saraceno’s] practice and his obsessions as a series of waves... with peaks and troughs, and with interference patterns. There’s more than just one frequency of wave, so you get different peaks coming [through]. So, the solar balloon has always been there, the lighter than air has always been there, the geometry has always been there, [but] sometimes it’s underneath where another wave is peaking (Thomson, 2014b: np).

While certain “frequencies” or “waves” gain greater degrees of attention and visibility in the studio, other frequencies are always percolating. There is a difference between a practice founded on the continuation of different projects, and one founded on different frequencies of attention. The former is a

well-established way of working; indeed, most practitioners of scholarly and / or creative work keep several projects going simultaneously, often on different time scales. The claim Thomson is making with the reference to wave-patterns is that Saraceno cultivates a few ongoing meta-streams or meta-currents that are usually linked to certain forms and provide the strata from which different projects emerge. How does one devise a methodology that is adequate to the always ebbing, peaking, flowing and multiplying qualities of this kind of artistic practice? Thomson – a long-term collaborator and close friend of Saraceno’s, and an artist in his own right – was an important interlocutor for this aspect of my methodology. Through many conversations, we identified four diagrams that would help organize a path through the pores of studio-percolation. As I progressed, the abstract figures of surfaces, nets, spheres and bubbles with which I began working, shifted to become membranes, webs, envelopes and interstices. The process of *shifting* occurred as I understood what a specific form was *doing* – how it was put to work – in the spaces of installations, across scales, in models, and in repeated experiments. In the quote that opens this chapter, Serres describes intellectual history as, “*a complex surface, conveying wormholes of sheer acceleration, bottlenecks of stoppage or equilibrium, zones of stationary values, several fragmentations...*” (emphasis mine; Serres, 2001: 377). The ability to think of the many stories of artworks in diagrammatic attunements and attachments was as central to my methodology as the sensing, recording and articulating of these stories. This methodological practice inflected my immersive ethnographic experience of the studio’s community and atmospheres. In the phase of “working knowledges together,” to which I will now turn, these diagrams functioned as modes of communication between my spheres of knowledge and those of the studio.

Working Knowledges Together

A major risk inherent in my ethnography was that my research would merge with that of Saraceno or the studio, and that I would lose a critical or objective “edge” as a researcher-scientist. The practice of working closely with Saraceno and his team was a bit like “crawl[ing] out to the edge of the cliff of the conceptual” (Vendler, 1995: 79 cited in Thrift, 2008: 12), and it placed many of my plans

(e.g. writing deadlines) and boundaries (e.g. normal working hours) at risk. It was easy to be carried away on the inertia of Saraceno's visions (and this happened on several occasions). Still, the work I did to regain my steps was always productive. Moreover, once I realized that the practices of the studio were as much about a series of organized fictions as the fabrication of forms, my task became more clear: not to retell these fictions, but to understand their histories, follow their unfolding from a series of equally relevant, latent possibilities, and, "make present what causes [the studio's] practitioners to think and feel and act" along the way (Stengers, 2010: 195).

Based on the degree to which I was immersed and participated in Studio Saraceno, my fieldwork could be called a "creative" or "para-ethnography" (Hawkins, 2013a; Holmes and Marcus, 2006; 2008a; 2008b). It was ethnographic because I devoted time and energy to joining the life of the studio. I shared coffee and food with the studio members, learned the names of all the spiders, witnessed the birth and death of countless models and prototypes, navigated the labyrinth of the Studio's "BACKUP" and "BACKUP2" hard drives, attended celebrations on boats on the Spree, dealt with noise, vibration, dust, heat, cold, paint and smoke. After weeks and months in Berlin, I increasingly understood the roles played by various studio members. Not unlike a *Nephila kenianensis* spider, I documented the "view" from the middle, including the patterns and rhythms of studio life and the necessary shifts in my own work and habits.

My ethnography was "creative" for several reasons. First, I extended my skills beyond those of documentation to drawing, designing and making. This applied especially to the design and construction of aerosolar sculptures, primarily in the context of teaching with Adrian Krell, Stefano Arrighi, Daniel Schulz, Martina Marciak, Kotryna Šlapšinskaitė, Alex Bouchner, Jol Thomson and Tomás Saraceno the Technical University of Braunschweig. The ability to highlight and joke about my incompetence in such tasks relative to the other studio members was one way to engage in conversations about techniques or practices, as also reflected in the work of Parr (2007) on filmmaking. Second, I became involved with the development of a few important exhibitions. And third, I edited and wrote texts for the studio's own books and catalogues, articulating not only the artworks but also the conversations and collaborations

supporting them. Often Saraceno asked for my thoughts on presentations, prototypes, and experiments. As our relationship developed, I was invited to meetings with curators, collectors, research scientists, and institutions like the French space agency (CNES), for example. My collaborative work with Saraceno was truly “multi-sited” (Holmes and Marcus, 2008a) and included: a conference presentation in Berlin, a magazine publication for an exhibition in Toulouse, aerosolar sculpture workshops in France and Germany, undergraduate and graduate seminars at the Technical University of Braunschweig, interviews with scientists at CNES in Paris, Tomás Saraceno’s first solo exhibition in Vienna, a public performance of the instrument *Cosmic Dust and the Breathing Ensemble* at the Haus der Kulturen der Welt in Berlin, an aerosolar sculpture seminar in Cappadocia, Turkey, and several days launching aerosolar sculptures at the Salar de Uyuni, Bolivia.

I have used the term “para-ethnography” following Holmes and Marcus (2008b) for a few reasons. First, because I found myself in an ecology of practices that was as much about the creation of marketable art-objects as it was about forms of knowledge production. Aspects of work at Studio Saraceno resonated with that of “medialabs” or “fab-labs” in their adaptation of methods from diverse fields including biology, spectrometry, computer science, geometry and sociology. The experience of this space of experiment and production necessarily affected my own “dialogues and doings” as a geographer and ethnographer, as I recognized the liminal border between my own methods of research and those carried out in the studio (Hawkins, 2011). In fact, the collection of materials for exhibitions like *Pour un monument à l’Anthropocene* at Les Abattoirs, Toulouse could be described as ethnographic, and resonates with claims made by art historians like Hal Foster and Miwon Kwon that contemporary artists increasingly adopt ethnographic methods to deconstruct the production of knowledge and the constitution of authorship embedded in that knowledge (Coles, 2000; Foster, 2009; Kwon, 1997). Second, “para-ethnography” conveys that my relation to Tomás Saraceno became one of, “working knowledges together” or, “negotiating the creation of new, partially shared imaginaries without... relying on one homogenizing translation into a dominant party’s terms” (Verran cited in Wakeford and Lury, 2012: 17). I believe the phrase “working knowledges together” aptly relates how Saraceno and I

shared, discussed and presented ideas and research, for example in the preparation for a paper at a large climate engineering conference (CEC14) in Berlin. It also encapsulates a style of presentation and articulation that we developed, and continue to practice now.

Underlying the practice of “working knowledges together” is the fact that my work cannot be articulated through the frame of traditional ethnography, nor along the lines of most of the work emerging in “participatory research” in social and cultural geography as demarcated by Kindon (2003) and Pain and Kindon (2007) among others. Partly, this is because the relations between myself, and the community of Studio Saraceno did not fit along the axes of researcher / maker, conceptual / concrete or critical / practical. In contrast to the projects of researchers who engage with contemporary art organizations and initiatives (Gibbs, 2014; Hawkins et al., 2015), for example, in which the researcher-scientist is understood to have some capacity to enrich or to have impact on the work of such groups, my engagement with Studio Saraceno exhibited different, no less complex, relations of praxis. At the beginning, the process of “working knowledges together” was not symmetric, as Saraceno played the role of the “dominant party” in organizing and directing the work we did together. From my first day at the studio, Saraceno suggested I help articulate one of his new artworks in the context of the exhibition *Pour un monument à l'Anthropocène* (2014) curated by Bruno Latour, Olivier Michelon and Bronislaw Szerszynski, and thereafter in various other projects, including one to develop a new curriculum for architecture and art students. While I do think our work became truly collaborative, the momentum of Saraceno’s visions sometimes threatened to overwhelm my own. Often, I enjoyed being overwhelmed in this way. However, as Holmes and Marcus (2008a) state, the problem many ethnographers face of “going native,” “is the problem of not just appearing to go along with the collaborative milieu in order to do ethnography but also responding to the environmental imperatives to work collaboratively” (2008a: 85). In other words, it is to become comfortable with constantly re-asserting the axes of collaboration in many contexts. I had to negotiate a space in which I could work productively with Saraceno, and let this process shift and re-orient my research questions without either absorbing Saraceno’s ideas for my

dissertation, or offering up my ethnography and working hours to be employed by the major currents of the studio's production.

To measure how well I succeeded, I can at least point to many changes in the nature of my position as a researcher at the studio, made explicit in the increasing interest taken in my work by the other studio members, the different roles Saraceno invented to carve a space for my contributions and the degree to which Saraceno began to cite my writing as an influence on his work, for example in credits on the *Aerocene* project website. Saraceno wrote the following:

I would like to thank Sasha Engelmann, [e]specially for dedicating numerous years [of] her rich and thorough PhD research on my work, her willingness and commitment to take part in different instantiations throughout this period of time, and the enrichment brought to my working field and practice. (Saraceno et al., 2015; *Aerocene* Website)

Most importantly, toward Spring 2015, Saraceno increasingly voiced his view of our collaboration, saying: "it takes a bit of time of understanding the space of each," but also, "this generosity of dialogue is what I enjoy most" (Saraceno, 2015: np). To me, these articulations speak volumes about the degree to which Saraceno and I became collaborators while maintaining a degree of autonomy. Nevertheless, as Hester Parr eloquently writes:

In the messy realities of participative encounters, perhaps especially those with creativity at their core, powerful capacities for change are evoked in unexpected and often personal ways amongst all actors, and hence continue to disrupt the myth of the objective and purely observant social scientist. (Parr, 2007: 130)

As this passage suggests, the reassertion of the roles of research does not leave one untouched, indifferent or objective. As I worked more closely with Saraceno, Jol Thomson, Stefano Arrighi, Kotryna Slapskinskaité, Adrian Krell, Sara Ferrar, Desire Valdez, Tato Chavez, Daniel Schulz, Ignas Petronis, Sofia Lemos and many other members of the studio, I became personally invested in this community and a part of it. While this collaboration was rewarding, significant effort lay in maintaining

a reflexive stance on what joining this community – and all of its spaces and degrees of relation – could mean for my research.

There are a few additional aspects of working in Studio Saraceno that deserve mention here. The first is its familial quality. Many of the active members of the studio are dear friends. They share food, apartments, language (mostly Spanish and Italian) as well as a common workspace. In a group interview during my first month at the studio, Pelacchi, a member of the production team, said: “Berlin is not my city and I have no family here, and for this I found my family at the studio” (Pelacchi, personal interview, 2014). This sentiment was echoed by others: “It’s like a family here... sometimes we get crazy but most of the time it’s a nice atmosphere” (Ferrar, personal interview, *ibid*) and, “this will be our house” (*ibid*). The previous years had witnessed dramatic change in the studio, as it moved to a larger space in Berlin and grew from around 12 to 30 members: “For me the sad thing is that in the last studio, because we were less people, we were very close, you know... now it’s strange because we are more people, but because of the way we are here there is less communication and this is a pity, but I think this will change... little by little” (Ferrar, personal interview, 2014). Sometimes, there were moments like this:

Last year we went all together to the lake. We were working but it was too hot, [so] we rented six boats and we stayed all afternoon in this lake all together. These moments are super cool to break the tension sometimes, and to learn more about each other... (Pelacchi, personal interview, 2014)

During my time at the studio there were many similar occasions to relax together, including a sunset boat ride on the Spree, a midnight drum circle on the roof of the studio, and aerosolar sculpture workshops that progressed from dusk until dawn. During these experiences, I witnessed moments and had conversations that illuminated much more about the architecture and society of the studio than many of my formal interviews.

Another, equally important point is that despite the growth of the studio, its organization is relatively horizontal. There are members with managerial responsibility and experience, those who

speak directly with curators, gallerists, and directors of museums, and carry out studio visits. However, at least during the time I spent working daily at the studio, it was sometimes unclear how authority was practiced. Saraceno maintains oversight over all projects, from the exact magenta of colored panels on his “cloud” models, to the precise angle at which they hang, to the species of spiders in hybrid webs and the angles on which the webs are turned, to the author-contributors and layout of print publications. Furthermore, as Ferrar, Valdez and Pelacchi told me, the skills required for studio work are only partially technical. There is a consensus that studio work is best when, “our minds are close to [that of] Tomás” (Ferrar, personal interview, 2014). More important than practical skill is that, “we don’t do it from our thinking we always do it from Tomás’ thinking” and, “all artworks are part of one vision... Tomás’ vision” (Pelacchi, personal interview, 2014). During an early interview Valdez expressed that she was still learning these patterns in the work, or “the mind of Tomás” (Valdez, personal interview, 2014). While this phrase suggests a disembodied “mind” of an artist, overseeing the work of the studio, it is better understood as a sensitivity to the ongoing sub-currents or strata that subtend work at Studio Saraceno. This form of sensitivity or attunement does not preclude members from experimenting: with a new material, a different orientation, or a distorted form. Ferrar said she sometimes makes new “tryouts” and shows them to Saraceno; sometimes he likes the direction and challenges her to make adjustments or to finish the idea in other ways. The point here is that in contrast to an architectural office or another large art studio where the work is dictated in hierarchical, managerial fashion, there is autonomy exercised by the members of Studio Saraceno from conceptual to architectural and production work – albeit an autonomy that comes with a degree of commitment to understanding Saraceno’s style. If these factors – of horizontality and autonomy – may sometimes reduce the efficiency of studio production, what is gained is a studio space that is more experimental (Melendez, personal interview, 2014). In fact, Studio Saraceno is very unique as an art studio in that it produces all of the components of sculptures “in house,” from delicate knot-tying to large-scale metal welding (Chavez, personal communication, 2016). Materials and concepts are adjusted, forms are re-arranged, new knots are tied, all in the ongoing spatial experiments with surfaces, webs, envelopes and interstices.



Figure 7: Pictured (left to right) are Chavez, Ferrar, Pelacchi and Valdez constructing a sculpture at Studio Saraceno in March 2014. Photography by Sasha Engelmann

The experimentality of production is a central part of the attachment formed between practitioners like Daniel Schulz and the work at Studio Saraceno. In an interview Schulz described how much he enjoyed experimenting with Saraceno on sculptures that fly:

I mean, [Tomas] put me always a bit on the border, to let things... really fly, to be able to construct a kite and let it fly, and yeah I was always try[ing] to get [it] into reality [so] that [the sculpture] works in the end outside with wind, and these moments were super nice together when things I constructed [flew], even if they were really simple, and nothing special and anyone else could have done it... some things were also a bit more complex and interesting where I would say maybe not everyone would be able to do it,

but this came a bit later, in the beginning it was really simple ... (Schulz, personal interview, 2015)

Schulz emphasizes the physical experimentation not only of constructing sculptures, but also of casting them into the wind (Figures 8 and 9). For Saraceno, as for Schulz, it is never enough that a sculpture *appears* weightless or aerodynamic – it must actually function this way, too. This gesture – of lifting a delicate sculpture into the air – distinguishes Saraceno’s work from that of most other artists who place frames around their artworks as soon as they are finished. It also creates and maintains an ongoing pattern of experimentation that keeps practitioners like Schulz inspired and engaged.



Figures 8 and 9: Testing some aerosolar sculptures (mostly kites) on Tempelhofer Feld in Berlin, November 24th, 2014. Left: Stefano Arrighi and Daniel Schulz. Right: Sasha Engelmann.
Photography by Sasha Engelmann and Stefano Arrighi

Although I did not make any wood or aluminum clouds, I also experienced a process of attuning to “the mind of Tomás”. One afternoon in late March 2014, Saraceno called the whole studio (about

thirty people) into the kitchen for a presentation. Before I could ask what was going to happen, Saraceno started speaking about the work of geologists and the placement of “golden spikes” in geologic formations. Saraceno’s way of speaking is very unique: he speaks fast in a South American accent, punctuated by very animated hand and body gestures. I was not prepared when, in the middle of a sentence, he hesitated, and looked at me across the room. Without thinking, I jumped in and elaborated on the concept of strata in Earth’s geologic layers, as if picking up a thread before it fell. But without warning Saraceno interrupted me mid-sentence and kept going, referencing the work of Latour on Earth system science. Again, he made a slight pause and this time I again felt compelled to continue where he left off. We continued like this for about an hour, sometimes taking questions from the Studio members. We stopped abruptly without having come to a conclusion.

This form of presentation was unlike anything I had done before, and felt like dancing: moving concepts and words around, semi-chaotically, without any clear goal. As I continued to work with Saraceno, this style of presentation became a skill that I practiced again and again. It certainly took some getting used to, and made giving standard conference presentations slightly challenging. Our presentation at the CEC14 conference (for which we had not rehearsed once) took the same form (Figure 10). However, afterward some studio members remarked to me how there was a good “back and forth” or “play” between us (Berendt, personal communication, 2014). The unique quality of these presentations was not evident to me until months later, during a series of meetings with curators in preparation for a new exhibition at the 21er Haus in Vienna. During these meetings, it suddenly dawned on me how accustomed I was to picking up on Saraceno’s gestures, understanding his South American, Italian and German-inflected speech, and catching and re-articulating certain points when I noticed they had not been picked up by his audience. Part of how I came to “work knowledges together” with Saraceno was to practice enunciating the concepts at play in his work, again and again, in both private and public spaces. This repetitive enunciative work fed directly into the more professional practice of writing together.



Figure 10: Tomás Saraceno and Sasha Engelmann giving a presentation on aerosolar sculptures and cloud cities at the Climate Engineering Conference 2014 (CEC14) in Berlin. Courtesy of IASS Potsdam.
Photography by IASS Potsdam.

Against Code: Collaborative Writing

I have often wondered why I was able to enter the studio and begin working so closely with Tomás Saraceno. At first, I attributed this to my perseverance in contacting the studio over the two years leading up to my fieldwork, and generally being in the right place at the right time. But a lunchtime meeting in May 2015 changed my understanding of this. During this meeting, Saraceno introduced me to Ignas Petronis, who had just joined the studio to work on upcoming publications. His introduction took the form of a small speech about how I had come to the studio, the various projects with which I had been involved, and my status as a collaborator with him in the studio and elsewhere. Saraceno said that I offered a critical discourse about his work that he found very “rich”. For him, my primary role was not in helping him with correspondence with distinguished academics. Rather, he emphasized that he saw useful and interesting reflections and impressions of his work in my writing, and in the writing we did together. This introduction was a preamble to asking me if I would like to be the official

“academic” or “scientific advisor” to the upcoming publications produced by Studio Saraceno for various exhibitions in Vienna, Paris, Karlsruhe and Singapore.

I now understand several aspects of what enabled me to exist and occupy a space within Studio Saraceno. The first is that I was allowed “in” because I came to the studio without, to use the terms of Deleuze and Guattari, attempting to interpret, in other words *to code*, the work of Saraceno, as so many art students, art historians and architectural theorists had before. The process of interpretation in contemporary art historical writing typically means that, “the interpreter is an agent of a dominant social code; the interpretation reproduces the material it considers as instances of the code” (Deleuze, Guattari and Brinkley, 1983: 13). As is evident from all formal interviews he has done, Saraceno desires to escape such codification: his responses to interview questions range from pseudo-allegorical stories about spider life, to mash-ups of texts from philosophers, scientists and entrepreneurs (Ackerman et al., 2011; Obrist, 2010). At the beginning of an interview with Marion Ackerman, Daniel Birnbaum, Hans Ulrich Obrist and Udo Kittelman, he stated:

Before we go any further, forget what is written here, *all my answers should resonate rather than be interpreted*, timber of colors, deaf composer, attuning vibrations, not sounds :-)
(emphasis mine; Saraceno in Ackerman et al., 2011: 42)

Such answers are enigmatic, even for those who know his work well. In other words, he, “abuses the discursive structures of the ‘major’ language to its own creative ends” (Hunter, 2007: 139). Language in this case might mean English, as well as the discursive currencies of contemporary art and architecture. As Brinkley (1983) writes following the work of Deleuze and Guattari on Kafka, “the desire to *de-code*... seems particularly crucial for minorities who want to remain minorities and affirm perspectives that are not those of the culture they inhabit” (italics mine; Deleuze, Guattari and Brinkley, 1983: 13). Saraceno’s work could be described as de-coding the intersecting cultures of both art and architecture – cultural spaces with which he has engaged for decades but never truly accepted. Saraceno’s is a practice that is fundamentally animated by experimenting. Indeed, “Experimentation,” Deleuze and Guattari

suggest, “is an alternative to interpretation” (Deleuze, Guattari and Brinkley, 1983: 14). Saraceno’s call for resonance over interpretation is illuminating.

If, according to Deleuze and Guattari, Kafka’s writing is “like crabgrass,” Saraceno’s artwork is truly spider web-like: a disorienting multiplicity of activities, materials and scales that can shift and form new configurations, yet retains a qualitative consistency (Deleuze, Guattari and Brinkley, 1983). As Deleuze and Guattari write of Kafka’s oeuvre, it is difficult to know where to enter this body of work (*ibid*). I suspect that the invitation I was given into the webbed space of Studio Saraceno was helped by my rather indeterminate personal and scholarly status: I was a student of Earth System Science and French literature before finding my way into the discipline of geography. I made my disciplinary background clear when I contacted the studio throughout 2013 and 2014. When I arrived there in March 2014, I had few preconceptions of what contemporary art could or should do. Moreover I had few connections in Berlin and was generally unaware of the particular scene of art there. And, in the aim of immersing myself in the studio, I was willing to try anything and everything from tying knots to editorial work to launching things in the air. All of these qualities I believe differed dramatically from the architecture and art history scholars who had previously asked to come to the studio to learn from Saraceno in order to develop their work in relation to his.

There is an ethics to this mode of working. The ethical dimension lies in the willingness *not* to apply interpretive or categorizing frames before immersing oneself in a site and a mode of practice. By this I do not mean abdicating positionality or neglecting expertise. Rather, entering the space of collaboration through a kind of *suspension of coding* allows a relational and ethical experiment to begin. This holds true not only for practices among researchers and artists, but also for engagements between different researchers, or between researchers and publics. I suspect that the further one progresses in a specific disciplinary field, the more coding becomes both useful and pervasive.³⁵ Resisting the

³⁵ On this point, Paul Harrison states it best for social scientists: “We – as practicing social scientists – are more or less bound to a language of mastery, a mastery which is the trait of social analysis as a work of thematisation, systematization, representation, conceptualization, and comprehension, and by which knowledge qua ontology

temptation to code therefore requires a careful training of openness to sites and situated voices; this is a technique that Stengers would argue can only be done by *risking* oneself in spaces alien to routine disciplinary work (Stengers, 1989/1997).

My role as a participant at Studio Saraceno intensified greatly when Saraceno and I began to write together. Throughout the course of one year, we co-wrote (together with Bronislaw Szerszynski) an essay called “Becoming Aerosolar: from Solar Sculptures to Cloud Cities” for Heather Davis and Etienne Turpin’s edited collection, *Art in the Anthropocene: Encounters Among Aesthetics, Politics, Environments and Epistemologies*. We also wrote a petition for changing the “laws of the air” which was distributed at the COP20 conference in Lima, Peru; a mission statement for the Institut für Architekturbezogene Kunst (IAK) at TU Braunschweig; descriptions of the *Aerocene* for the project website and news publications; and many shorter, unpublished texts. Perhaps unsurprisingly, these writing projects were difficult endeavors, partly because of Saraceno’s style of communication, and the intensity with which he expressed concepts: on one occasion he declared: “you write... *I feel* these [ideas]” (Saraceno, personal communication, 2015a). Such intensity of feeling often resulted in entire days of heated conversation and editing around the content of a text. But also, these experiments in writing together came to be organized around the ethos of the projects *Becoming Aerosolar* and the *Aerocene*. The possibility for Saraceno to write, and write-with, was (and is) predicated on a project that is articulated through a process of *becoming*:

To *become aerosolar* is to imagine a metabolic and thermodynamic transformation of human societies’ relation with both the Earth and the Sun. It is an invitation to think of new ways to move and sense the circulation of energy. And, it is a scalable process to re-pattern atmospheric dwelling and politics through an open-source ecology of practices, models, data... (Saraceno, Engelmann and Szerszynski, 2015: 59)

finds itself perpetually in conflict with the responsive journeying or going toward the other in their alterity” (Harrison, 2007: 596).

In other words, the quality of my work in the studio, and specifically with Saraceno himself, took on much greater possibility when we began to collaboratively articulate a field of actions, experiments and imaginaries called *becoming aerosolar*. To some extent *becoming aerosolar* and certainly the *Aerocene* might be termed “parafictions” in that they conjure worlds that are radically other than, but contiguous with, the present (Lambert-Beatty, 2009).

Creative geographers like Harriet Hawkins have addressed the process of collaborating on texts with artists as part of ethnographic research. Hawkins (2013b; 2015b) collaborated with artist Annie Lovejoy on *Insites*, an artist’s book drawing together textual and visual material relating the boundedness of site and creative production. As Hawkins eloquently relates, the process of producing this book involved activities that were more-than-editorial:

...talking with Lovejoy and walking and exploring with her, taking photos and drawing together, swimming in the sea and digging in the garden together, reading the books and looking at the artworks that interested her, sharing articles from art theory and geography, as well as looking back through her a sketch books and reading pieces of written work. (Hawkins, 2013b: 159; see also Hawkins, 2015b)

Similarly, the texts and publications I produced with Saraceno were distilled from countless meetings at Studio Saraceno, aerosolar sculpture launches, train rides all across Germany, sharing scholarly articles about everything from architecture to astrobiology, discussions with seminar students and many late nights in Berlin. Moreover, as Parr (2007) has shown in participatory video work, the process of editing the material, framing the concepts and the narrative, selecting elements to emphasize and delete, honed our understandings of what *becoming aerosolar* and the *Aerocene* could mean.

I read the story of my methodological engagement with Studio Saraceno as one of participating in the creation of a minor literature around Saraceno’s work. Phrased differently, my role is in developing the “interstitial theory” in Saraceno’s practice (Katz, 1996). I know from my experience and interviews with Saraceno’s long-term collaborators that my engagement with Saraceno manifested in one of his significant attempts to articulate his work in text or essay form: to develop a language that

provided a home for the diverse theories and experiments he had collected over many years. Most importantly, the texts we wrote together were less dialectic than “genuinely cartographic” (Katz, 1996): they gathered concepts in sequences and groups that were meticulously re-arranged and re-organized. The energy given to the phrasing of ideas, and the way they moved in the text, and in what sequence, was of utmost importance. In addition, these literary projects forced Saraceno, myself and co-authors like Jol Thomson and Bronislaw Szerszynski to be more precise about our roles in the collaboration. Therefore, in the process, these writing experiments, “[made] usable and shared maps of the worlds we inhabit[ed] collectively” (Katz, 1996: 495). To quote Saraceno again, this was “to understand the space of each” (Saraceno, personal communication, 2015a). If a picture is worth a multitude of words, such maps of practice and collaboration “can be worth a whole forest” (Latour, 1999: 24).

As I stated in the beginning of this chapter, my dissertation is not meant to be an overview of the work of Saraceno and his studio, but is an opening-out of my critical engagement with four major currents of the studio’s practice and research as they speak to wider themes of the aesthetic, the scalar, the more-than-human and the social. In other words, these are the four patterned frequencies with which I can sense, sonify and play-back Saraceno’s oeuvre. Or, they are airborne waves of communication between my position as a creative geographer and Saraceno’s position as an artist. Like all airborne waves, even those generated by the solitary spider, they are variously diffracted and shifted: these diffractions transmit the nature of the communication itself, as well as the intervening medium. This dissertation is the story of the recording and modulation of these vibrations, and an articulation of what is unique and captivating about their echoes for the discipline of geography.

Surfaces, Webs, Envelopes, Interstices

If there is an ethical dimension to the modes of practice I have detailed in this chapter, it is an experimental ethics. The capacity to experiment, and to experiment by working knowledges together, or *finding common lures*, already manifests an “alternative to interpretation” that shifts the space-times and registers of research (Deleuze, Guattari and Brinkley, 1983: 14). Indeed, as Olafur Eliasson stated in an

interview with Thomas Jellis, “experimenting is something to extend time” (Jellis, 2015: 373). The process of feeling-into a method is itself an experiment that lengthens the time one takes to find tools adequate to the encounter of research. This approach to method is akin to Saraceno and Schulz’ accounts of experimenting with aerial sculptures: the method is not adequate unless the thing *really flies*.

Each of my four empirical chapters harnesses different styles of interrogation and experiment. The first empirical chapter on surfaces draws largely from first-hand experience negotiating the artwork *On Space Time Foam* at Hangar Bicocca, Milan, during a site visit in winter 2013. This experience occurred before I had visited Studio Saraceno; therefore my notes from this adventure encompass my first impressions of Saraceno’s work without the reference point of studio materials or interviews. I later worked with a series of drawings in Studio Saraceno that helped me to map the concepts at play in *On Space Time Foam*. The second empirical chapter on “hybrid webs” was developed in the space of my first six months of time at Studio Saraceno, interspersed with a few travels back to the UK. It is therefore supported by my initial key-informant interviews, the *14 Billions* exhibition catalogue, and archival material – mostly images, diagrams and notes – found at the studio in this time. This second chapter also reflects a growing understanding of the role of the web as an aesthetic device that transacts Saraceno’s concepts and works, and is also a productive instrument through which to conceptualize the project of cosmological aesthetics.

In contrast to these two chapters, my third chapter on envelopes draws from my participation and engagement in “aerosolar sculpture workshops” throughout winter and spring 2014- 2015 in Toulouse, Berlin, Braunschweig and Vienna. This chapter marks a shift in my methodology, as I began to actively collaborate with Saraceno on the concept of *becoming aerosolar* through writing and experimentation. This was also the time when I began teaching with Saraceno at the IAK, TU Braunschweig. The process of collaborative teaching and curriculum development was an incredibly rich space of engagement, and is reflected in this chapter. Finally, the last chapter on the “interstitial politics,” of aerosolar sculpture practices is based on participation in the eventful politics of Saraceno’s *Aerocene* project, and repeated contact with the community and performance known as *Museo Aero Solar*, in which Saraceno is a

founding member. Over time, I learned that although it exists outside of the studio, *Museo Aero Solar* holds several keys to Saraceno's artistic values. This last empirical chapter is also informed by the production of two exhibitions: first, *Pour un Monument à l'Anthropocène* (2014) at Les Abattoirs, Toulouse, co-curated by Bruno Latour, Bronislaw Szerszynski and Olivier Michelon, and for which I co-edited a publication; and second, *Tomás Saraceno: Becoming Aerosolar* (2015) at the 21er Haus in Vienna, for which I co-wrote an essay in the exhibition catalogue, co-organized a symposium, and co-taught a group of graduate students who also presented their work in the exhibition.

Although the process of writing and editing required that I revise the materials for each chapter numerous times, there is nevertheless a development in the empirical bases for the four chapters: from embodied observation and attention to an atmospheric and membranous site-specific artwork; to an immersion in Studio Tomás Saraceno with all of its various human and non-human inhabitants; to an empiricist engagement with a series of unfolding aerosolar practices, sites and politics. Rather than erase or smooth-out these differences, I think they tell a relevant story of my own becoming-with or feeling-into the cosmological experiments at Studio Tomás Saraceno.



Interstice III: Sketches by Tomás Saraceno.

The drawings portray ideas for art installations, references, notes, reading lists, and various other things in the late-afternoon light streaming through studio windows during a day in summer 2014.

Photography by Sasha Engelmann.

The Cosmological Aesthetics of Surfaces: *On Space Time Foam*

The undulations produced in the nets by the weight and number of visitors shifts the network, pulling other visitors towards certain points like a vortex as their bodily weights become added together. Your ability to move from point A to B becomes affected as the critical mass deforms space and time, spaces disappear underfoot, a black hole that's not yet there! – Tomás Saraceno in Ackerman et al., 2011

How can a surface animate an experience of the cosmological qualities of space-time? This is one of the primary questions mobilized in Tomás Saraceno’s *On Space Time Foam* (2012-13): a large-scale installation at the Hangar Bicocca near Milan that engulfed bodies in a series of transparent, airy layers, “destabilizing the geometry of experience” (Martin, 2011a: 458). The installation invited viewer-participants to traverse a fluid, membranous interior, suspended many meters above the museum floor. In doing so, it intensified the co-constitutions of bodies, surfaces and airy masses, and produced unusual social encounters. The situation of disorientation in the space of Saraceno’s installation, vividly described by Bruno Latour in a symposium on the artwork, is the result of a situation where, “the space actively challenges its occupant” (Wigley, 1996: 34). However, the philosophical, ethical and aesthetic force of *On Space Time Foam* lies less in the disorientation it produced, than in its function as a practical and conceptual “elemental ‘tool’” (Martin, 2011a: 465) with which we can comprehend the relations between bodies, surfaces, space-time and the social.

To paraphrase Martin (2011), Stewart (2011) and Choy (2011) among others, the experience of immersion demands different modes of address; in particular it demands modes that come to being through an awareness of the way atmospheres confound the boundaries of bodies, spaces, and surfaces. This chapter cultivates an atmospheric site-writing based on several days of immersive engagement with Saraceno’s *On Space Time Foam*, “using words in such a way that they can carry the weight, and the depth, of the phenomena in question” (Ruppel, 2008: 32). These descriptive elements are oriented

around surfaces. Elsewhere I have argued that creative techniques of *surfacing* register the impressions of the invisible yet tangible matters of air (Engelmann, 2015b). Like Jeffries' metaphor of patterning, *surfacing* is a verb: to surface is to render the matter and motion of surfaces explicit (*ibid*). A fluid and viscous account of surfaces is found in the work of Luce Irigaray, whose critique of Heidegger's metaphysics is inspired by the felt presence of air, and whose vocabulary in *An Ethics of Sexual Difference* and *The Limits of Transference* proposes the “mucous membrane” as a sensible site of pneumatic exchange (Irigaray, 1999; 1993). Many of Saraceno’s artworks, and especially *On Space Time Foam*, are Irigarayan in their volumes and contours, their facilitation of movement from inner to outer and back again, and their morphological resonances with inner bodily organs.

On Space Time Foam was an artwork composed primarily of pressurized air and plastic, its properties deriving from differences between airy bodies inside and outside the installation. The work’s suspensions and surfaces also shaped the possibilities available to moving, breathing bodies. In this way the artwork co-produced both physical and affective space-times. In the first sections of the chapter, the experience of the artwork is thought together with Irigaray’s writing on membranes in order to unfold the installation’s provocations toward thinking through the mingling of bodies *with* surfaces.³⁶ Such discussion prepares the conditions for reflections on the dual experiences of intensity and extensity channeled through the spatio-temporal fields emergent in this artwork. The surficial relations animated within *On Space Time Foam* were cosmological since they forced different gestures, movements, and modes of practice; in doing so, they unhinged habitual coordinates of space-time and scale. As we travel through these porous passages, we will first address one of the primary sites from which *On Space Time Foam* emerged: the porous surfaces of Tomás Saraceno’s sketchbook.

³⁶ For an engagement with the philosophy of Luce Irigaray in the context of the installations of contemporary artist Pipilotti Rist, see Hawkins (2015a). Hawkins’ approach is focused on the specific “language of light” mobilized by Irigaray and Rist, while in this chapter I give more attention to the spatio-temporal fields emergent from the play of surface and atmosphere.

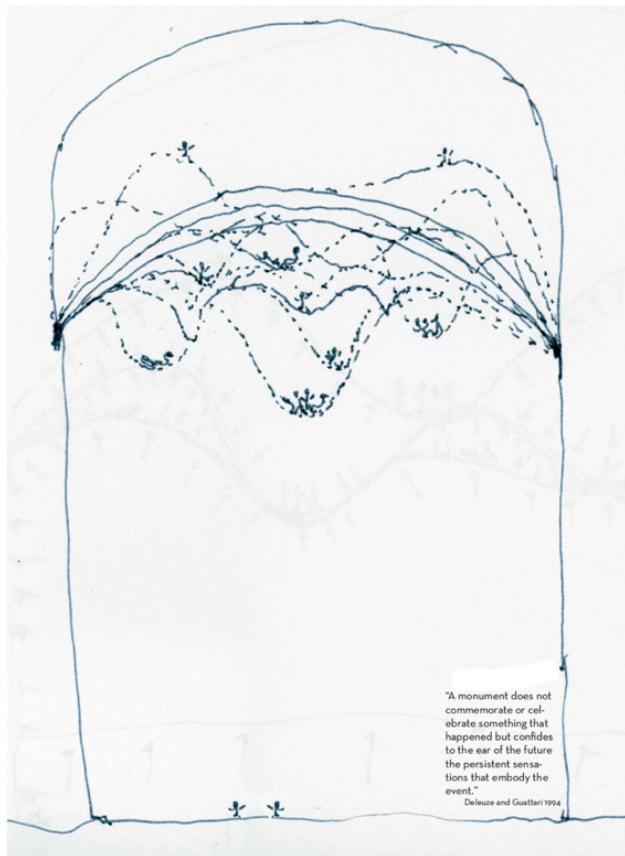


Figure 1: Sketch *On Space Time Foam*, 2012

Later scanned and combined with a quote from Deleuze and Guattari (lower right): “A monument does not commemorate or celebrate something that happened but confides in the ear of the future the persistent sensations that embody the event...” (Deleuze and Guattari, 1991/1994: 183-184)

© Studio Tomás Saraceno, 2012

Sketchbook Surfaces

The drawing above is a useful diagram with which we can grasp Tomás Saraceno’s artistic practice. A diagram of a semi-cylindrical shape is populated with thin figures who ride the undulating curves of a series of layers – layers whose permeability is denoted by dashes. Peering through the image is another series of linear gestures: one can faintly discern arrows pointing upwards and downwards against the wavy lines. The arrows evoke force, like in vector diagrams made by physical scientists. In general, the formal elements (kinds of line, shape, structure) in both the first drawing and the “under-drawing” are the same. In a small typed paragraph on the bottom right hand side of the image is a quote

from Deleuze and Guattari: “A monument does not commemorate or celebrate something that happened but confides to the ear of the future the persistent sensations that embody the event” (Deleuze and Guattari, 1991/1994, 183-184). The drawing itself does indeed have a monumental character, showing human bodies suspended on a semi-flexible super-structure. But what is monumentalized here? What sensations are carried forth to the future?

In Tomás Saraceno’s sketchbook undulating lines are promiscuous, portraying turbulence, international migration, the theory of relativity, tectonic plates, “social black holes” and geological strata, among other things. The rendering of a surface-line in the pages of a sketchbook is, for Saraceno, a diagrammatic exercise that produces novel associations. His casual everyday sketches inform his large-scale installations, insofar as they continually re-assemble the geometric forms and concepts with which he works. In addition, given the range of unusual characters that populate the sketchbook, this archive manifests Saraceno’s transversal and “translogical” patterns of thought (Guattari, 2000; Massumi, 2002) as well as the artist’s conceptual engagement with other thinkers. In other words, the lines of Saraceno’s sketchbook are threads of association, conceptualization and collaboration that make up the artist’s conceptual web. As Saraceno’s former assistant and current collaborator Jol Thomson wrote:

For Tomas there is no singularity of surface, or discipline, or space, *everything is overlaid and passing through each other*... the strange attractor comes to mind, like a higher dimensional Möbius strip” (emphasis mine; Thomson, email correspondence, 2014: np).

A sense of the “passing through” of surface, discipline and space is one of the unique contributions made by Saraceno’s work to my engagement with art, aesthetics and atmosphere. Such insights also have consequences for thinking politics, scale and the social – threads that will be developed throughout this chapter and dissertation.

What are the qualities of Saraceno’s sketchbook gestures? Kathleen Stewart writes, “A line drawn is important not so much for what it records as for what it leads the [drawer] to see. It is an autobiographical record of a discovery of an event – a trace and suspension of a wobbly emergence of

alertedness” (Stewart, 2014: 10). Saraceno’s drawings are by no means finished or polished; they are quick “doodles” made in the studio, during meetings, lunches, or five-minute periods in between. But they convey alertness to certain dimensions of a form, an installation, or an experience. They are what Brian Massumi and Erin Manning would call, “technologies of lived abstraction” – practices that relate “the creativity of thought-action crossings, through which life is germinally aesthetic” (Manning and Massumi, 2014; Stewart, 2014: 10). These drawings are “wobbly” traces of resonances between forms, materials and ideas; they are concepts in transition. But their presence in line on the surface of a page is significant: the act of marking conveys an important intensity, a “thought in the act” (Manning and Massumi, 2014; Taussig, 2011).

Drawing, indeed, is something Saraceno would have perfected in his training as an architect. Ingold (2007) observes that most trained architects are constantly sketching (Ingold, 2007: 162). However, if Saraceno’s sketches initially depart from an architecture or installation, they quickly diverge. His sketches are more diagrammatic than geometric. And they are diagrammatic in the sense elaborated by Gilles Deleuze in the work of the painter Francis Bacon: loose sequences of seemingly random groups of lines provide the “generative constraints” for invention and improvisation (Deleuze, 1995). In Saraceno’s sketchbook there is often a series of forms, with arrows or numbers pointing the way, permeated by unusual figures: animals, planets, forces and shapes. Taussig comes closest to describing this kind of production when he writes:

...like ivy or some exotic weed, the diary shoots out tendrils and flowers. As the seasons proceed, so new growths form with different colors and shapes creating new patterns superimposed over the decaying leaves and flowers. (Taussig, 2011: 25)

I began full-time research at Studio Tomás Saraceno after the end of the exhibition of *On Space Time Foam*. Due to a recent move of the studio, the sketches that I was able to collect were limited. However, at the time of my initial fieldwork, Saraceno was preparing a model for a new artwork to be exhibited in Toulouse the following October. He intended to create a one-layered membrane on which viewers could walk, suspended above the museum floor. Thus it would have been very similar to *On*

Space Time Foam, except with fewer layers, and appropriate for the dimensions of a smaller museum.

In the sketches he made at that time, references to “H. Bicocca” are frequent, suggesting that *On Space Time Foam* was a presence in the development of the new artwork. So, even though the sketches I found were made about one year after the opening of *On Space Time Foam*, they exist on the same “wave pattern,” of concepts and experiments at the studio (Thomson, 2014b). The continuity and relation between *On Space Time Foam* and later artworks is metaphorized in the drawing that begins this section: it is a diagram of a large-scale, membranous artwork animated by wavy lines; underneath it, peering through, one can see the shadows of another diagram with the same shape and wavy surface structure. *On Space Time Foam* may have been a discrete artwork in the lens of the art world; but for Saraceno, it was a temporary, local realization of a sustained interest in a specific kind of surface, and the experiences of air and space-time it makes possible.

This insight emerged primarily through contact with Saraceno’s sketchbook. Paging through the hard-bound, yellow book which was the receptacle of the majority of Saraceno’s sketches at the time, I started to observe how the pressure of Saraceno’s pencil on the paper fiber meant that one could often perceive the outlines of sketches below the immediate surface. The significance of this was not immediately apparent to me; it was only weeks later, back in London, while looking at my photographs of the sketchbook pages, that I noticed again the faint, spectral shadows of layered sketches in each image. Though the photographs were not of very high quality, it was still possible to see multiple shapes above and below, and from a careful sequencing of these, to find several consecutive pages in which the multiple surficial tracings could be studied further. Why is it valuable to consider the under-drawings, the faint outline of a sketch underneath and beyond the surface? First, these inter-surficial relations bring into view the quality of the sketchbook as an artifact, a specific site of production that is very different from the single page or the screen. In a sketchbook, the *relations between pages* are as (if not more) important than the individual pages themselves. What appears to be an accidental layering of scribbles, and what can in fact barely be perceived unless one is physically holding the sketchbook, has implications for understanding the processual qualities of the ideas registered, their multiple pathways

and trajectories.³⁷ The sequence of sketches in a sketchbook visualizes the “meshed continuum” through which a creative process flies – the conceptual and practical animation of the ideas therein (Delanda, 2002: 22).

My realization was that there is a lot happening on the individual pages of Tomas Saraceno’s sketchbook, but there is even more happening between them. In the sketchbook lines generate words, not the other way around. From the style of surface-marking and the diversity of analogies it is clear that Saraceno does not work in a slow or measured fashion but quickly harnesses ideas, analogies and patterns and allows these to proliferate. Scale is not a workable term here: a drawing of a snail points to a womb, which points to planet Earth with a butterfly spinning in orbit. Many sketches reference *On Space Time Foam*, but none of the pages pertains *only* to the artwork. Each page alone tells a story of a sequence of ideas, but together the pages relate a conceptual-imaginative play, more of a dance than logic.

Evident as well in Saraceno’s sketchbook is sensitivity to what Luce Irigaray calls “the tangible” (Irigaray, 1993). Irigaray argues that the visible and the tactile are not equal terms in the spectrum of sensation. If, according to Merleau-Ponty, the visible and the tactile are like “two hands touching,” for Irigaray, “the visible and the tangible do not obey the same laws or rhythms of the flesh” and cannot be situated in a symmetrical chiasmus (Irigaray, 1993: 161). Instead, Irigaray asserts that all sensation is based in the *tangible*, the fluid bath of experience. In Saraceno’s sketches, notes on tactile sensibilities and bodily immersion are principal. He scribbles across a drawing of a membrane: *where there is no air, there can be no space and no time*. This statement is a bold one. In the context of Saraceno’s other drawings, I interpret this statement to mean that air coheres and mediates different experiences of space-time, different spatio-temporal patterns and fields. Irigaray echoes:

³⁷ This statement assumes to some degree that the person using the sketchbook has used it more or less as a consecutive sequence of pages, rather than skipping around all the time from page to page. However even if this were the case, the sketchbook is best conceived as an artifact that holds an assemblage of entities, rather than individual or discrete units.

The extent of space, the horizons of time, and all that becomes present and absent within them are to be found gathered together in air as in some fundamental thing... Everything is assembled there. And thought attains the heart of this assembly only by assimilating itself to this serene spatiality – air. (emphasis mine; Irigaray, 1999: 167)

Everything is assembled there: both Irigaray and Saraceno, albeit in very different ways, assert that air has a gathering force. This force becomes even more explicit with the vehicle of a surface.

What is perhaps most Irigarayan in Saraceno's drawings is the membrane, illustrated in the envelope-like diagrams: the membrane is a mediator between shelter and world, breath and surface. Likewise, for Irigaray the “mucous membrane” is the, “most intimate interior of my flesh,” “another threshold of the passage from outside to inside, inside to outside, between inside and outside, between outside and inside” (Irigaray, 1993: 170). For Irigaray, any imagination that rests only on the visible fails to acknowledge the “membranic” quality of experience. Saraceno’s sketchbook is not a collection of distinct drawings but a living thing in which lines spin off and resonate with others like the threads of a spider web. Another name for the sketchbook might be “tactile composition” – a surface that pulses with the process of things taking shape (Stewart, 2011). The mutual permeability of fiber and pencil, the movement of lines, the proliferation of forms and patterns, and the performance of porosity and threshold render Saraceno’s sketchbook an artifact with energetic, trans-scalar, webbed qualities.

Selections from the sketchbook will continue to play an active role in this chapter, as we turn now to the cosmological aesthetics of *On Space Time Foam*.

III. The Membrane of *On Space Time Foam*

On Space Time Foam consisted of three flexible plastic layers stretched over twenty meters high across the area of one room of a massive ex-airplane hangar in Bicocca, a town on the outskirts of Milan. Participants waited in line in the cavernous hangar adjacent to another massive corridor exhibiting Anselm Kiefer’s *Seven Heavenly Palaces* (2004-15). Since only a few people could experience *On Space Time Foam* at one time, participants signed their names on liability forms and received an

appointed time at which to return and ascend the installation. When they returned they were taken up to the top of the artwork in groups and instructed on what items of clothing they could or could not wear. Starting from the top layer, five people were allowed to step down onto the transparent plastic topography, and given about ten minutes to navigate the new conditions. The encounter was membranous, not necessarily because of the semi-transparent, gelatinous appearance of the installation's surfaces, but because the shifting, voluptuous contours had indisputable force. Membranes are a specific kind of surface: they facilitate exchange, but they also organize the conditions, qualities and quantities of this exchange. A membrane is more functional than haptic. The intensity of the experience of *On Space Time Foam* derived primarily from the fact that it was the membranic surface driven by the redistribution of bodies of air, and not always only the human participants, which was in charge.

Folding-In

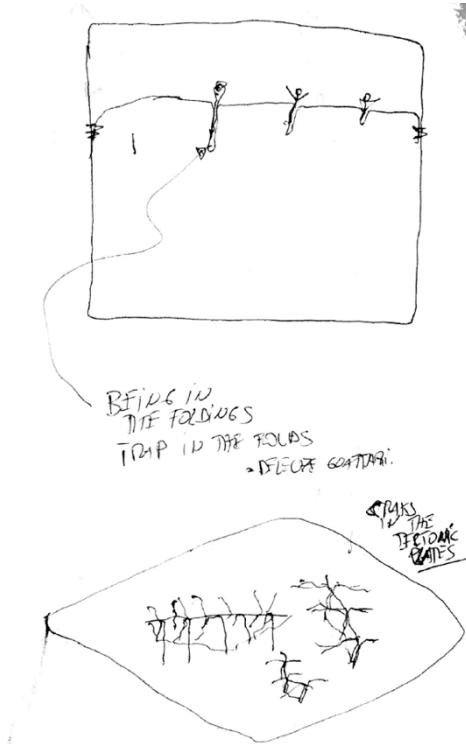


Figure 2: Sketch *On Space Time Foam*, 2012
The caption reads “Being in the Foldings / Trap in the Folds – Deleuze and Guattari”
© Studio Tomás Saraceno, 2012

The ascent is windy. We climb several metal staircases, hearing sucking and whooshing noises around us, and feeling stray hairs wave around our faces in swirling gusts of air. Once at the top floor, we are instructed. No shoes, no jackets, no phones, no sharp objects. Then we line up toward an opening where a rope ladder drops away. Through the opening we see an undulating transparent material, gray and reflective, and creasing in various ways as it peaks and troughs. There is a sound like a big flag flapping in the wind, and echoes of human voices. I rub my arms, it's freezing.

I step down on a short rope staircase, my feet wobbling as the knots stretch. At the bottom of the ladder there is no other choice but to step, or rather to slide, onto the slippery, pliant surface. An anticipatory tension, drawing the stomach in. A split-second closing of the eyes. Outstretched arms. The drop. A half sinking, half sliding struggle, and the immediate sense of a force beneath. I make a crease as I crawl into the middle; it closes behind me. I don't move, I fold. Peering down I see other bodies, folding too.³⁸

Moving onto the surface of *On Space Time Foam* was a negotiation of folds of flexible surface-matter. At a symposium at Hangar Bicocca in February 2013, Bruno Latour insisted that the most memorable aspect of *On Space Time Foam* was not the interaction between people on each plastic layer, but the shapeless medium itself: “it is actually the plastic, which is the great social, sociological, invention of his piece” (Latour, 2013: np). Latour observed that viewer-participants, “begin to get very complex feeling of medium, which is not nice ... it's frightening and it has all sorts of ecological metaphors of water, air... you can suffocate a bit in it, it has various degrees of resistance” (*ibid*). For

³⁸ This passage, and those that open the following three sections in this chapter, are adapted from field notes, from my first-hand experience of the installation artwork *On Space Time Foam* in February 2013.

Latour, the originality of the artwork was in its unpredictable contours. The quality of the material, and the pressure with which it was inflated, meant that it was impossible to gain any measure of control.

Why was an experience of the plastic of *On Space Time Foam* so disconcerting? A number of factors were at play, including the height at which the layers of the artwork were suspended, the size and transparency of the layers, and the experience of entering a strange space with five other people. However I believe that a large degree of the artwork's aesthetic impressions resulted from its unusual performance of surface. This was a surface that had shifting, voluptuous contours. It allowed passage of some things and not others, and only in certain directions. It communicated ripples and folds from each viewer-participant to every other participant. And it was enveloping, in ways that seemed both familiar and unnerving. This had implications for the spatial and respiratory economies of viewer-participants, and for possibilities of movement. Given its scale and flexibility, and its preclusion of any "grasping" (visual or otherwise), *On Space Time Foam* bends away from a critique based on the visual or the haptic. Irigaray offers a fluid, porous vocabulary, suited to the experience of this installation.

The term "membrane" has particular purchase for understanding *On Space Time Foam*. For Irigaray, "membrane" has two suggestions: it refers to the surfaces of organs (such as the placenta) and bodily interiors, and also to a, "sensible medium" "in which I touch or am touched" (Irigaray, 1993: 135). The latter "sensible medium" has connotations of bodily thresholds, like the lips and the vagina, but can also summon a more abstract and invisible sense of touch, caress and palpability (Paterson, 2009; Whitford, 1991). The medium in Irigaray's writing is a binding agent, a substance "between-two"; it has implications for the relations between mother and daughter, and female analysts and their patients, as well as two lovers (*ibid*). Moreover, the term "membrane" is most often qualified as "mucous membrane" or denoted simply by "the mucous" (Irigaray, 1991; Mulder, 2006; Whitford, 1991). While a longer study would draw out the subtleties in "membrane" and "mucous", I will take these terms to approximate the same kind of surface-relation. If "mucous" conveys the opaque and slippery interior, "membrane" conveys its function.

In my first moments on the shapeless surface of *On Space Time Foam* I was confronted with the fold: my body's weight created a hollow in the undulating surface, but I did not have total control over where I traveled. I could make some headway by crawling on all fours, pushing the material in front of me down with my hands and then with my knees. The surfaces all around were curved to various degrees. Sometimes one of the plastic walls was so high I had to change direction: this is what Latour referred to as the “threat” of the artwork (Latour, 2013). As soon as any of the five participants on the layer moved, the shape of the surface changed. Indeed as we will explore further, the title of the work, referencing space-time topologies, is apt: the surface was in constant transformation, each actor partly generating and partly forced-in to his or her own atmospheric space-time.

Folds are (archi)tectonic. In another of Saraceno’s drawings (Figure 2) small stick-figure humans are inserted like toothpicks in the narrow folds of a lateral surface. Two of them wave their arms above their heads, as if flailing or calling for help. The sketched surface is relatively flat, unlike the wavy lines that framed the surface in the sketches discussed earlier; this gives an impression of solidity and permanence. Underneath is the caption, “Being in the Foldings / Trap in the Folds / Deleuze and Guattari” (Saraceno, 2012). Finally there is an arrow to the bottom of the page where another plane has been drawn, this time with cracks in the surface; it is labeled “Cracks in the tectonic plates”. The folds of the surface on which humans move are compared to inconsistencies in Earth’s crust, suggesting that human participants are not in control, moved by a willful deforming plane. But there is something else at work here.

Lefebvre writes that it is, “the task of architectonics to describe, analyse and explain [the persistence of patterns in social space], which is often evoked in the metaphorical shorthand of strata, periods, sedimentary layers, and so on” (Lefebvre, 1991: 228). Despite the constant influx of new participants and the flexibility of the artwork, the “social space” of the installation witnessed “tectonic” practices (Figure 3). There were a few rules of engagement, dictated to the participant groups before entry onto each surface. But more importantly, the surface itself organized movement: “you cannot move without all of this transformation which takes very different shapes which are uncertain and have a

lot of inertia” (Latour, 2013: np). The spatial patterns of the work were apparent to me when I stood underneath the installation and looked up, observing all three layers and bodies in motion (Figure 4). One could see that similarly to the way figures in the sketch were stuck in a semi-solid groove, the moving participants tended to follow the trajectory of the fold created by the co-constitution of the surface, the air supporting it, and the movements of other participants (Figure 6). In other words, there were “desire lines” that seemed to map the past and future pathways of bodies.

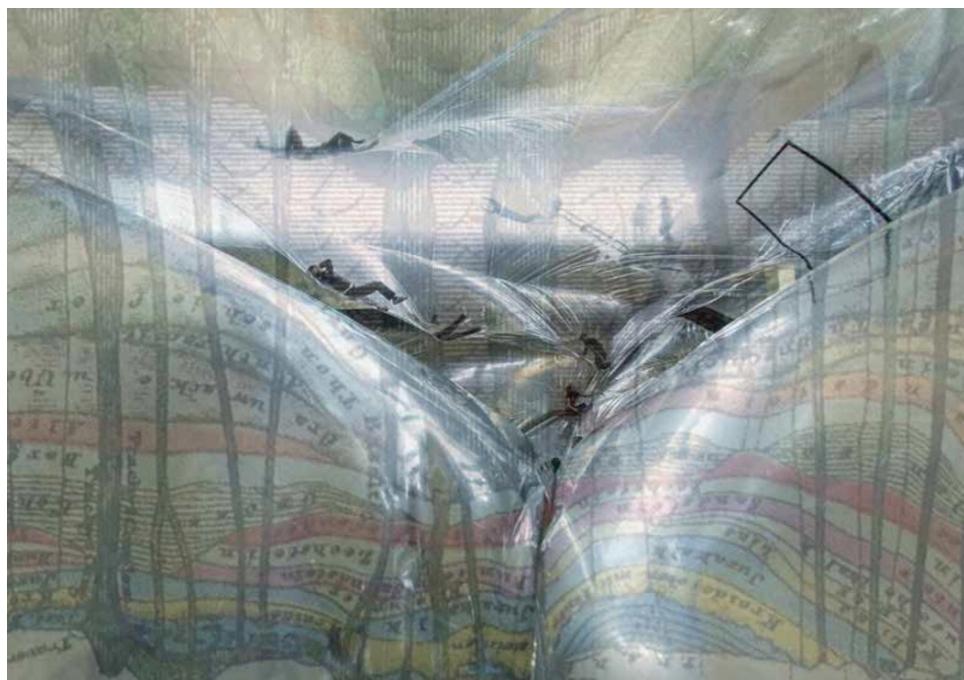


Figure 3: Tomás Saraceno, Collage *On Space Time Foam*, 2012
 Installation view, Hangar Bicocca, Milan. Curated by Andrea Lissoni.
 Courtesy the artist; Tanya Bonakdar Gallery, New York; Andersen's Contemporary, Copenhagen; Pinksummer
 contemporary art, Genoa; Esther Schipper, Berlin.
 © Studio Tomás Saraceno, 2012

How can we think of passage across a barrier that is willful, that maintains difference, but is simultaneously flexible and fluid? Rachel Colls and Maria Fannin have investigated the surfaces of bodily interiors, and specifically those of the placenta, focusing on, “what interior surfaces ‘do’ rather than just ‘what they mean’” (Colls and Fannin, 2013: 1087). The placenta creates a barrier between maternal and fetal blood. But it is also a regime of passage: “The placenta and placental tissue enact

particular mobilities by facilitating, mediating, and preventing the movement of particular substances / products between the mother and the fetus" (Colls and Fannin, 2013: 1093). In *Je, Tu, Nous* Luce Irigaray and embryologist Hélène Rouch debate the placenta as a form of relation, and as a space "between-two". Interpreted by Colls and Fannin (2013), "Their insight is that the placenta is both a material, flesh 'object' as well as a sensible companion for thought" (Colls and Fannin, 2013: 1097). If, "The placental model of relation," "can thus serve as a model for thinking differently about the presumptions of boundedness, fixity, stasis, and identity," what opportunities are afforded by the experience of "between-two" in *On Space Time Foam* (Colls and Fannin, 2013: 1099)?



Figure 4: Tomás Saraceno, *On Space Time Foam*, 2012
Installation view, Hangar Bicocca, Milan. Curated by Andrea Lissoni.
Courtesy the artist; Tanya Bonakdar Gallery, New York; Andersen's Contemporary, Copenhagen; Pinksummer
contemporary art, Genoa; Esther Schipper, Berlin.
Photography by Sasha Engelmann, 2013

One of the opportunities for thinking through the between-ness of atmospheric experience in this installation opens out onto reflections on differently gendered bodies. As Latour and Irigaray have

already hinted, we can think with *On Space Time Foam* as a distinctly feminine space. Such a reading will shimmer throughout the remainder of this chapter. In addition, the artwork offers many resources for a psychoanalytic interpretation: in simple terms, the installation could be framed as an invitation to a space of regression. However, for the aesthetic project of this dissertation, the conceptual and imaginative work mobilized by *On Space Time Foam* is not adequately captured in a psychoanalytic framework. Rather, the morpho-logics of *On Space Time Foam* invite us to think imaginatively about the relations between intensity and extensity as spatio-temporal forces. Such insights emerge first from the fact that *On Space Time Foam* confounds notions of interior and exterior, envelopment and exposure, within and without. Latour noted that there was a professional mountaineer stationed at the side of the installation in case a participant got in too much trouble with the plastic folds (Latour, 2013). He mused that this is like the case of a Möbius strip where, “when you are in the outside you don’t know if you’re in or out” (*ibid*: np). In this way, the space of experience of *On Space Time Foam* confused the habitual coordinates of containment and / or exposure.

It is important to underscore that the experience of the installation was laden with specific affective qualities. As evidenced by the presence of the mountaineer, the artwork introduced a level of threat into the equation of being suspended in an interior. As Latour expressed in several metaphors, the flexible medium had a strange and antagonistic character: “it’s not a peaceful piece” and, “it’s very difficult to talk [about] the medium which would simultaneously react and exclude...” (Latour, 2013: np). *On Space Time Foam* offers the opportunity not only to think with a surface, and to ask what surfaces do, but also to feel what it means to be swallowed, mediated and partially controlled by one. As Ash (2013; 2015) has explored extensively, the feeling of being engulfed or enveloped is also true for 3D cinema, video games, virtual reality and other forms of entertainment immersion or augmented reality. But these experiences are familiar to us – they are “threats” we know and seek. Latour makes an important point when he defines the plastic, movement and air-driven medium as one that “would simultaneously react and exclude.” The intense blurring of inside and outside space, combined with the

palpability of an atmospheric threat, are what made the surficial experience of the artwork both unsettling and provocative.



Figure 5: Tomás Saraceno, *On Space Time Foam*, 2012

Installation view, Hangar Bicocca, Milan. Curated by Andrea Lissoni.

Courtesy the artist; Tanya Bonakdar Gallery, New York; Andersen's Contemporary, Copenhagen; Pinksummer contemporary art, Genoa; Esther Schipper, Berlin.

Photography by Sasha Engelmann, 2013

An experience of *On Space Time Foam* was a negotiation of moving, contouring layers. In Irigaray's formulation, the "raw" sensations of touch are never simply physical but convert into traveling affects, emotions, and vibrations (Grosz, 1989; Irigaray, 1993). In this way the tactile, tangible, or palpable in Irigaray's philosophy is profoundly communicative (Grosz, 1989; Butler, 2006; Paterson, 2009: 171). These philosophical concepts, and their playing-out in Saraceno's artwork, trouble boundaries between body, surface and atmosphere. They also challenge perceptions of geometric

coordinates, as viewer-participants “communicate” with each other via folds and ripples traveling through the transparent surface. Nearness and farness become less relevant than the depth and persistence of folds. Martin (2011) argues that something similar is achieved by an encounter with fog: “a form of ‘withness’ that extends across various registers of time, space, and memory” (Martin, 2011a: 465). However in the case of *On Space Time Foam*, the key vehicle is not fog or cloud, but the surface. It is the surface that creates zones of between-two, of fluid-tactile immersion, and of simultaneity of intensity and extensity that confounds static notions of scale. It is also the surface that facilitates the movement of “passing through” that is so prominent in the pages of Saraceno’s sketchbook and in the cosmological aesthetics developed here. How much further might we pass?

Between-Two

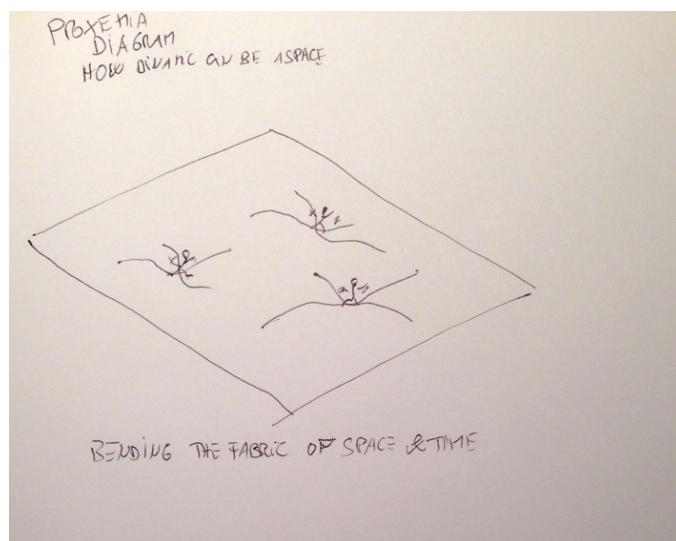


Figure 6: Sketch *On Space Time Foam*, 2012
 The writing reads: “Proxemia Diagram How [-] Can Be Space / Bending the Fabric of Space & Time”
 © Studio Tomás Saraceno, 2012

A water skimmer is a surficial being. Slender legs rest laterally on water's polar film, barely pressing down, in gentle recline. Hydrophobic hairs render leg-tips water-resistant, yet some parts rest gently under the surface. Splayed, stretched, yet relaxed, she senses her weight, the advent of ripples, a tiny breeze, a wiggling fish in the depths. She is "between-two", not suspended but poised, not hovering but balanced, her toes sensing the strong bonds between hydrogen and oxygen, the weaker affinities of hydrogen and hydrogen. She is not "at" the surface but spaced with and within it.

I am no water skimmer, heavy on this surface, knees and hands sliding around. The heavy plastic pushes back. I feel like I'm sinking, but not all the way – I can't jump, reach, lift or roll. My body slips along. It "meets resistance... or finds itself caught up in something it can't get out of" (Stewart, 2007: 77). It gyrates to the pliant stuff, hands getting red on the palms. Something huge runs through the surface, not the plastic itself, but like it: at once abstract and concrete, it is a morphing, gelatinous thing. Imposing new rules, new speeds, new frictions. It spawns trajectories. It nurtures fantasies and fears. It pauses and then moves. It intensifies in the folds. There's more viscosity than flow, running through us and between us...

A multi-layered sine-wave. A tide ebbing and flowing. *On Space Time Foam*'s surfaces generated unusual affective currents, and were like visual-tactile conduits of affect itself traveling between viewer-participants in vibrations, tensions and circumventions (Anderson, 2009). According to Bachelard, the "aerial imagination" is animated by rising and falling (Bachelard, 1988). If we wish to study, "how delicate emotions develop, the first thing to do... is to determine the extent to which they make us lighter or heavier" (Bachelard, 1943/1988: 2). At least part of *On Space Time Foam*'s affective intensity was a result of the unpredictably moving, air-pressured surface, which generated different impressions of weight, lightness or suspension. This vertical rhythm of rising and falling was central to the artwork's spatial and cosmological aesthetics.

Despite its height and transparency, an experience of *On Space Time Foam* was not of weightlessness. If there was certainly a sense of rising and falling, the sensation of falling was much more pronounced. Every attempt to move was a fall forward onto the plastic surface. Latour also remarked on this quality of the artwork, saying that his initial expectations of being able to bounce on the installation were quickly dissuaded (Latour, 2013). Thus the primary internal movement, and what Bachelard would call the “poetic reverberation” of the artwork, was of a “weighted atmosphere” or the “heavily nebulous” (Bachelard, 1943/1988: 103). Weight was felt not only in the body but also in the other senses, as sight lines and proprioceptive orientations were weighed downwards. Stewart articulates this best: “The subject, in searching out the contours of a world, attaches to the moving, striking, and sometimes strange or weird intensities that pull attention into alignment with phenomena” (Stewart, 2007: 122). Each body weighed and curved surface-space. In this way, the weighing of bodies produced both physical and affective spatio-temporal fields emanating outward.

Atmospheres are also entities that weigh. In Marx’s famous speech, atmospheres “press down” and “weigh” upon life (Marx cited in Anderson, 2009: 77). Likewise in Choy’s (2011) account of the humid, polluted storms of contemporary Hong Kong, and in Don Delillo’s post-modern novel *White Noise*, there are evocations of inescapable, opaque, dense airy masses (Choy, 2011; Delillo, 1988). Latour commented: “I think the suffocation aspect [is] one part of it, [because] you can actually be uncertain about the air you breathe, and when you move, you move in strange ways” (Latour, 2013: np). The meteorological and affective experience of air in the installation had consequences for the spacing and surfacing of bodies. Following Anderson’s (2009) insight that atmospheres, “occur before and alongside the formation of subjectivity, across human and non-human materialities, and in-between subject/ object distinctions,” we can assert that the atmosphere of *On Space Time Foam* was not formed from bodies on one hand, and the artworks’ architecture on the other, but transmitted through the relations of intensity, extensity and weight between viewer participants, air, and the plastic form (Anderson, 2009: 78).

These insights resonate with comments made by Saraceno in an interview with Caroline Jones:

On Space Time Foam took a lot of studies, and it was important that the three membranes were transparent, and people could see others entering above their heads, or below their bodies. In the end, it relied on a huge trust in human's capacity for socialized synchronicity, responsibility, behavior, solidarity. I'm fascinated by the butterfly effect. But this was, by contrast, very simple. Even if somebody were far back in the cube of air were to move, it would immediately affect my position in the space. This is an experience that is not so common. I think the Earth, or the ground we have been walking on since we have been children, is something that does not perform in this way every day. So the art experience here was imagining somehow [and] learning to coexist. (Saraceno, 2016: np)

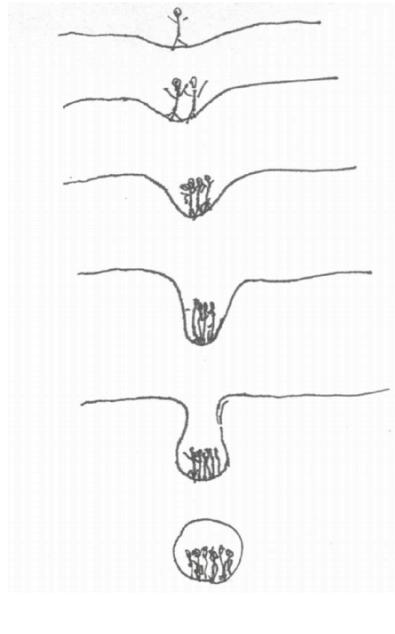
As Saraceno emphasizes here, it is worth noting that *On Space Time Foam* produced a distinct loss of personal boundaries and personal space in general. Besides sharing a transparent surface and a volume of air, viewer-participants saw the forms of many other bodies echoed below (and above), realizing they were among many negotiating the same interior. The multiple layers of plastic caused folds of the layer beneath and the one above to intersect, generating oblique lines of site. Thus the experience of *On Space Time Foam* was:

...a shared outpouring, to the loss of boundaries... leaving the circle which encloses my solitude to meet in a shared space, a shared breath, abandoning the relatively dry and precise outlines of each body's solid exterior to enter a fluid universe (Irigaray, 1993: 180)

Irigaray's passage evokes the exuberance of a "loss of boundaries," "a shared space, a shared breath" in a "fluid universe". This is an exuberance that seems antithetical to Latour's descriptions of the threatening, "disconcerting" or "strange movements" of the installation. This, however, is how I would describe my own experience of the artwork: as simultaneously exhilarating and disconcerting. Furthermore, it is precisely in this space of disjunction between the disconcerting condition of the loss of boundaries, and the exuberance of a fluid universe, that novel spatio-temporal conditions and fields emerge and are sensed. Traveling further through the membranic experience of *On Space Time Foam*

will furnish us with more sensations of the forces of gravity, inertia and attraction animated by the surface-effects of this installation.

Drop



Figures 7 and 8: Left: Sketch *On Space Time Foam*, 2012
© Studio Tomás Saraceno, 2012

Right: Tomás Saraceno, *On Space Time Foam*, 2012

Installation view, Hangar Bicocca, Milan. Curated by Andrea Lissoni.

Courtesy the artist; Tanya Bonakdar Gallery, New York; Andersen's Contemporary, Copenhagen; Pinksummer contemporary art, Genoa; Esther Schipper, Berlin.
Photography by Sasha Engelmann, 2013

All of a sudden three of us are near the middle. Two of us try to crawl away, the third just watches. It's inevitable, we are all in the same place, we touch. A shadow smile, an apologetic glance. Eyes rolling up, seeing shapes above, and down to the mingling crowd below. The plastic is straining, creasing more now. This is awkward. Down below the small dots of heads, and the flash of a camera angled upwards. We're hanging like a dewdrop, trapped by space itself.

A crease opens in the hill on the left, one sees her chance and hoists over, palms grabbing the surface, slipping and grabbing again. She's out. The crease is bigger, a pathway out of 'here'. Lying across backward, one opens it further for the other. The three disperse, rearranging mass, inflating more with every second. Rupture averted.

Journeying from the upper layer of *On Space Time Foam* down to the lower one was peculiar: once two people approached too near to each other, this would cause a slope in a large area of the installation. The trap was inescapable. Bodies were drawn together across shiny slopes like droplets of water traveling towards bigger droplets and streams. During such events, the atmospheric pressure keeping up the plastic layers seemed to be overcome by laws of attraction and gravity, so that the whole space strained toward one single point. This is what Tomás Saraceno calls a “social black hole”.



Figure 9: Tomás Saraceno, *On Space Time Foam*, 2012
Installation view, Hangar Bicocca, Milan. Curated by Andrea Lissoni.
Courtesy the artist; Tanya Bonakdar Gallery, New York; Andersen's Contemporary, Copenhagen; Pinksummer contemporary art, Genoa; Esther Schipper, Berlin.
Photography by Alessandro Coco, 2012

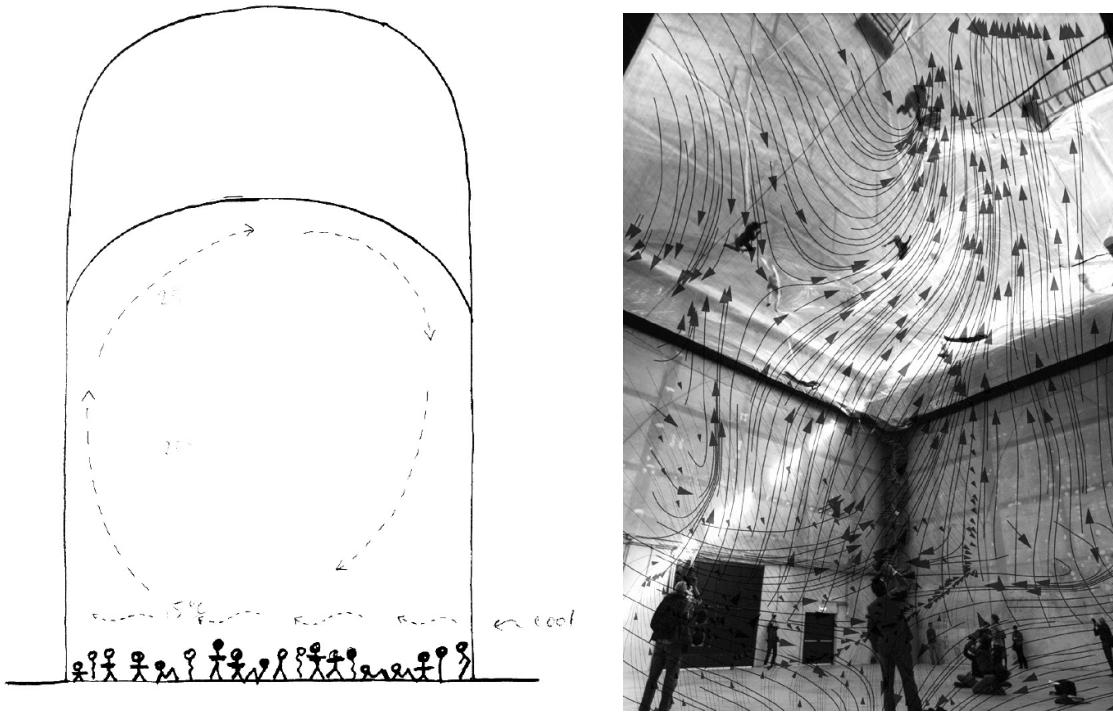
In these situations, the relations between the weight of bodies, the atmospheric pressure under the plastic layers, gravity, space and time (or space-time) were all intensely felt. While spaced-out across a membrane layer, bodies could negotiate a certain amount of freedom. However as soon as a “social black hole” began to form, the degrees of freedom available to bodies decreased dramatically. The entire landscape reflected this change in freedom. One’s breath came quicker as one fought to remain outside of the event horizon of the socio-spatial black hole. One’s trajectory of movement sloped toward the lowest point on the membrane. It became clear that the atmospheric pressure under the layer was not strong enough that it supported bodies arranged in *any* configuration. In fact the possibility occurred to me that a certain configuration of bodies might overwhelm the atmospheric pressure keeping everyone simultaneously afloat.

Once in the social black hole, breathing softened, although fear was not lessened. Rhythms shifted. Lines of site re-oriented. The social nature of the situation was impossible to avoid, as strangers were forced to touch, even to rest against one another. The stubborn fact of gravity, which was felt everywhere in this installation, became a real organizing constraint, holding the group firmly in place and drawing the combined mass downward. The Icelandic artist Olafur Eliasson reflects on gravity in an interview with Thomas Jellis, stating that the act of *thinking* about gravity is already a strong meditation on *felt* gravity (Jellis, 2015). There are countless micro-experiments with gravity, Eliasson says, that produce the insight that mind and body are one. But Saraceno’s experiment in *On Space Time Foam* is to bring gravity, atmosphere, bodies and space-time into both negotiable and non-negotiable relations. Thinking about gravity is one thing; feeling the force of gravity at a limit scenario where your space and atmosphere have been diminished and you are pressed against four other bodies is quite another. This last scenario is an experiment that shrinks space, compresses air, and *extends time*.

The kind of gravity sensed in the social black hole was certainly a physical gravity, described by Bryant (following Einstein) as, “a field or a topology that other objects follow in their movement” (Bryant, 2013: 12). But as Saraceno hints with the phrase “social black hole” there was another kind of

gravity at work: the gravity of a forced and unexpected social encounter. The installation artwork activated, “spatio-temporal gravitational fields” and revealed, “how these fields constrain and afford possibilities of movement and becoming” (Bryant, 2013: 14). For Bryant, spatio-temporal gravitational fields are produced by cities, texts, communication technologies, machines, creatures, poems, and myriad other entities, both concrete and abstract. In the case of *On Space Time Foam*, gravitational fields were produced by atmosphere and affect, bodily postures, gestures, lines of sight, and rhythms of breath, among other movements and circulating signals. Importantly, the flexible, transparent surface, and the air supporting it, facilitated the transmission of entities, signals, weights and affects, mediating the installation’s spatio-temporal fields.

The qualities of threat and disorientation of *On Space Time Foam* are now better articulated as the result of a destabilization of the coordinates of space and time that are the hinge-points of everyday experience. In other words, the spatio-temporal fields produced by the regular movement of bodies across perpendicular floors and sidewalks, the spatio-temporal fields of regular, unconscious breathing patterns, as well as those spatio-temporal fields produced by polite distancing from strangers: all of these are shifted to various extremes in the experience of *On Space Time Foam*. Such a destabilization of the geometry and gravity of experience cannot fail to have cosmological resonances. In the remainder of the chapter we will think further about the ways that *On Space Time Foam* enrolled the atmospheric experiences of ground-based viewers; then, this chapter will close with some remarks on surfaces as cosmological entities.



Figures 10 and 11: Left: Collaborative drawing of membranous installation, by Tomás Saraceno and Sasha Engelmann, 2014. Right: Tomás Saraceno, Collage *On Space Time Foam*, 2012; Installation view, Hangar Bicocca, Milan. Curated by Andrea Lissoni. Courtesy the artist; Tanya Bonakdar Gallery, New York; Andersen's Contemporary, Copenhagen; Pinksummer contemporary art, Genoa; Esther Schipper, Berlin. © Studio Tomás Saraceno, 2012

Envelope

The experience of a “social black hole” in *On Space Time Foam* was physically and affectively intense and worked to unsettle the relations between atmosphere, space-time, bodies, surfaces and social assembly. But what occurred for viewers on the ground, looking up at these dramatic events playing out on the plastic above? As I witnessed first-hand, the experience of ground-based viewers was not dissociated from that of the space-time travellers above. In fact the grounded participants also participated in the co-constructions of space-time and atmosphere in the installation.

On Space Time Foam depended on bodies of air for its shape, structure and flexibility. As such, the weight of people on the surface, the number of people below, the opening and closing of the airlock door on the ground, and the ambient temperature could alter the tension of the layers of plastic as well as

the air pressure in each interstitial space. One of the most important features that could affect the installation's architecture was the airlock door that allowed people on the ground to enter into the space directly below the floating participants. Near it were signs that said, "Do not hold door open," and there were usually attendants stationed there who made sure this did not happen. In any case the door had to be yanked open aggressively and made a very loud *whooshing* sound, demonstrating that the pressure on the other side of the wall was different than that in the rest of the airplane hangar. Allowing the door to stay open for too long would cause the pressure differential between the hangar and the installation to decrease and the suspended plastic layers to deflate, bringing participants down with them.

The drawing below (Figure 12) from Saraceno's sketchbook illustrates the artist's speculation on what might happen given different distributions of participants in the installation. When there is only one person on top of the artwork and two below, there is a small pressure differential. However when there are more people on the plastic surfaces, their combined weight causes the volume of air in the work to decrease and the pressure in that space to increase. The length of the arrows indicates the larger amount of pressure in the second scenario. The differences maintained by the membrane were altered by the presence and respiratory economies of viewer participants.

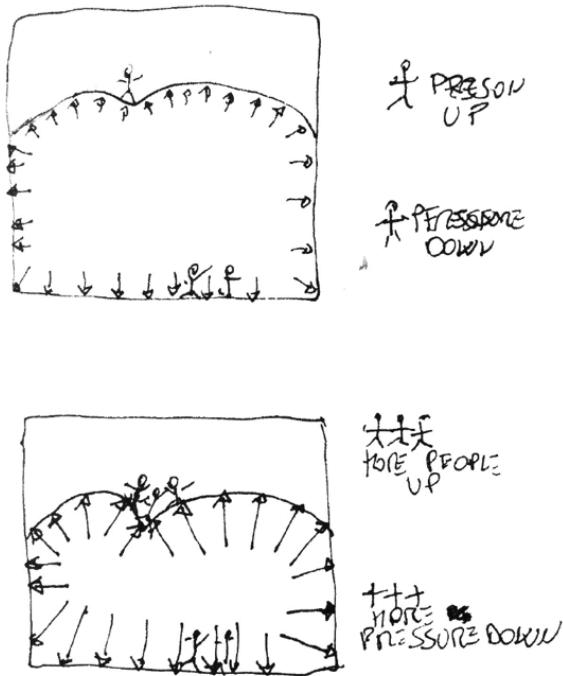


Figure 12: Sketch *On Space Time Foam*, 2012
 The text reads: "Person Up / Person Down / More People Up / More Pressure Down"
 © Studio Tomás Saraceno, 2012

Other factors could also alter the differences at play in the artwork. According to another drawing from Saraceno's sketchbook, the respiration of many people in the lower part of the installation could cause the proportion of oxygen relative to carbon dioxide to decrease. Since carbon dioxide has a greater molecular mass than oxygen, the participants on the upper layers would theoretically feel an increase in the surface tension of the plastic. However the proportion of carbon dioxide to oxygen in the lower space would reach toxic levels long before any bodies above registered a difference in pressure. Saraceno writes, "Reciprocation of Air!!! ... How often / you need to / open the / door & ventilate / the planet??" (Figure 13). If *On Space Time Foam* destabilized the geometrical axes of experience, the conditions expressed in these drawings embody even greater extremes of atmospheric, social and spatio-temporal encounter.

Saraceno's exercise in linking the quantity of CO₂ and Oxygen in the lower and upper spaces is also an exercise in atmospheric timing: the fluctuating proportions of these gases could theoretically result in different amounts of breath-time available to each body. It metaphorizes the situation of Earth's atmosphere: although we are unlikely to run out of breathable oxygen in planetary air, the rising levels of greenhouse gases are already conjuring questions of how much time we have left before climatic catastrophe strikes. Indeed, the notion of a climate *threshold* is often enrolled in these conversations. Thus, for Saraceno, as for the scope of this dissertation, there is a useful analogy between the atmospheric thresholds of this artwork and those of our global climatic condition. Lines of pressure, degrees of solidarity, porous, flexible surfaces: all are devices with which we can begin to grasp spatio-temporal fields and forces in spaces as small or as vast as our imagination allows. *On Space Time Foam* transmitted spatio-temporal and climatic horizons through the vehicle of an aerial surface, a surface that in consequence has cosmological qualities.

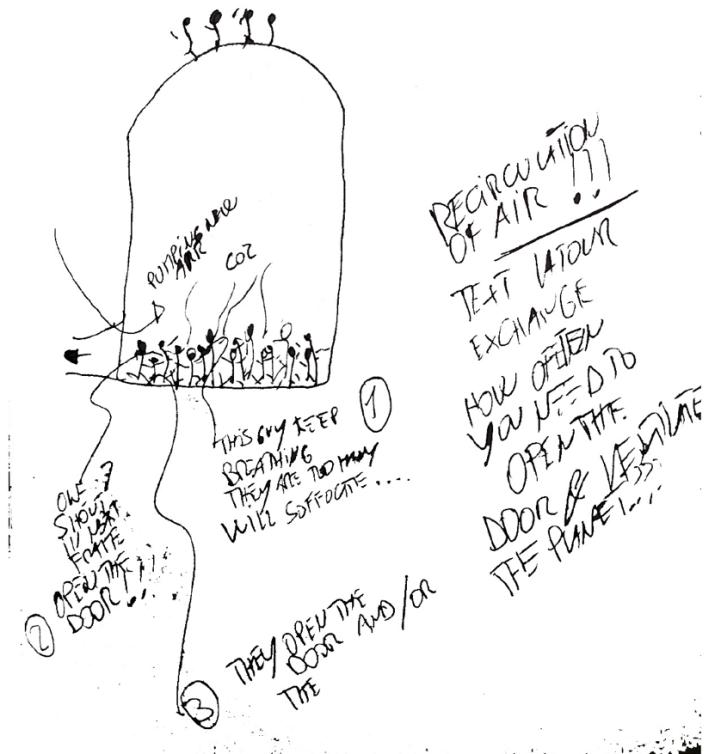


Figure 13: Sketch *On Space Time Foam*, 2012
The right hand text reads: “Reciprocation of Air!!! / Text Latour Exchange /
How Often You Need to Open The Door & Ventilate the Planet???”
© Studio Tomás Saraceno, 2012

The Cosmological Aesthetics of Surfaces

This chapter has thought and practiced-with the porous spaces of one installation artwork in Tomás Saraceno’s oeuvre. However, *On Space Time Foam* is part of a wider body of experiments on the spatio-temporal and social impressions of surfaces and envelopes, extending in various trajectories throughout Saraceno’s practice. During my initial period of fieldwork at Studio Saraceno in 2014, and in the years working closely with Saraceno afterward, I witnessed the development of the artist’s atmospheric concepts alongside experiments with various kinds of membrane and envelope. The membranous artwork that was initially proposed for the exhibition at Les Abattoirs in Toulouse in Autumn 2014, and from which I collected drawings for this chapter, was ultimately set aside in favor of a collective project and sculpture called *Museo Aero Solar* (Figure 14). *Museo Aero Solar* is an *aerosolar sculpture* that is composed of re-used plastic bags; these bags are cleaned, cut and connected together by numerous volunteers to make a shimmering mosaic, and ultimately an airborne envelope. It is a very different artwork, and manifests a different mode of participation and collectivity. But it is also a membrane, one that performs a series of differences across a threshold (Figure 14). And it is one that will continue to surface and resurface in this dissertation. Over time, I came to understand that *Museo Aero Solar* embodies many core principles and concerns animating Saraceno’s experiments.



Figure 14: *Museo Aero Solar*, collective work co-founded by Tomás Saraceno, Alberto Pesavento and many others, 2007. Photography from *Museo Aero Solar*, Prato, Italy

Source: www.museoaerosolar.wordpress.com

Thinking with surfaces, air masses and spatio-temporal fields means attending to the inseparability of meteorological and affective atmospheres: the nebulas, auras, morpho-logics, poetics, reverberations, turbulences, mediations, gradients and differentials that collectively produce atmospheric experience. Drawing from Irigaray and scholars in geography, I have described how surfaces, atmospheres and bodies, gathered together in contingent configurations, are co-constitutive of intensity and extensity, gravity and space-time. If Irigaray's project in *L'Oubli de l'Air* was to, "rediscover a relation to air" absent in Heidegger's "dwelling" she does so through rendering the textures of air in text. In contrast, the experience of a work like Saraceno's *On Space Time Foam* helps us rediscover a relation to air and atmosphere as cosmic and cosmological entities. They are cosmological since they draw together entities and phenomena from the concrete to the conceptual and imaginative: they exhibit a gathering-force that has consequences for experience of space-time. But the discovery of the

cosmological quality of atmosphere is equally a product of the vehicle of surface. In *On Space Time Foam*, atmosphere supports and animates the folds of surfaces, surfaces that transmit spatio-temporal fields of varying degree and scope. Social patterns populate in these folds, participating and co-producing spatio-temporal experiments. *On Space Time Foam* teaches that cosmological conceptions of atmosphere and surface require the understanding that air is not a “medium” that has a “simple location” (Whitehead, 1925: 58), nor is a surface passive, rigid or impermeable. Both atmosphere and surface are lively spatio-temporal agents.

This expression of surface as cosmological is also furthered by an engagement with the work of Isabelle Stengers. A surface structures the impressions of a “cosmic” ensemble of bodies, materials, forces, concepts and imaginaries (Stengers, 2008): an ensemble whose relations of tension and looseness, orientation and direction are more important than precise outlines and boundaries. A broader project would explore how techniques of surfacing develop different spatio-temporal regimes in explicit encounters between humans and non-humans. In particular, this chapter has employed Saraceno’s *On Space Time Foam* as a sensible companion for thought in apprehending the cosmological qualities of surface and surfacing.



Interstice IV: Tomás Saraceno, *Outer space seems not so unfamiliar*, 2014. Work on paper, signed and presented as a gift to Sasha Engelmann in 2015. In this work, a spider weaves into exo-planetary orbit. Published by Niels Borch Jensen Editions, Copenhagen-Berlin/ Printed by Mette Ulstrup and Julie Dam. Courtesy the artist; Tanya Bonakdar Gallery, New York; Andersen's Contemporary, Copenhagen; Pinksummer contemporary art, Genoa; Esther Schipper, Berlin.

Filaments Becoming Visible: The Lure of *Hybrid Webs*

Spider Salon

A whorl, helix, swirl, twirl, flourish, spiral, wave

Here is a half-moon sweep, there a bow hovering

There a knarled yoke from corner to middle mangle

where light is caught, sometimes shimmering

In so many alien seas and terrains

Tegenaria, Cyrtophora and Stegodyphus are in today's 'salon'

a group with no first. no second. no third,

All simultaneity of thread, duration of light (is it years?)

This is something that we have already heard

From ancient vectors, silent before the fall,

"If survival is spectacle the performance is all"³⁹

For Tomás Saraceno, spiders are instrumentalists: “*Spiders play together a complex symphony, and when they play one string it reverberates in all the other strings*” (Saraceno, 2016: np). The *Spider Salon* is an event at Studio Saraceno in which a human, usually an esteemed guest, communicates with spiders. As words are offered, the spiders may vibrate or pluck their web(s), causing sound to erupt in the salon, and changing the direction of the conversation. Human and spiderly practitioners form a temporary autonomous cosmos, “a world of sensitive strings” (Aït-Touati, 2014). Such a cosmological experiment is paradigmatic of a long history of multispecies ethnography and collaboration at Studio Saraceno. In this chapter, I attend first to the role of the “cosmic web” in the production of the large-

³⁹ This is a poem composed by Sasha Engelmann. The final line is taken from: *Away . We . Go .* spoken elements of event score by Etienne Turpin, *Arachnid Orchestra Jam Sessions*, www.arachnidorchestra.org

scale installations *Galaxies forming along filaments like droplets on a spider's web* (2009; hereafter, *Galaxies*) and *14 Billions (Working Title)* (2010; hereafter *14 Billions*). Second, I will address the many experiments with hybrid multi-species webs at Studio Saraceno. All of these webs will, together, articulate how Saraceno's multi-species social experiments synthesize and transact the cosmic and the sensible, in compositions of radically disjunctive species-space-times. These webs, as cultivated and exhibited by Studio Saraceno and many arachnid collaborators, express cosmological aesthetics in two primary ways: first, by demonstrating the intensity of the disjunctive, aesthetic leap; and second, in the performance of the *lure*.

Implicit in such ideas are the following questions that have been posed by human geographers: how does one "co-author with the alien" (Last, 2013) or, "co-author [with] the cosmos" (Yusoff, 2015)? The artworks completed by Saraceno in collaboration with spiders are not finished sculptures, but the products of infinite daily experiments in co-habitation, population dynamics and reciprocity between spiders, humans, house flies, larvae, exotic species, devices and metabolisms. The artist's web works necessarily implicate the life stories, assemblages, age and health of individual spiders, as well as their environmental conditions, and the degree of human perturbation they tolerate and respond to. The processual and patterned production of *hybrid webs* at Studio Saraceno forces thought on the axes of more-than-human sympoiesis, on collaboration between and across multitudes of creatures, and on the possibilities of inventing encounters with matters and entities that are foreign to us. Cosmological aesthetics emerges from these collaborations and experiments with entities at the limit, or beyond, the sensory realms of human and spider practitioners.

Webs that Web

Since 2007, Saraceno has developed a large portion of his artistic practice around working with spiders. But for Saraceno, working with spiders is working with webs: orb-webs, tent webs, funnel webs, cosmic webs, hybrid webs, social webs and "webs that web" (Thomson, 2014a). There is no overstatement of the term here. In the past ten years, Saraceno completed a long-term project in

scanning and analyzing the web of the black widow (*Latrodectus mactans*). This project resulted in two major artworks: *Galaxies* (2009) and *14 Billions* (2010). In collaboration with arachnologists and engineers, Saraceno also made an application to the European Space Agency (ESA) to send a black widow spider to the International Space Station (ISS) in order to discover what structure it would weave in microgravity. Studio Tomás Saraceno accommodates the life-worlds of around three hundred spiders, and especially certain species of “social spiders.” As mentioned, recent trajectories of research include forays into the field of bioacoustics, namely the sonification of spider webs through the use of a *laser dopler vibrometer*, as well as attempts to “play back sounds from the cosmos” to spiders using a piezoelectric needle (Krell, 2014).

The web defines an entire zone of production for Saraceno and his studio. There are specific people who are concerned with the webbed works and the keeping of spiders. There is a room in which all of the hundreds of spiders live, breathe, weave and die (although many manage to escape).⁴⁰ Writing about webs in the practice of Studio Saraceno is a case of following lines of inquiry into an almost endless mass of material. There are the physical presences of the spiders and the webs themselves, but also documents and images, notes on experiments, spreadsheets cataloguing the various webs produced, sold and stored, records of the various web exhibitions, correspondences between Saraceno, Adrian Krell, Jol Thomson and leading spider and insect scientists, videos and sound files of spider recordings, equipment such as video cameras and wire frames, commercial orders for crickets and house flies, and books and articles on everything from spider orientation by moonlight to the evolution of webs over eons.

An insight that emerged in my fieldwork in June 2014 was that even in the case of intense collaboration with one spider, *there is never only one web*. The experiments with webs are always already about the relations between webbed forms. They are about comparing webs to other webs,

⁴⁰ Over the course of my fieldwork with Studio Saraceno, the “spider room” changed dramatically. In March 2014 all the spiders were housed in one small room in the downstairs space of the studio. By August 2016, there were multiple “Spider rooms” on the lower and third floors of the studio, each with a different specific microclimate that was attended and regulated by more than one studio member.

through analogy, metaphor and metonymy, but more precisely about the meshing, layering and attracting of webbed forms to each other. They are about allowing webs to enter into *zones of proximity* that threaten their separate shapes and geometries, yet do not dissolve them. A metaphorical device that came to my mind several times is of two or more “strange attractors,” topological entities that transform yet maintain certain recurrent shapes or tendencies. The kind of relation which I sensed in the more-than-one but less-than-many style of experiment with webs at Studio Saraceno involved holding patterns and suspensions: best articulated as *disjunctive synthesis*.

Formally introduced in *Anti-Oedipus*, but resonating in Gilles Deleuze and Felix Guattari’s writings on literature and painting, “disjunctive synthesis” occurs between two distinct ideas, objects or “organs” (Deleuze and Guattari, 1972/1984). According to Deleuze and Guattari:

A disjunction that remains disjunctive, and that still affirms the disjoined terms, that affirms them through out their entire distance, without restricting one by the other or excluding the other from the one, is perhaps the greatest paradox. ‘Either... or... or,’ instead of ‘either/or.’ (Deleuze and Guattari, 1972/1984: 76).

A disjunctive synthesis is not a “common ground”, a reconciliation, or a fusing of different “organs” on the “body of the *socius*”; rather a disjunctive synthesis between entities means affirming “their distance as that which relates the two as different” (*ibid*: 77). What makes the disjunction a disjunction, and not a conjunction, is that, “It is the holding together that is felt, in excess of one or the other” (Manning and Massumi, 2014: 33). A disjunctive synthesis is “the pattern of passings through the middle” that relates two very different things, a conjunction of opposition on the “recording surface” (Manning and Massumi, 2014; Stivale, 1980: 49). Most important for my purposes here, disjunctive synthesis can occur across sensory registers and scales through the emergence of nonsensuous similarity. It is a relation that may occur between movement and language, for example, or between the visual and the virtual, based on a “transversal limit”, threshold, or process. The most spectacular of such transversal limit, perhaps, is born of the filaments of a spider web and a cosmic web: creature and cosmos.

The Cosmic Web

In an artwork exhibited by Saraceno at the 53rd Venice Biennale – *Galaxies forming along filaments, like droplets on a spider's web* (2009) – a web challenged the edges of the art gallery.

Knotted strings formed spherical formations from which filaments extended to the floor and ceiling (Figure 1). According to Bruno Latour, the artwork performed the network, as conceived in Actor Network Theory (ANT), and Spheres, as conceived in Peter Sloterdijk's "atmospheres" of immunity, "explicating the material and artificial conditions for existence" (Latour, 2012: np). Latour observed that the artwork rendered tangible the fast-moving relations in the long black cords; at the same time, it suspended spheres in a spatial "hierarchy" that was resistant to most disturbances, yet intrinsically dependent on the filamentary network (*ibid*). In Latour's reading, *Galaxies* reconciled networks and spheres, two dominant frameworks for the social in a, "loose expression of globalization," (*ibid*). If those theories are compatible rather than antagonistic, "we can have our cake and eat it too" (*ibid*). This is no doubt an important and elegant argument. However, an understanding of the space and process of this artwork's production summons other insights related to the installation's spatial language, insights that pertain to the multispecies collaboration from which this work emerged. The objective of the following sections is not to interpret this installation further, but to render palpable the kinds and qualities of multispecies sociality through which installations like this one were (are) invented. As in the case of *On Space Time Foam*, these experiments may be considered as localized realizations of a specific creative attention to webs and the creatures that make them.



Figure 1: *Galaxies Forming along Filaments, like Droplets along the Strands of a Spider's Web*, 2009. Installation view, 53. Biennale di Venezia, 2009, with the support of Fondazione Garrone, Genoa, Italy and Fondazione Sambuca, Palermo, Italy, special thanks to Pinksummer contemporary art. Courtesy the artist; Tanya Bonakdar Gallery, New York; Andersen's Contemporary, Copenhagen; Pinksummer contemporary art, Genoa; Esther Schipper, Berlin. Photography by Alessandro Coco.

Here, Saraceno's spider-collaborators make a cosmological proposition. In 2005, the Max Planck Institute announced in its Research News column that:

The Virgo consortium, an international group of astrophysicists from Germany, the UK, Canada and the USA has just released first results from the largest simulation ever of cosmic structure growth and of galaxy and quasar formation. This “Millenium Run” used more than 10 billion particles to trace the evolution of the matter distribution in a cubic region of the Universe over 2 billion light years on a side (Max Planck Research News, 2005: np).

The associated article, published in the June 2nd issue of Nature, showed how the comparison between computer-simulated data and large-scale observations could clarify the processes of the formation of real galaxies and black holes (Springel et al., 2005). A news release from the 12th October 2006 in Astrophysics Journal Letters reads:

In nature spiders earn our respect by constructing fascinating, well-organised webs in all shapes and sizes. But the beauty masks a cruel, fatal trap. Analogously, the NASA/ESA Hubble Space Telescope has found a large galaxy 10.6 thousand million light-years away from Earth that is stuffing itself with smaller galaxies caught like flies in a web of gravity. (*Astrophysics Journal Letters*, 2006: np)

The Spiderweb Galaxy was so named because of the way other galaxies seemed to approach along strings and filaments, and were progressively sucked into the “spiderweb” or black hole. As Saraceno and his team read and researched further, the comparison between the structure of the universe and that of a spider web seemed persuasive (Saraceno, 2014). But models of the universe seemed to exist only in the supercomputers at institutions like the Max Planck Institute. Saraceno had already completed many photographic works employing the motif of the spider web, for example in juxtaposing aerial views of towns with architectures of webs (Saraceno, 2009). But the repeated metaphorization of the cosmic and spider webs inspired Saraceno to study the highly tensile, complex architectures of spider webs more seriously. In 2008 Saraceno and his team began working with living spiders in order to investigate the comparison between the structure of the universe and that of an organic web. The catalogue essay for Saraceno’s contribution to the Venice Biennale reads:

Astrophysicians use the image of a spider web to describe the formation and structure of the universe; they state that significant geometric similarities exist between both phenomena. The idea was quite simple initially – to place spiders in a scale model of the Venice Biennale room. From there one would hope to see related forms from the spiders web and the Millennium Simulation. (Saraceno, 2009: 14)

The project was a poetic one, in the true spirit of poiesis, or an art of making: to allow a spider to weave a web in a scale model of the gallery, and then scan it, and enlarge it in three dimensional space, so that it might be accessed by humans and also compared with the “cosmic web” of the Millennium Simulation. As the events were told and retold to me by numerous members of the studio, the idea or the process were not actually simple. The experiment to encourage a black widow spider to weave a web in a scale

model of the gallery, and to make an accurate visualization of this web, posed many challenges. The risks of working with a black widow spider were somewhat mitigated by the involvement of Dr. Peter Jäger, an eminent arachnologist and head of the Senckenberg Institute. Other challenges included the difficulty of finding spiders, including a black widow, to keep in the studio; creating a scale model that had enough texture to allow spiders to climb the walls; keeping the spiders alive and healthy; selecting materials to highlight the web, such as aerosols; transferring the three dimensional web into a digital file; and rebuilding the digital file on a much larger scale (about 30X) in the gallery space.

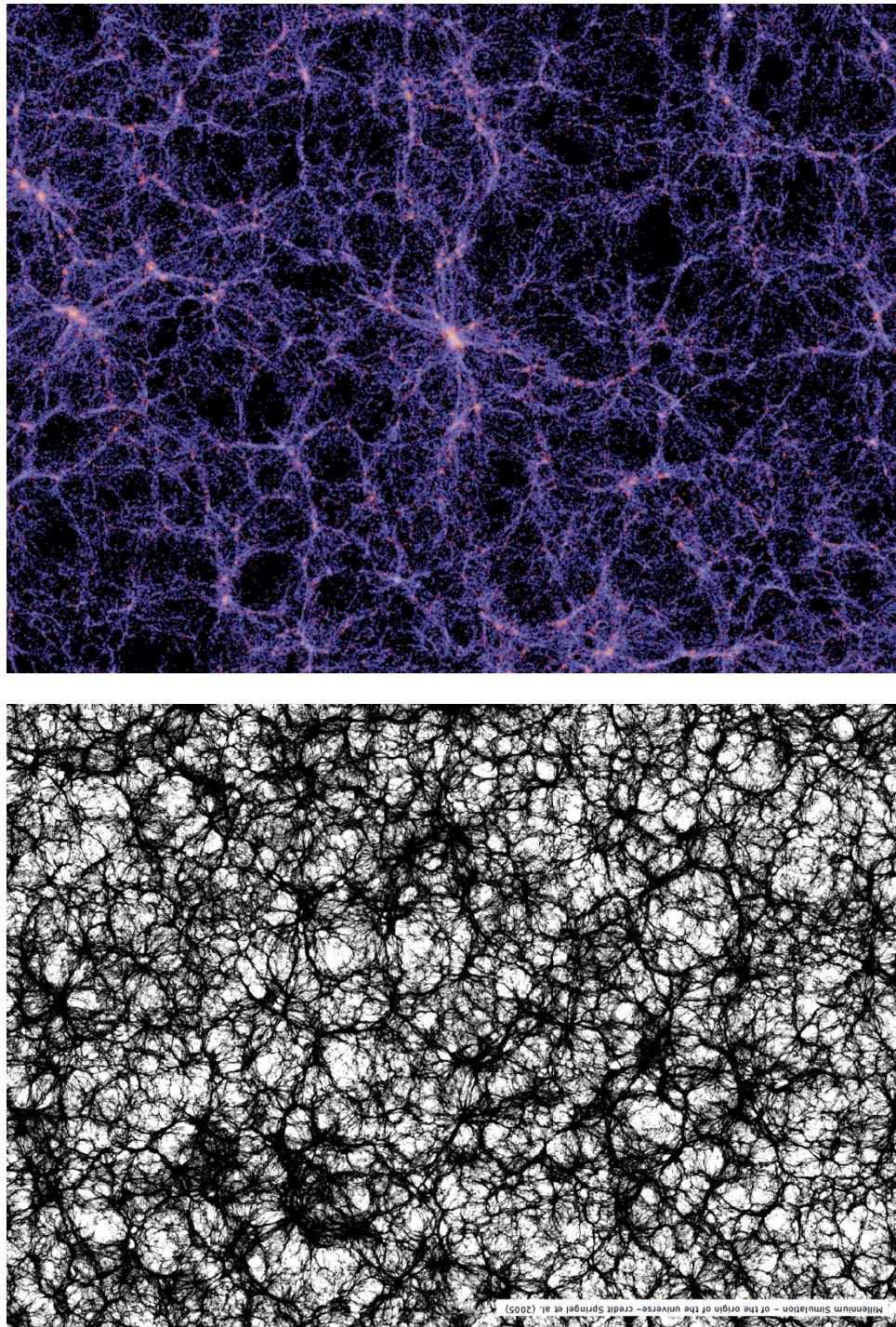
To further complicate things, the “cosmic web” is a strange kind of web. In 2008 and 2009, Saraceno and his team, especially Adrian Krell, initiated conversations with some of the world’s leading spider scientists and astrophysicists, including Dr. Peter Jäger, and Dr. Volker Springel, head of the team at the Max Planck Institute that had produced the Millennium Simulation. What was revealed in these conversations was that the cosmic web was not actually a web, and that it would be virtually impossible for a spider to reproduce such a structure, or to create a space with any geometrical similarity to the cosmic web. In an interview later published in Saraceno’s catalogue for the Venice Biennale, Dr. Springel outlined several reasons why the cosmic web is not like a spider web (Springel in Saraceno, 2009: 43). First, he pointed out that the “filaments” one can see forming in the Millennium Simulation are composed of dark matter:

The stuff that is colorful here is actually *matter which you can't really see*. On the computer we can paint it and we can illuminate it. What is visible a little bit here is that the backbone of structure of the universe consists of these filament-like structures, which are part of the cosmic web, and along these we find galaxies that are arranged like pearls on a string. (emphasis mine; Springel in Saraceno, 2009: 44)

The cosmic web evolves everywhere at once. Dr. Springel describes a flight in the model:

Now you see how the web is slowly emerging. In fact, that is what we call the cosmic web. *It's simultaneously forming everywhere*. It is constantly transforming. You see that the web is first

very fine, but then these filaments become ever more visible because they attract each other through the action of gravity. (Springel in Saraceno, 2009: 44)



Figures 2 and 3: The Cosmic Web. Above: still image from the Millenium Simulation; Below: A page in Tomás Saraceno's Venice Biennale (2009) catalogue. Courtesy the artist.
Studio Tomás Saraceno, 2009.

Finally, Dr. Springel explains that the cosmic web is highly irregular:

Overall it is kind of irregular, it's a mess. There is regularity but it's not made from a clear design. *There is no clear geometric rule.* Maybe no one understands the rules according to which a spider makes its web. But if one knows these rules, one could perhaps make a new web that looks like a spider web. And here—in cosmology—the rule is very complicated. The rule is: you start from the Big Bang and go forward in time in an expanding universe, and let self-gravity act on the initial structure seeds. This leads to the emergence of the web. But can you come up with a geometric description that gives the same web?... And could you use that to create the web now without going through this complicated time-evolution? Such a thing nobody has found yet. (Springel in Saraceno, 2009: 45)

The irreducible difference between the cosmic web and a spider web is that the principles governing the cosmic web are those of the repulsion and attraction of ordinary and “dark” matter. There is no clear geometric rule, in fact geometry is irrelevant, since the cosmic web is a field of emergence, of “random” and “nonlinearly sharpened” axes that somehow still seem to have a pattern (Springel in Saraceno, 2009: 46). But Saraceno’s focus was elsewhere. He commented, “Mostly I like it to see the *filaments becoming visible...*” (emphasis mine; Saraceno, 2009: 45).

The irreconcilability between the cosmic web and spider webs is further supported in an interview with arachnologist Dr. Peter Jäger. The interview includes the following exchange:

Tomás Saraceno: There are astrophysicists who compare the structure of the origin of the universe with the structure of a spider web. Here I like to show you some pictures of the best visualization of that origin, the Millenium Simulation.

Peter Jäger: Ah, I see. But *this here is very untypical for spiders because spiders have only one line or thread, nothing else.* Of course they can make three or two-dimensional webs, but this is another type of action. Do you know what I mean? The results seem to be similar but the action or the process is something different. If a spider works here, then there; followed by a return to

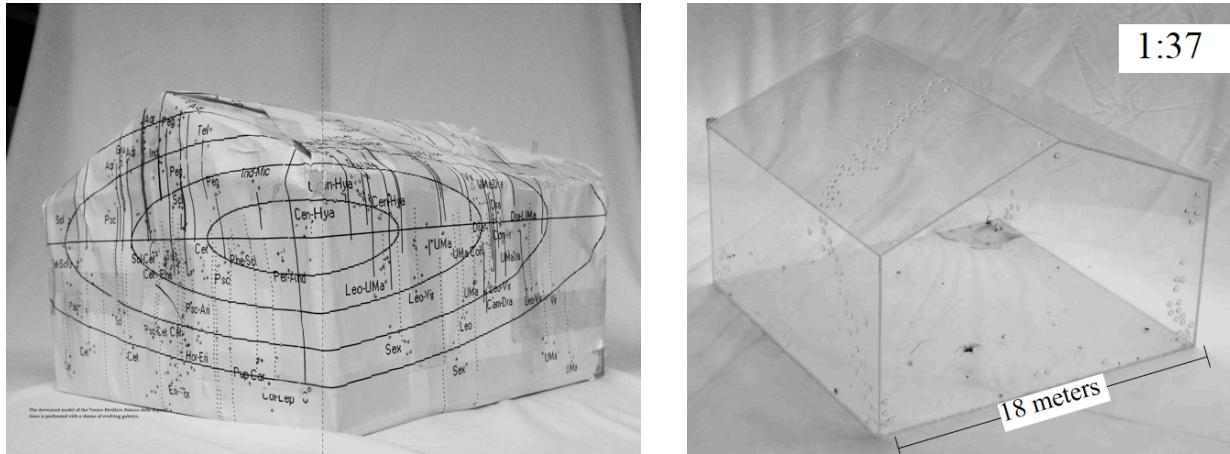
the first spot and... *this is as if the spinnerets were multiplying every time and so one has billions upon trillions of spinnerets doing this.* (Saraceno and Jäger in Saraceno, 2009: 28)

The difference is not only of rule, dimension and complexity, but also of biology and metabolism. There cannot be “significant geometric similarities” between both cosmic and organic webs, because neither are in fact truly geometric: the cosmic web is better described as a virtual field of emergence dictated by matter’s entrainment to quantum forces, and a spider web is the excretion of an animal’s body into its milieu in a form that is dependent on numerous environmental factors as well as the creature’s physical and reproductive state. Both types of “web” have elements of what Elizabeth Grosz calls “the combination of universal forces regulating all the cosmos – gravitational forces, magnetic forces, the force of light and so on – and the historically contingent eruption of life on earth in the particular forms it has taken – forces that are cellular, chromosomal, biological, regulated by impersonal cosmic forces through which evolution operates” (Grosz, 2008: 110). Materializing these cosmological forces in the filaments of webs required a specific set of technologies of illumination and recording. If the first gesture in Saraceno’s project was to identify the fundamental forces governing web structure in two different cases, the next was to find a way to bring their shared cosmological qualities into relation.

Filaments Becoming Visible

Underlying the previously cited conversations with Dr. Jäger and Dr. Springel was a series of experiments with living spiders at Studio Saraceno in Frankfurt. Progressing in parallel, the spider experiments involved placing spiders in plexiglass houses perforated with holes for ventilation and friction. In consultation with Dr. Jäger and Dr. Samuel Zschoke, a variety of different spider species were chosen for their three dimensional webs. These included *Latrodectus mactans* (black widow) *Tegenaria* (tunnel web spiders), *Stegodyphus* (semi-social ballooning spiders), and *Cyrtophora* (semi-social tent-web spiders). The goal was to establish an understanding of a spider web via analysis of its structure, so that it could be produced at a much larger scale in the gallery room at the Venice Biennale. The hope remained that this web would furnish some insights on the cosmic growth and distribution of

matter. Therefore, the holes perforating each spider's house were not random: "The locations of the holes were based on a printed and folded geometry of the universe two billions years ago, to help the spider climb and weave the 'galaxies'." (Saraceno in Arrhenius and Saraceno, 2011: 4). Of course, folding a map of the universe around a spider's dwelling and marking the place of star clusters is not a gesture that purports to represent space-time as astrophysicists know it. Rather, this was a gesture that, from the very beginning, differentiated Saraceno's spider experiments from those of arachnologists or astrophysicists, and created a frame for something entirely different to occur.



Figures 4 and 5: left: the map of the galaxies folded over the plexiglass house. Right: the house showing perforations in the place of galaxies. Courtesy the artist.

© Photography by Studio Tomás Saraceno, 2010

Although not quite a “holding pattern,” what the material presence of the holes in the spider’s plexiglass house illustrates is that the terms of this project were never about mimicking a spider-web structure. It was always about the production of something different from either the cosmic web or the organic web – a “third” structure that might approach the spider’s web but would not seek to replicate it. It was about rendering explicit a shared “cosmicity” (Bachelard, 1988).

After some initial problems with the productivity of the different species, the spiders wove webs inside these houses. With advice from Dr. Jäger, Saraceno and Krell also began to add different species of spider into the same plexiglass house, one after another. They produced a house in which a black

widow had woven a web, and then a *Tegenaria* had woven a web *on top of it*. But the single black widow web was quickly selected as the most desirable option for reproduction in the gallery, because of the space it would afford gallery visitors:

Dr. Jäger proposed that we use a Black Widow. He explained that his selection was based on its astonishing web, which contains an upper part that is usually very dense and three-dimensional, with less sticky glue-like threads stretching down to the earth to catch prey. The idea seemed perfect to us since it was expected that our visitors should not be confused as food for our universal spiders, but would all the same, be trapped on these cosmic filaments. (Saraceno, 2009: 14)

The black widow web, with its retreat in one corner and longer threads reaching out to catch prey, would accommodate bipedal visitors. Saraceno matter-of-factly writes, “the next step for us was to try and make a 3D scan. Soon thereafter we entered the Goethe University Hospital at nine o’clock that evening” (Saraceno, 2009: 14). Late at night, Saraceno and his team attempted to render the spider’s nest visible by conducting an CT-scan on the structure. However, the scans at the hospital were unsuccessful, even after various aerosols were added: “One scan was made, then another, more iodine added, then cornstarch powder, but still nothing. At one in the morning we decided to leave” (Saraceno, 2009: 14).



Figure 6: CT-scanning of a three-dimensional spider web at Goethe University Hospital, Frankfurt am Main, 2010.
Courtesy the artist. © Photography by Studio Tomás Saraceno, 2010

From the beginning, then, Saraceno's project cultivated a capacity to produce something different from either the cosmic web or the organic spider web: a third 'structured society' that might approach both webs but would not replicate them. "Structured society" in this instance is borrowed from Whitehead to refer to the way this "third web" would nevertheless hold together as a quantity of "actual occasions" in the midst of the cosmic and creaturely. The project was about rendering explicit a shared cosmological quality between the spider's dwelling and that of our galaxy. Crucially, the "between" that eventually brought these entities into relation was not a melting-together of the cosmic and creaturely, but a mobilization of their differences, "as that which relates the two as different" (Deleuze and Guattari, 1972/1984: 77).

If, following the lead of Saraceno and his team, we attend to spider webs as aesthetic objects with the capacities to intensify feeling rather than objectively mirror equations and models, we find that the astrophysicists who repeatedly recalled spider webs as they examined the structure of dark matter were not so far off. Still, the process of reaching this insight was not straightforward. In order to model a spider web in at least three dimensions, one must scan and digitally process one web. However, “At around 0.0004mm, the threads were smaller than the CT-scanner’s capacity of 0.6mm” (Saraceno in Arrhenius and Saraceno, 2011: 5). With very little time before the Venice Biennale, Saraceno and the studio went back to the drawing board, reaching out to specialists in spider science and engineering alike. As Krell told me in an interview, many methods were tried, including some basic laser illuminations: “in the studio we were trying to illuminate it with a sheet laser … and then first we were thinking to make a video and then to combine all the dots all the data… But this didn’t work” (Krell, 2014: np). Saraceno expressed his frustration: “I couldn’t believe that nobody had ever made a three dimension scan of a three dimension complex spider web, that there is no existing machine that can read and decode a spider web or such a thin structure… [like] nerves… the brain....” (Saraceno, 2009: 14). Finally, they got a tip. Krell recounts, “somebody said to us in the university of Darmstadt they are using stereophotography to measure landscapes by plane… we came to them with this idea and they said yes, let’s try it” (Krell, 2014: np).

At the technical University of Darmstadt several scientists aided in the scanning and digitization of the web, including Dipl. Eng Dieter Steineck, Dipl. Eng. Christof Wulff and Dipl. Eng. Rolf Dieter Dueppe. Saraceno writes:

After a few attempts and a rush to buy a thinner laser, four of us got settled into a tiny room. The lights were off and the exposure was made long. It worked perfectly! The laser intercepted the spider web and caused extremely small dots to appear on the intersections. *A starry night seemed to appear before us in the picture, and so the cosmos and galaxies were yet again with us!*

Downstairs in another room a virtual 3D-screen had already generated a small section of the

whole spider's house. Wearing black glasses, as though straight from the very best 3D-cinema, we watched our cosmic spiders weaving their 'galaxies'. (Saraceno, 2009: 15)

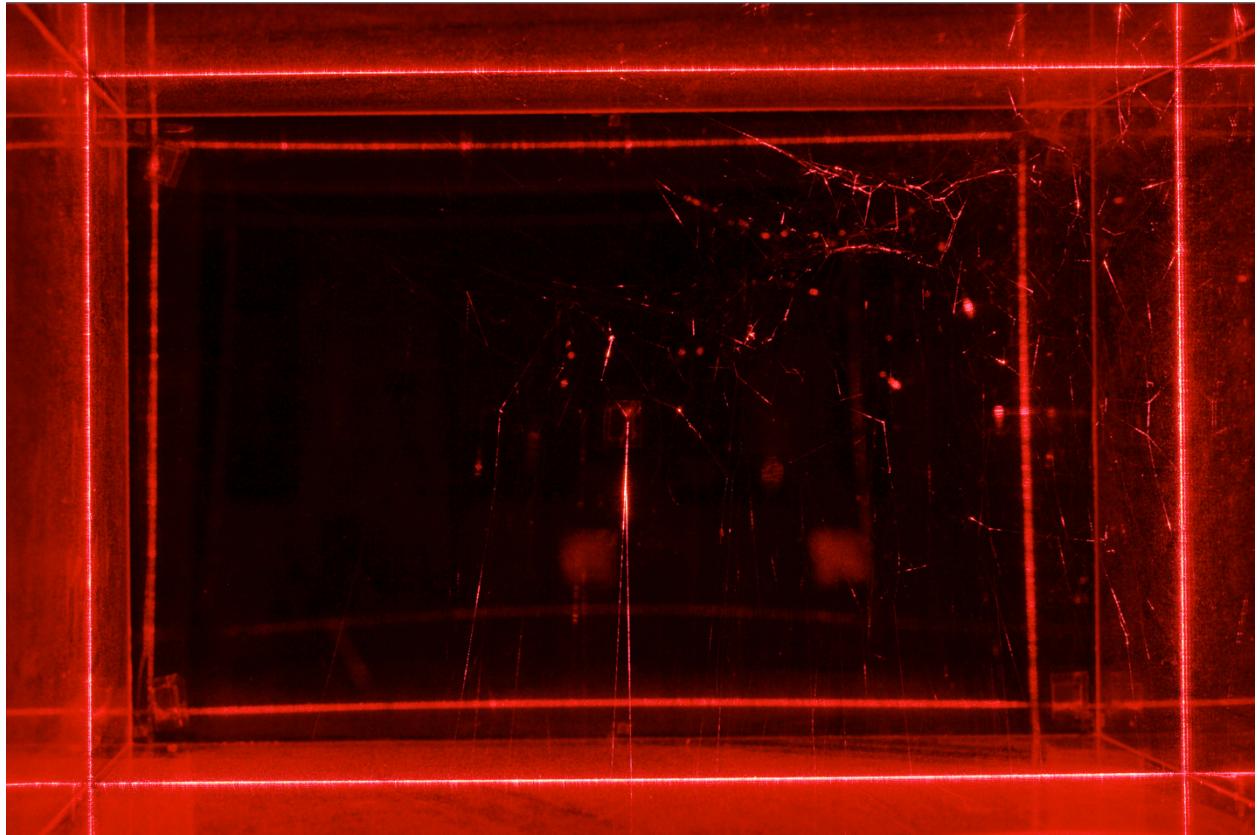


Figure 7: Solitary musical instrument Triangulum built by Latrodectus mactans. Variety of stereoscopic captures, left camera, 2014; Courtesy the artist. © Photography by Studio Tomas Saraceno, 2014

The cosmic was there, *yet again*. In fact the cosmic web had been hovering in the experiment the entire time. But as the sheet laser illuminated a vertical section of the spider web, the cosmic web reappeared. Krell described: "if you are in the dark room and you illuminate the spider web then you really can see a lot of dots... and it's like in the night" (Krell, 2014: np). In still photos of the laser slices, there is certainly a visual echo of the Millenium Simulation: the red strands are highlighted like the strands of dark matter in the computer simulation. But it is the *filaments becoming visible*, the segments emerging from darkness, which conjured the cosmic web for Saraceno and Krell. At that moment in the lab at

Darmstadt, there was a transaction, a contact-point between the ordinary and the cosmic. The experience was visual but also nonsensuous: with each laser slice, the filaments displayed an intensive quality of emergence, a virtual field of potential, which immediately echoed the intensive characteristics of the cosmic structure in the Millenium Simulation.

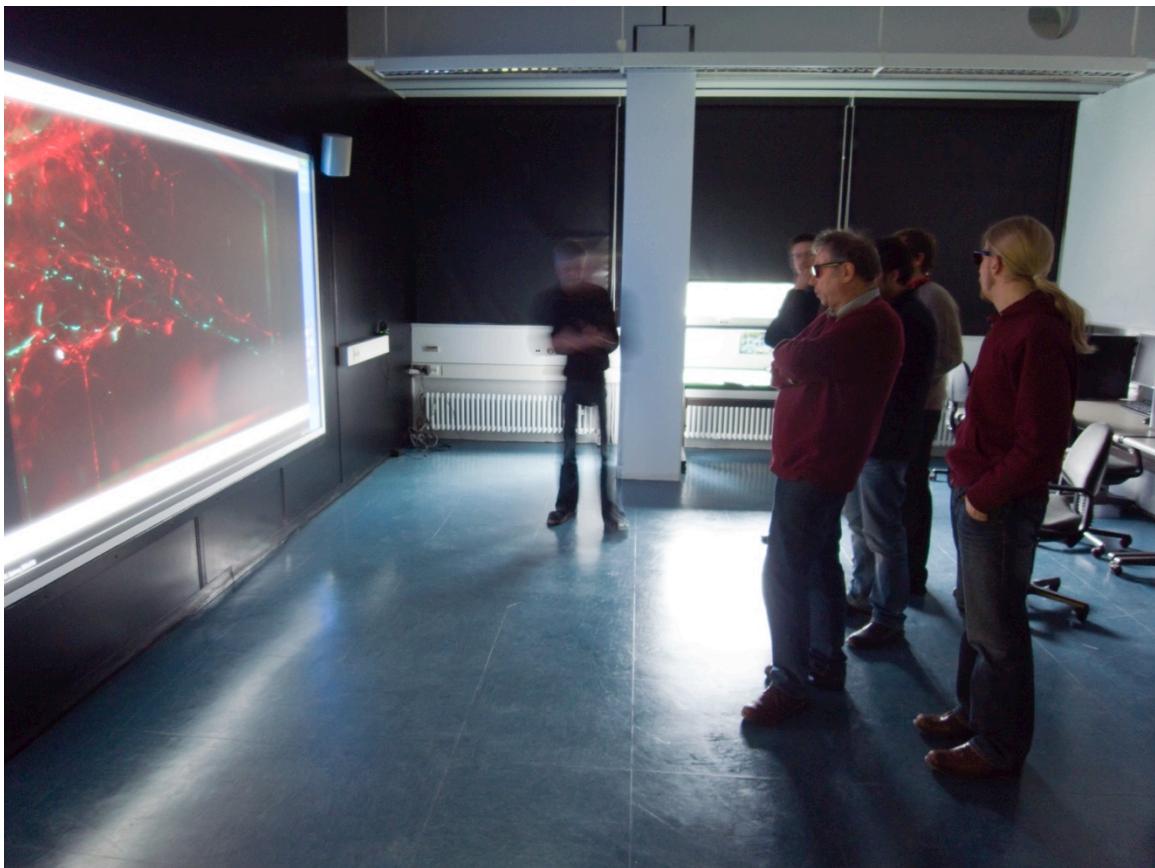


Figure 8: TU-Darmstadt Institute for Photogrammetry and Cartography viewing stereoscopic pictures
Studio Tomás Saraceno, 2010. Courtesy the artist.
© Photography by Studio Tomás Saraceno, 2010

It is precisely this non-sensuous quality of emergence that creates a relation between the spider web and the cosmic web, and which is the aesthetic force of this experiment. It is also this quality of webbed (im)materialization, informed by computer simulations and abstractions, which ties this aesthetic project to the predictions of “dark” or “exotic” matter and energy. Following Stengers (2008), Halewood (2008) and Alliez (2008) as they think together with Whitehead’s philosophy, we can

consider dark matter as an abstraction created by scientific practice toward which scientists and their instruments and equations are *lured*; it exists less as a “truthful object” than as a direction for thinking and feeling. The possibility for the physical spider web to exhibit qualities of emergence consistent with the abstraction of dark matter depended on a temporary “recording surface” onto which patterns, vectors and “non-linearly sharpened” axes could register (Springel in Saraceno, 2009: 46). In Whitehead’s terms, it was a process that created the possibility for the “structured society” of the spider web – the *nexus of actual occasions* that endured in the web’s shape and materiality (Whitehead, 1978[1929]) – to *prehend* the (less) structured society of the cosmic web in a way that was explicit to human participants. This prehension could also be described as a luring of the physical spider web to the simulation of dark matter, and vice versa. Crucially, the actual occasions cohering in the spider web *actively prehended* the cosmic web, as much as the human viewers felt the qualities of holding patterns and prehensions between the two.

The aesthetics of Saraceno’s creative experimentation with webs, and the propositions of the spiders themselves, lie not in the impressive, incredibly complex structure of the black widow’s web, or the dramatic purple and blue tendrils of the Millenium Simulation, but in the experiment of bringing these separate actual entities into disjunctive, synthetic relation. Non-sensuous qualities of emergence in both the spider and the cosmic webs are drawn forth. In this way the work also exhibits what Whitehead terms the, “becoming of a continuity” not only between a spider web and a computer simulation, but between the occasions of experience that formulate the present “cosmic epoch” (Whitehead, 1978[1929]) as well as those occasions of radically different ones. The notions of *disjunctive synthesis* and *lure* will continue to inform the engagement with webs in the following sections, as we think with the process of reconstructing the web in the space of a gallery.

Web Re-Construction

After photographing each laser-illuminated slice of the web in the laboratory, the studio assembled all of the images into a three dimensional CAD file. Since there were still many gaps

between the filaments, a team of architects painstakingly connected each filament digitally over the course of a few months. The deadline for the Venice Biennale came and went: instead of showing the final result of the web-scanning project there, Saraceno proposed an installation that recalled the way clumps of matter form along filaments in the astrophysical simulations. *Galaxies forming along filaments like droplets on a spider's web* (a title taken from an article by BBC science editor Dr. David Whitehouse, writing about cosmic structure) was one product of a longer term engagement with the metaphorization of the cosmic web (Figure 1). The nonhierarchical design of the installation, and the utilization of very simple materials (black string and cord) echoed the starkness of the Millenium Simulation, and had a diagrammatic quality. One might call it an “eidetic image” – an abstract, functional image of cosmic structure growth – lacking the irregularity and detail that is found in the original models. Moreover, compared to the experiments and models of the three dimensional webs assembled at Studio Saraceno, *Galaxies* is comparatively static.

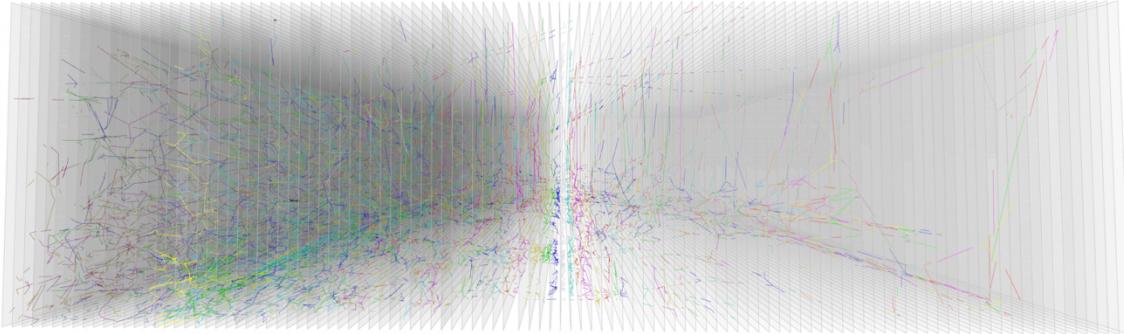


Figure 9: Tomás Saraceno. *14 billions (working title)*, 2010. 3-D file is prepared for the installation, Bonniers Konsthall, Stockholm. Commissioned by Bonniers Konsthall. Courtesy the artist; Tanya Bonakdar Gallery, New York; Andersen's Contemporary, Copenhagen; Pinksummer contemporary art, Genoa; Esther Schipper, Berlin.

© Studio Tomás Saraceno, 2010

As this process continued to unfold, there were still filaments becoming visible. As the architects progressed in assembling the three dimensional data, they produced an orthogonal projection of the web, or a flattening of the structure in two dimensions. This orthogonal image was placed on the floor and ceiling of a helicopter hangar in Bonames, outside Frankfurt. For each intersection on the orthogonal image the studio assistants (including Jol Thomson) strung a length of fishing wire vertically between the points. There was a “book of numbers” which had the heights at which threads intersected (Krell, 2014; Thomson, 2014c). Working in shifts, the assistants used the projection, fishing wire and the book of numbers to patiently tie and connect all the nodes until a web began to form. As they worked, the architects back at the studio were finishing processing the three dimensional data (Thomson, 2014c). “The funny thing about making a web,” Thomson remarked, “is that you need another web!” (Thomson, 2014c, np). The web in the CAD data, the under-web of fishing wire, and the “third” emergent web progressed in relation to each other.



Figure 9: Tomás Saraceno. *14 billions (working title)*, 2010. Reconstruction process, Bonniers Konsthall, Stockholm. Commissioned by Bonniers Konsthall. Courtesy the artist; Tanya Bonakdar Gallery, New York; Andersen's Contemporary, Copenhagen; Pinksummer contemporary art, Genoa; Esther Schipper, Berlin.
© Photography by Studio Tomás Saraceno, 2010

In one of several interviews, Thomson described the long hours in the cold hangar. He said, “some of us became spiders and some became prey” alluding to the fact that for some people, the web just “made sense” (Thomson, 2014c: np). Thomson admitted to learning the logic of the structure so well that he began tying nodes without consulting the map or the data. And the web made its way into dreams: “people just started to dream about it” (Thomson, 2014c). He likened it to the feeling of having an afterimage burned on one’s retina after looking at a silhouette in a sunny window. The web in the digital CAD file, the “under web” of fishing wire, and the emerging filaments of the scaled-up web meshed and overlapped with each other. Each performed a different function in the same space. The emerging web, made of black string and nodes, rendered concrete the virtual filaments in the CAD file. The fishing wire web supported the translation of the digital data into various heights and coordinates in three-dimensional space. As nodes were tied and connected, the black filaments of the third web emerged from the liminal “under-web” of fishing wire. Constructing the area corresponding to the retreat of the black widow was the most difficult, since this was the area of the highest density of threads and nodes; therefore this was left to the final few weeks (Thomson, 2014c). But at this point, assistants like Thomson had begun to understand the logic of the filaments and tensions. As Thomson later described, it was not about precision or exactitude, as much as a visual-tactile awareness of the nodal connections. The web echoed into the daily, spatial-cognitive states of the studio assistants. It is no wonder they dreamed the web, too.



Figure 11: Tomás Saraceno. *14 billions (working title)*, 2010. Reconstruction process, Bonniers Konsthall, Stockholm. Commissioned by Bonniers Konsthall. Courtesy the artist; Tanya Bonakdar Gallery, New York; Andersen's Contemporary, Copenhagen; Pinksummer contemporary art, Genoa; Esther Schipper, Berlin.
© Photography by Studio Tomás Saraceno, 2010



Figure 12: Tomás Saraceno. *14 billions (working title)*, 2010. Reconstruction process, Bonniers Konsthall, Stockholm. Commissioned by Bonniers Konsthall. Courtesy the artist; Tanya Bonakdar Gallery, New York; Andersen's Contemporary, Copenhagen; Pinksummer contemporary art, Genoa; Esther Schipper, Berlin.
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The third, scaled-up web that was eventually constructed in the helicopter hangar formed the installation *14 Billions* (2010). It was the product of the original black widow spider web, the scanning and digitizing process, the immense architectural labor in connecting the filaments, and the manual work of many studio assistants. To describe the installation, Saraceno uses *biomateriomics* – a term from a book by Steven Cranford and Marcus J. Buehler. Biomateriomics means, “examining the fundamental links between processes, structures, and properties at multiple scales and their interactions” and it “explains system functionality from the level of building blocks” (Cranford and Buehler, 2012: vii). It is concerned with, “interfaces between living and nonliving systems” and recognizes that, “the relationships between form and function can be exploited in a meaningful way by recognizing the similarities between Beethoven and bone, or Shakespeare and silk” (*ibid*). The process of scanning, digitizing, scaling up, under-webbing and filament-forming was an effort to think about the materiality

of the experiments carried out by astrophysicists and arachnologists alike, including Dr. Springel and Dr. Jäger. The materializing of the web was less about fidelity to either “web” model, but about attending to qualities of the *cosmic* and *cosmological* expressed within them. As Thomson said in an interview:

[14 Billions] [dis]orients what it is to be scaled... there is of course the cosmic web... you're suddenly outside and it's a spider web but you're also inside of this thing, so there's this infolding passing through scales which makes the cosmic... palpable” (Thomson, 2014c).

As a result of the immense efforts of everyone involved, the web was successfully constructed in the helicopter hangar in Bonames. It was then packed and shipped to the Bonniers Kunsthalle Museum in Sweden, where it was installed in a gallery room that had been built and prepared for its dimensions. The process of packing and re-installing the web was itself a herculean effort: how to take down and pack such a delicate and complex structure without breaking or tangling it into an irreversible knot? The solution was a system of taping nodes to layers of plastic sheets that were then rolled into a large “sausage” and shipped via truck to Sweden. Miraculously, when the package was unrolled, the web was still intact and could be hung in the gallery.

Saraceno chose to install the web upside down: rather than positioning the dense ‘retreat’ near the ceiling, he chose to install it near the floor. This decision did not impress spider scientists like Dr. Peter Jäger and Dr. Yael Lubin, for whom the orientation of a web is one of its most crucial biological qualities (Jäger, 2014; Lubin, 2014). At the next conference for the Society of Arachnology, a petition was signed by dozens of scientists to re-install the web-sculpture in its “correct,” biologically derived orientation (Arrhenius and Saraceno, 2011: 210-211). This has not happened yet, and I doubt it ever will. For Saraceno, there is no “correct orientation” for *14 Billions*. Drawing from biomateriomics, the “system functionality” of *14 Billions* was more about a certain quality of “holding together,” or “endurance” than about biological reproduction or mimicry (Stengers, 2011).

The title *14 Billions* refers to the approximate age of the universe. This reminds us of the fact that despite the installation’s structure, its relationship to the black widow web and the Millennium Simulation is one of disjunctive synthesis. It is a binding together of the immense and the miniature, the

vast and the intimate, finding “cosmicity” in both (Bachelard, 1988). In this way it coheres the holding patterns of both the organic webs and those of the Millennium Simulation. As Thomson relates, the work’s logic is one of “infolding, passing through” where one does not know whether one is in or out, enveloped or exposed – a situation we have already encountered in the previous chapter (Thomson, 2014a). Instead there are tensions, nodes, and filaments drawing on each other, lifting each other, and supporting each other. *14 Billions* manifests a cosmological aesthetics of creatures, hands, digital scans, software, rope, dreams and galaxies; and it is a transmutation of the *filaments-becoming-visible* of astrophysical simulations and a black widow web into sensations circulating through a gallery.



Figure 13: Tomás Saraceno. *14 billions (working title)*, 2010. Reconstruction process, Bonniers Konsthall, Stockholm. Commissioned by Bonniers Konsthall. Courtesy the artist; Tanya Bonakdar Gallery, New York; Andersen's Contemporary, Copenhagen; Pinksummer contemporary art, Genoa; Esther Schipper, Berlin.
© Photography by Studio Tomás Saraceno, 2010



Figure 14: Tomás Saraceno, *14 Billions (working title)*, 2010. Installation view, Bonniers Konsthall, Stockholm. Commissioned by Bonniers Konsthall. Courtesy the artist; Tanya Bonakdar Gallery, New York; Andersen's Contemporary, Copenhagen; Pinksummer contemporary art, Genoa; Esther Schipper, Berlin. © Photography by Studio Tomás Saraceno, 2010

The Spider Room

We find ourselves in a buzzing world, amid a democracy of fellow creatures. (Whitehead, 1978[1929]: 50)

The spider room is a small, dimly lit space, containing shelves and shelves of rectangular wire frames, each containing webs. In total the room holds about three hundred spiders, although this number rises and falls due to the influx of new spider species and egg sacks, and the natural or violent death of grown spiders. The spiders weave webs in the open frames standing in trays of water, which (to some degree) prevents them from wandering into each other's frames or out of the room altogether. The room

is coated with black paint and black sheets of plastic, and the door to the room is padded. Due to the water in the trays, the room is quite humid. Houseflies ricochet around the shelves and ceiling, and smaller wingless jumping flies hop on the wires. Jars teeming with fly larva stand open. As one might expect, combined with the humidity, the air has a particularly nauseating stench.



Figure 15: Tomás Saraceno and Hanna Baranowska in Acclimatized Spider Laboratory at Studio Tomás Saraceno for the solo exhibition *Cosmic Jive*. Tomás Saraceno: *The Spider Sessions*, Museo d'Arte Contemporanea di Villa Croce, Genova (2014). Courtesy the artist. © Photography by Studio Tomás Saraceno, 2014.

Hanna Baranowska⁴¹ works in the spider room. She usually comes to the studio three days a week, and spends the hours between 10am and 7pm, “making sure everyone is happy” (Thomson, 2014a). Her job is twofold: to feed and take care of all of the spiders, and to facilitate the production of “beautiful hybrid webs” (Baraowska, 2014b). The first is a very repetitive task, while the latter requires acute observation of the progress being made in each web, judgments on when each web is “finished”

⁴¹ At the request of this individual, I have used a pseudonym.

and how nice it is, and decisions on which different spider species to add to already completed webs, in order to produce a hybrid. Baranowska enjoys both parts of her job, and even admits to spoiling some large spiders with crickets. However it is the latter part of her job that interests me here, since it requires not only several aesthetic judgments, but an understanding of each spider species' habitual web structure and how it might look combined or superimposed on a different one.

Baranowska begins each day saving drowning spiders: "well first of all I check if they're all okay ... sometimes they fall into water and if it just happened then I can still save them, so it's important to check if any spiders are in water" (Baranowska, 2014a: np). She continues, "Once I've saved them, then I'm gonna feed them, so they all get their favorite food and her [*Nephila*] I like feeding best. She gets more crickets in the morning and maybe one later in the afternoon" (ibid). The *Nephila* spider was a large spider perched in a web in a very large wire frame on the floor of the spider room. When I spoke to Baranowska in March of 2014, the *Nephila* had woven a large orb-web spanning the length of the frame and was perched vertically at its axis. Baranowska explains what happens after the morning feeding:

HB: Once I've fed them I check what happened, if there's any new webs and if they're ready, if they need to be mixed with another species or... if they're finished

SE: How do you know if they're finished?

HB: I mean you kind of know what the finished structure looks like. So once they've built this dome then they won't do much more.

SE: I see

HB: They would just keep on repairing it if it gets damaged but this is the finished piece, not much more will happen, so if I see that then I try to take them out as quickly as possible because if it gets dusty also it loses this iridescent quality. (Baranowska, 2014a: np)

An important part of Baranowska's job is to recognize the 'finished' forms of each spider's web. Since there are many different species of spider, she has learned to notice when each spider has woven a web that is more or less the limit of what it will construct. For example, a *Tegenaria*, or "tunnel web spider"

will weave a three-dimensional tunnel-web sometimes in the center of a frame, but more often around a corner. Then it builds itself a retreat in the corner as well. A *Cyrtophora* spider, on the other hand, will build a mesh-like tent web, usually horizontally, suspended in the middle of a wire frame with long freestyle strands to the top and bottom. Once a spider has completed its characteristic web, she removes the spider from the frame and adds a different spider that will build a web nearby or on top of the first web. We discussed this in another interview:

SE: So you wait for the spider to finish the web, then you take the web, and then do you put a new frame for the spider to begin again?

HB: Yeah, or I put it in a web that they can be mixed with... so [a] different species

SE: And how do you know which ones will mix the best?

HB: I guess it's just trying no? Because you can't tell, you can't really tell... also if they're gonna just destroy the previous web or if they're gonna use it in a really nice way... so it's just chance

SE: But maybe you have an idea why...

HB: yeah there's stronger kinds of silk and there's weaker silk so its better to start with the one that's stronger, then put a weaker spider in or a smaller spider that won't destroy the structure.

So for instance, *Nephila*, she would never go in second, she always has to be the first one, her silk is the strongest. (Baranowska, 2014a: np)

The order of adding the spider species is very important, since, as Baranowska points out, certain species have more durable silk than others. Another important factor is the spiders' "sociality". Sometimes two spiders can work in the same wire frame, but this is very rare, and requires both spiders to be conspecifics, or of a "social" or "semi-social" rather than "solitary" species. The distinction here is very important. A solitary spider, such as a black widow or *Nephila*, will only weave a web by itself and will attack any spider that enters its webbed milieu. A semi social spider, in contrast, will build a web that is partially supported by, or touching, another web. Social spiders are usually those that live in colonies, and cooperatively maintain their webs. The species in the *Cyrtophora* genus are semi-social or social

spiders, while the *Tegenaria* is a solitary spider. Even though there are only about forty known social spider species in the entire *Araneae* order (which contains 40,000 known species), many of the active spiders at Studio Saraceno are of this “social” type.⁴²

Three hundred social and semi-social spiders is an unusual ecosystem and provokes questions on the qualities of conviviality in this space. As part of a varied engagement with the “more-than-human” (Whatmore, 2006), social scientists have begun to attend to creatures that are not ‘big like us’, that are strange or monstrous (Ginn, 2013; Dixon, 2009). If much of this literature has attended to human-animal companionship (Haraway, 2008; Hinchliffe, 2010; Lorimer, 2010), and its bio-geographical traces (Barua, 2014) Davies (2012) in particular has studied mice and glowfish in laboratories, speaking not only of individuals but of populations: creatures which are, “not only multiple, but a multitude” (Davies, 2012: 626). Furthermore, Dixon (2008; 2009) and Johung (2015) have addressed the ways bio-artists employ the expressiveness of non-human beings to critique the styles of genetic manipulation in industry. The spider room at Studio Saraceno also hosts both multiple species and a multitude of spiders whose expressiveness is the primary medium of artistic production. The fact that the spider room is part of an artist’s studio does not mean it is free from the questions of animal welfare and bioethics raised by Davies (2011; 2012) and Dixon (2009) among others.

However, in response to such concerns, it is important to emphasize the degree of care and reciprocity that occurs between spiders and studio members like Baranowska, expressed through the degree of observation and empathy that is necessary for such multispecies collaboration to succeed. As Saraceno and Krell invited the first spiders into the studio in 2008 and 2009, they faced enormous challenges in maintaining an ideal environment for the spiders to weave webs. It took significant research with spider scientists like Dr. Peter Jaeger to develop the conditions in which the spiders would weave. The fact that they ultimately did begin to weave suggests what Despret (2013) calls, “embodied

⁴² In March 2014, one of the Nephila spiders in the spider room died. Baranowska told me that she suspected that the death was the result of an attack by a gang of “German spiders” who were uncharacteristically aggressive. She deduced that the German spiders had raided the web of the Nephila during the night and ripped off two of her legs. Anecdotes like this made me realized how complex the interspecies relations in the spider room really were, and how important a role Baranowska played in managing these relations.

empathy” between humans and spiders. Such empathic attunement, “...becomes multiple, as are bodies, as are encounters, as are animals who are the living actors of these encounters” (Despret, 2013: 69). In making this claim I am aware that many would question the symmetry of this empathic relation between humans and spiders. There is of course no valid way to conclude whether the empathy is either embodied or truly symmetrical. I can only relate my experience of witnessing the way that Adrian Krell could pick up a *Nephila* and encourage her to cast a thread between two poles: something that a spider almost never does in the grasp of another creature. Numerous other witnessed moments similarly suggest that at Studio Saraceno, spider bodies behave differently and familiarly toward their human collaborators.

The spiders’ agencies on humans often emerged through storytelling and narrative. Baranowska often told stories of spider dramas. As already conveyed, she even developed personal relationships with some spiders, preferring to spend more time with them. Her influence on the spider populations at Studio Saraceno, and the way the spiders became accustomed to her practices, indicates how: “the process of tuning works both ways, on human as well as on nonhuman agency, constitutively intertwining a double process of emergence” (Stengers, 2008: 96). The spider room hosted a reciprocal “dance of agency” in which generations of spiders also became more habituated to the studio space and to their human collaborators (Stengers, 2008: 96; Pickering, 1995).

The inter- and intra-actions between different species of spiders in this small (if porous) space are perhaps the most unusual aspects of Studio Saraceno. It is precisely these relations between species and populations of spiders that have direct outcomes on the qualities of the unusual “hybrid” webs produced in this environment. I learned from Baranowska that hybrid webs are considered the most “beautiful” when the two structures approach each other to the highest degree, without assimilating or destroying each other. Phrased otherwise, the most aesthetically powerful hybrid webs are those in which the second spider approaches or prehends the first spider’s web to the greatest extent. Another quality contributing to their beauty is the iridescence of the silken threads, which can be preserved if the web is protected from dust. This resonates with Whitehead’s claim that beauty is best defined as the

holding of differences that are adapted to each other, or, “interwoven in patterned contrasts” (Whitehead, 1978[1929]). Iridescence accentuates this affect: the refraction of differently colored light along the quasi topological surfaces of approaching webs contributes to the sense that they are attracted to each other, although held apart.

The structures generated by spiders at Studio Saraceno are not static ‘geometries’ since they are both flexible and change over time, and have no defined ‘shape’. Still, each spider has a specific way of engaging with its environment and will harness opportunities and overcome challenges in a distinctive way. During my time at the studio this point took some time for me to grasp. It is not a case of a series of silken copies. Rather, the spider measures and reacts to its conditions, sometimes performing great acrobatic feats to make a structure operable. While there are some parallels with the way birds make their nests, or crustaceans their shells, spiders create and extend surfaces and scaffolds from their bodies, rather than building on top of existing ones. Baranowska’s sense of when a spider web is finished is not only a recognition of repetitive forms and surface structures, but also understanding when a spider has exploited the facets of its milieu in the most extensive way. In other words, the spider’s weaving approaches a limit scenario in which it has measured, sensed, captured and produced its immediate spatial environment.

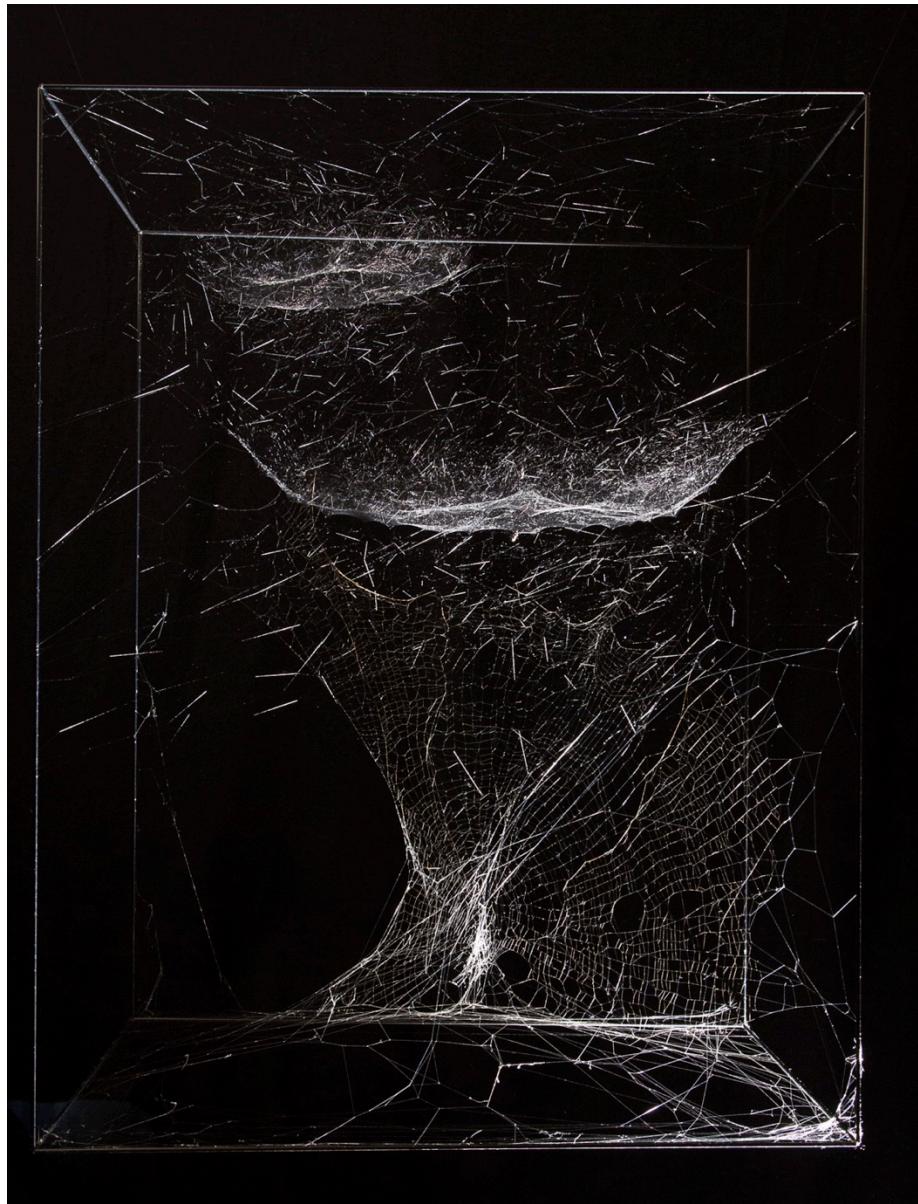


Figure 16: Tomás Saraceno, *Hybrid musical instrument Cygnus A*: built by a solitary *Nephila kenianensis* and two semi-social spiders *Cyrtophora citricola* (2014). Courtesy the artist.
© Photography by Studio Tomás Saraceno, 2014.

The term “finished” is slightly misleading, since spiders also recycle, clean and eat parts of their webs. Some orb-web spiders, for instance, eat their webs every day, and weave them again at night. According to Henri Lefebvre, a spider’s web is not an “abstract space” composed of “such separate objects as its body, its secretory glands and legs, the things to which it attaches its web, the strands of silk making up that web, the flies that serve as its prey” (Lefebvre, 1991: 173). Characterizing a spider

web in this fashion would omit any intelligence in the spider's acts, claiming that its web is a product of "blind instinct" or "Nature" (*ibid*). Unlike shell-forming creatures and flowers, a spider will weave many webs in its adult life, sometimes in the space of only a few hours and sometimes in sub-optimal conditions. It solves problems and makes mistakes; takes chances and gambles; fixes and repairs. There is something very plastic and poetic about a spider's production of space and residence.

In visiting the spider room and witnessing the progression of countless webs, I learned to recognize the shapes of various species. A spider's web is a casting of space, and an expression of the genetic code that the spider has evolved with a certain prey. In this context it is more apt to think of a spider web partly as an extension of the creature's body into the environment, and partly a projection beyond the body of, "those dualities which help constitute the body as they do the animals' relationship to itself and its productive and reproductive acts" (Lefebvre, 1991: 173). These extensions and projections are dynamic, tensile, resilient and delicate. It is this duality of both extension and projection that is manifested and contrasted in the hybrid webs produced in the studio. When two spiders of different species have woven their webs in the same frame, two different zones of space-time flicker into contact. Methods and strategies of life are juxtaposed and superimposed. Folds, twists and curves and patterns become more distinct in comparison.



Figure 17: Tomás Saraceno, *Hybrid semi-social solitary musical instrument Arp87* built by: a couple *Cyrtophora citricola* - one month, one *Agelena labyrinthica* - two months, one *Cyrtophora moluccensis* - two weeks, and one *Tegenaria domestica* - four months, turned 4 times 180 degrees on Z axis. (2015)
Courtesy the artist. © Photography by Studio Tomás Saraceno, 2015

The hybrid webs take on a diverse range of forms and morphologies. During my time at the studio in July 2014, I saw one large wire frame in which a colony of *Cyrtophora* spiders, much like those we met earlier in the second chapter of this dissertation, had woven a large, flat tent web horizontally in the middle of the frame. Curiously, a solitary *Cyrtophora moluccensis* spider had woven another, denser web directly on top of it, so that the two web structures were suspended in the center of the frame (Figure 18). The *Cyrtophora moluccensis* spider was still in the frame, perched in a small retreat. I asked Baranowska about the two suspended web structures and she said, “sometimes they do this and

this is actually desirable, because most of the time they just go to the corner” (Baranowska, 2014: np). When I asked, “why is this desirable?” she answered, “because it looks more interesting when they build the new structure on top of the existing one, but it doesn’t happen that often” (ibid). Again I queried, “is there anything you can do?” and she replied, “No it’s up to them, I can’t force them” (ibid). A very “interesting” web like the one I described is produced under very specific conditions monitored by Baranowska and the studio, but ultimately the superposition of structures is unpredictable.

Baranowska had a Google spreadsheet in which she kept track of the progress and value of each web, usually employing words like “very nice”, “beautiful” or “interesting” in the margins. There was also a “star system” whereby if a web was “beautiful”, Baranowska added a number of stars to indicate how beautiful it was relative to other webs (Baranowska, 2014). The most interesting and “beautiful” webs are displayed in galleries and museums. In June 2014 a new exhibit of spider webs (and spider sounds) called *Cosmic Jive* opened at the Museo d’Arte Contemporanea di Villa Croce, Genova. During that same month Saraceno also sent webs to a group exhibition in Kiel, one in Berlin, and to several other galleries and art fairs. In museums and galleries, the hybrid webs were displayed in rooms made entirely black, except for spotlights shining directly onto the webs. These conditions of display reduce the presence of the wire frame and highlight the meshed surfaces of the multiple webs.

In the studio, in soft daylight, the layered structures of the *Cyrtophora citricola* and the *Cyrtophora moluccensis* were captivating (Figure 18). The two forms, hovering one on top of the other, had a ghostly presence. There was a surface-like impression of each web, more pronounced in the *Cyrtophora moluccensis* than in the *citricola* structure. But neither was only a surface, since shining threads extended in all directions between, above and around them. No, these were not two surfaces, but weavings or meshings-together of zones in space, interspersed with connectors. This hybrid web is not merely a sculpture. It is a philosophical-aesthetic proposition about sensibility, extension and sociality. This hybrid web, among others, will lure us further in the development of an aesthetics of the cosmic and cosmological.

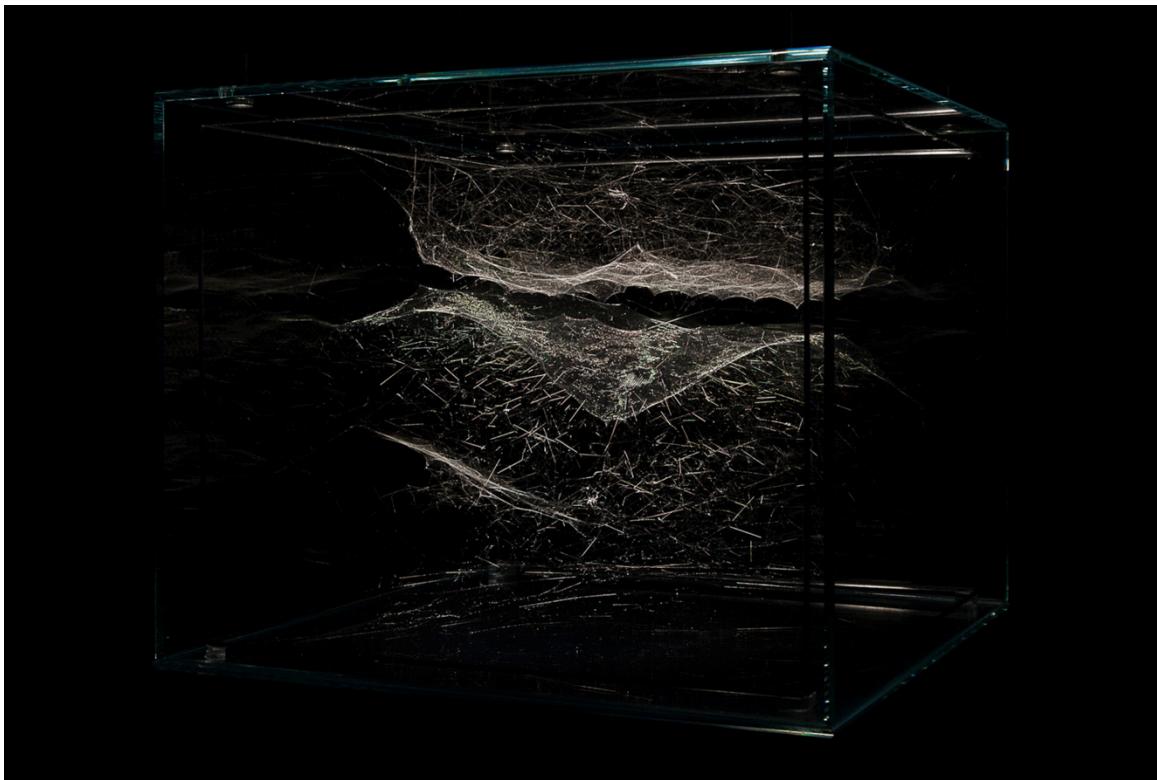


Figure 18: Tomás Saraceno, *Hybrid semi-social semi-social musical instrument Antennae Galaxies built by: a pair of Cyrtophora citricola - two weeks, and a single Cyrtophora moluccensis - one week* (2014)
Courtesy the artist. © Photography by Studio Tomás Saraceno, 2014

Hybrid Webs

If the *Gwion Gwion* and Lascaux cave paintings described by Kathryn Yusoff render explicit, “what passes between... holding together or forcing apart” (Yusoff, 2015: 388), the hybrid webs produced in Studio Saraceno perform the aesthetics of this “radical asymmetry” in stunning variation. The aesthetic and affective force of the hybrid webs is greater than the combination of multiple webs suggests. The force of the hybrid webs lies in the middle, in the discernible interweaving of both webs, and in the sense that their structures are in suspension, in a “holding pattern” (Manning and Massumi, 2014). What happens in the middle of each hybrid web is that, “the either-or is held fast together in passing contrast. It is the holding together that is felt, in excess of one or the other” (Manning and Massumi, 2014: 33). The closer the webs come, while still remaining distinguishable structures, the greater the sensation of the “holding together”. It is not clear how the structures approach each other or

maintain their distance: “Somehow,” they are “collectively beginning, collecting difference” (Manning and Massumi, 2014: 34). “Somehow,” they are “suspended in disjunctive synthesis” (*ibid*).

In this fragile suspension, each web refracts its difference from the other. This is especially true in hybrid webs where an orb-web spider like *Nephila* weaves a two-dimensional web near that of a tent or tunnel-web spider like *Steatoda* or *Tegenaria*. Iridescent connectors cross the zones of both webs, giving texture to the middle space and highlighting the shared material. The sensuous perception of the visual qualities of spider silk comes together with nonsensuous perception of tension and pattern. Surfaces tend toward each other and then veer away. Finer, denser areas capture more light, while long radial threads emerge as one circles the frame. The woven spaces illuminate and disappear; oppose and merge, emerge and oppose. This is the paradox of disjunctive synthesis in visual-spatial terms: of the “either... or... or...” (Deleuze and Guattari, 1972/1984).

In Whitehead’s terms, the hybrid webs create aesthetic intensity in the contrasts of their species-specific spatial patterns. As a concept of aesthetic feeling, Whitehead’s “patterned contrasts” resonates with disjunctive synthesis. For Shaviro (2009), the purpose of Whitehead’s notion of “patterned contrasts,”

...is to increase, as much as possible, the experience’s “intensity of feeling”. Such a building-up of intensity through contrast is the basic principle of Whitehead’s aesthetics, applying to all entities in the universe. At the low end of the scale, even the most rudimentary “pulses of emotion” (like the vibrations of subatomic particles) exhibit a “primitive provision of width for contrast” (Whitehead, 1978[1929]: 163 in Shaviro, 2009: 68)

It is the intensity that is “built up” in such contrasts, or such disjunctive syntheses, which distinguishes the aesthetic work of hybrid webs, or Saraceno’s experiment in comparing the black widow and cosmic webs, from other artworks or experiments inspired by the webs of spiders. This is not to say that other aesthetic techniques can’t produce this degree of intensity. However, the visceral aesthetic force of *14 Billions* or *hybrid webs* is one that derives its energy from disjunction rather than assimilation, difference rather than mixture.

My initial reading of the hybrid webs as “strange attractors” is not far off, if one considers the production of webs in terms of Deleuzian multiplicity: as the products of “tendencies” which are linked together by “bifurcations” or “progressive differentiations” (DeLanda, 2002: 22). In Deleuze’s ontology, multiplicities give form to processes, not to final products; they are “sets” which can result in highly different products depending on the number and degree of divergence. There are multiplicities in the cascades of hydrodynamic flow systems (from conduction to convection to turbulence), in the amplifications resulting from inbreeding of mice in labs (Davies, 2012) as well as in the way morphological detail unfolds in embryogenesis. Delanda emphasizes that multiplicities are, “concrete universals” or “concrete sets of attractors” which undergo progressive differentiations in pattern and symmetry (Delanda, 2002: 22). In the example of embryogenesis, “the role of gene products in such an unfolding is to *stabilize* a particular morphogenetic pathway by facilitating a sequence of pattern transition, resulting in a particular morphology” (Goodwin cited in Delanda, 2002: 22). In the production of spider webs, what begins as similar radial scaffolding is progressively differentiated. Each web is an “attractor” in the sense that it is a recurrent form that a given spider species will produce: the limit scenario of a multiplicity.

It is therefore useful to think of webs as the gene-stabilized products of the same set of attractors or multiplicities. The hybrid webs are not clear and abstract, but “obscure yet distinct” and “*meshed together into a continuum*” (emphasis in original; Delanda, 2002: 22). Deleuze’s description of the way multiplicities coexist could very well have been a description of two or more hybrid webs. According to Deleuze, “ideas”, or multiplicities, coexist:

...at points, on the edges, and under glimmerings which never have the uniformity of a natural light. On each occasion, obscurities and zones of shadow correspond to their distinction. [Multiplicities] are distinguished from one another, but not at all in the same manner as forms and the terms in which these are incarnated. They are objectively made and unmade according to the conditions that determine their fluent synthesis. This is because they combine the greatest

power of being differentiated with an inability to be differentiated. (Deleuze, 1968/1994: 187 cited in Delanda, 2002)

Reading this passage sideways with hybrid webs, we arrive once again at the notion that the aesthetic force of the spiders' compositions lies precisely in the feeling of holding together of radical asymmetries of form, energy, and space-time across an unlikely but palpable continuum, one that never has "the uniformity of natural light" and is dominated by "obscurities and zones of shadow." The powerful, shimmering differences of these hybrid webs are combined with their inability to be differentiated entirely. And the sense that there is always something hidden or obscured across the spectrum of difference is their fascination. It is also precisely this aesthetic affect that artist Sarah Casey has experimented with in her own artwork on evoking dark matter. In her pieces titled *Dark Objects*, *Barrier(s) of Darkness* and *Dark Nets* (2015) Casey experiments with semi-reflective and luminescent surfaces to lure the viewer-participant into zones of shadow beyond or behind the paper-surface. As in the case of hybrid webs, the viewer's position in reference to the artwork determines how much of the piece is revealed, and how much is withdrawn.

This description of hybrid webs as partially obscured, withdrawn, luring entities, also resonates with Harman's "non-relational ontology of objects." In Harman's thought, objects (like trees, volcanoes or particles) hold something in reserve, and it is this private or withheld aspect that is *alluring* (Harman, 2011). The concept of "allure" includes not only perception by human subjects, but also, "seeps down even into the heart of inanimate matter" (Harman, 2011: 302). Shaviro is right to assert that there is a quality of the aesthetics of the sublime in Harman's concept of allure (Shaviro, 2011: 279-290), even though, as Harman counters, the sublime is an aesthetic theory oriented specifically to the human, while allure is not (Harman, 2011). Harman's ontology holds purchase for the objects and aesthetics elaborated in this paper, especially since Harman's objects, like spider webs, do not constantly express relation; rather they only sometimes, and under very specific conditions, enter into such relations, producing novelty. The development of cosmological aesthetics would benefit from a closer reading of Harman's ontology's capacities to convey the spectrum of luring and alluring relations. Still, if both

Whitehead and Harman champion a non-anthropomorphic philosophy, Whitehead's philosophy is better placed to understand scientific models and mathematics as devices that lure, even though their truthfulness or object-ness is often unknown. Although he wrote almost one century before Harman, Whitehead leaves the door of the "cosmic epoch" open for non-baryonic or 'dark' matters' impressions to be registered and conceptualized as aesthetic forces, even if the true spectrum of such forces is not understood.

If the black widow and cosmic web experiment at Studio Tomás Saraceno and TU Darmstadt drew its aesthetic force from the non-sensuous similarity between the physical spider-web and the simulated cosmic web of dark matter, in which the ordinary and exotic web flashed synthetically together, the multi-species hybrid webs draw their aesthetic force from their capacities to lure prehensions along an "obscure yet distinct" continuum of difference, where light and filaments collaborate to evoke alternative zones and space-times.⁴³ These are the facets of cosmological aesthetics that are most explicitly proposed by Saraceno's collaborations with spiders. Moreover, these principles – of disjunctive synthesis and the lure – are resources that allow the edges of experimental and theoretical science to enter aesthetic theory. And they are the modes in which an aesthetics of the inhuman, the insensible and the 'exotic' might be (re)woven. By fostering an encounter between the philosophical concepts of Whitehead and Deleuze-Guattari and the multi-species collaborations of Saraceno, we arrive at an aesthetics that allows for dark entities to enter a space of feeling, a space of thought.

⁴³ As Peggy Hill, a behavioural ecologist with a specialty in animal communication, writes in one of Saraceno's *Arachnid Orchestra 'Jam Sessions': What happens to the waveforms as they travel along the web threads contributes to the uniqueness of the web* (Hill in Saraceno et al., 2016).

Conclusion: Dark Fictions and Filaments

Saraceno's webs do not only plunge you in the infinitely small. They also make you a cosmic traveller. To be able to move through a space that resembles the cosmos is an experience that generally belongs to fiction, or to philosophy, or both. (Ait-Touati, 2014)

In the spirit of Whitehead's philosophy, I have proposed another orientation of aesthetics that is lured by scientific abstractions of the dark or imperceptible. The theory of cosmological aesthetics is one that is born on critical and conceptual adventures by experiments with the propositions of dark, exotic matter. It is one that intensifies in encounters that create occasions for non-sensuous similarities, attractions, and diffractions to emerge. And in the ethos of these lures and leaps across filamentary space-times, cosmological aesthetics finds a metonym in a certain creature that has figured prominently: the spider. Spiders, and their various webs, have not only been agents and contributors to this adventure in aesthetics, but have themselves invented the thought-metaphors and diagrams for aesthetics of the non-baryonic, the dark, and more generally, the insensible.

As literary scholar Féderique Ait-Touati states in the passage above, memorable aesthetic experiences of the cosmos have always populated both fiction and philosophy. Indeed, as she relates in *Fictions of the Cosmos* (2009), the “lunar journeys” of Lucien’s *True History* and Kepler’s *Dream* created the imaginative platform for scientific propositions of heliocentrism. The great physicist and astronomer Vera Rubin, who was the first to calculate the existence of dark matter based on galaxy rotation, would likely assert that Wolfgang Springel’s Millennium Simulation is a fiction, too (Rubin, 1998). As the physical and cosmological sciences have progressed – offering spectacular evidence of the Higgs particle, cascades of neutrinos or simulations of dark matter – it seems that in the production of aesthetically powerful shocks to thought, philosophy and fiction have been outdone by astrophysics and cosmology. Yet the ability to craft memorable experiences of “cosmic traveling” that transcend scale and space-time is arguably not in the remit of physics or astronomy, but in the poetry of Paul Claudel, in

the fictions of Lucien, and as Ait-Touati affirms, in the collaborative achievement of Tomás Saraceno's webs. Saraceno's work apprehends the frontiers of description of the physical universe through collaboration with an unusual but familiar creature. It is the simultaneity of human and nonhuman, scientific and artistic experiment that generates aesthetic devices that accommodate the edges of embodied sensory experience and the scientific projects that fabricate worlds far beyond them.

This chapter has proposed the web, and more specifically the emergence of filaments in Tomás Saraceno's collaboration with spiders, as a "fresh instrument" to develop an aesthetics of the other-than-human in social theory (Whitehead, 1978[1929]: 162). The web is an agile device for this aesthetic project since it articulates that entities can cohere, "in-fold," and pass through each other in modes that do not dissolve differences but refract them (Thomson, 2014b). Like the network, the web helps us to think independently of scale: to transact the miniature and the immense. But unlike the network – empty as it is of atmospheres (Latour, 1999) – a hybrid web maximizes the "friction" crucial to a new theoretical device (Stengers, 2008; Halewood, 2008).⁴⁴ As curator Luca Cerizza wrote of an exhibition of Saraceno's hybrid webs called *Cosmic Jive* (2014), these webbed sculptures are full of textures and traces that one can, "feel on one's skin": the palpable lines, smells, signatures and excretions of a multitude of creatures. A hybrid web is an important device for cosmological aesthetics since it presents to us, as it does to the spider, what we can immediately feel and sense, while luring us towards things we cannot: a cosmic web of dark filaments in which we are always already participating, always vibrating.

⁴⁴ Tim Ingold elucidates the differences between networks and webs. He argues that the French word *réseau*, from which the word "network" is derived, "can refer as well to netting as to network – to woven fabric, the tracery of lace, the plexus of the nervous system or the web of the spider" (Ingold, 2011: 85). One important distinction is that the filaments of a spider's web do not connect or join things up, as in the lines of a communications network, but are exuded from the body of the animal, and therefore are actually the extensions of the spider's body and the lines along which it lives. Ingold makes another point in the following:

"...the thread-lines of the web lay down the conditions of possibility for the spider to interact with the fly. But they are not themselves lines of interaction. If these lines are relations, then they are relations not between but along. (Ingold, 2011: 85)

The crucial difference between networks and webs is that the web is a pattern, a mesh, or a platform of possibility, not an expression of predefined relations. Rather than a map or a system, it is an entity that facilitates the capacity to be lured.



Interstice V: “*The sense of nature is changing*”... A pedagogical experiment in social sculpture, collective knowledge and social assembly at the IAK, TU Braunschweig invented by Tomás Saraceno. Guest lecturer Dr. Etienne Turpin sliced a book (*Art in the Anthropocene; Encounters Among Aesthetics, Politics, Environments and Epistemologies*) into hundreds of separate pages that were selected randomly and read aloud by students in a performative attempt to practice group intelligence. See Appendix I. Photography by Sasha Engelmann.

Aerosolar Sculptures and Cosmic Cascades



Figure 1: Aerosolar Sculpture Launch, 2015
Institut für Architekturbezogene Kunst | TU Braunschweig
Becoming Aerosolar Seminar | Tomás Saraceno, Professor
With Sasha Engelmann and Jol Thomson
Photography by Sasha Engelmann

The sun dances on the world. – Diana Beresford-Kroeger⁴⁵

Aerosolar Sculptures

How does a unit of light – a photon – meet with matter? Irish biochemist Diana Beresford-Kroeger explains:

...[the leaf] swings the electrons out of the sun, and out of the tree, and into a form of electron known as a “pi” electron. The pi electron bumps around the ring-form structure of quercetin and

⁴⁵ Diana Beresford-Kroeger in conversation with Kika Thorne, in E. Turpin (Ed.), *Excess, Scapegoat Journal*.

quercetin, just long enough to form a *cascade* and jump that electron into the life of the tree.
(emphasis mine; Beresford-Kroeger and Thorne, 2013: np)

This account of the leaf's ability to harness solar energy is interesting because of the choreographic qualities attributed to subatomic particles like photons and electrons: they dance around the aromatic compound quercetin into the life of the tree-organism. Indeed Bataille's economies of planetary expenditure – especially his notion that solar energy is excessive, and is therefore channeled into hedonistic display and indulgence – might find a metaphor in Beresford-Kroeger's account of the semi-reckless jump and leap of photons. On the other hand, the precision (*just long enough*) of the photon's cascade resonates with Michel Serres' argument that economies of energy are computational, down to the membranes of cells and exchanges of ions (Serres, 2014; see also Pasquinelli, 2015). In light of these alternatives, and the theory of cosmological aesthetics this thesis seeks to develop, we might ask: is it possible to experiment with the energetic cascades catalyzed by our nearest star? How might we test, understand and modify the ways sunlight is expressed in matter?

One way to open such a space of experimentation is to work with the immersive, elemental media moved by the sun: to work with air. And in doing so, to meaningfully engage not with solid forms, but with angles, spirals, and vortices, or what Serres calls the *tourbillon* (Serres, 2000). An *aerosolar sculpture* is a type of artwork by Tomás Saraceno that performs the light of the solar in aerostatic and aerodynamic flight. Such a sculpture requires no helium or hydrogen, no combustion of fuel, and no propellers or turbines to fly. Implicit in the performance of aerosolar practices is the understanding that, "for things to interact they must be immersed in a kind of force field set up by the currents of the media that surround them" (Ingold, 2011: 93). Most aerosolar sculptures depend on several circumstantial factors in order to become airborne: solar irradiance, temperature, convection, weather, and the albedo of the Earth's surface. Crucially, they also depend on the different skills of actors who design, construct and launch them. The cosmological aesthetics of aerosolar sculptures is embodied in the solar-energetic relations these sculptures establish, and in the ecology of practices motivated by these relations.

Saraceno has invented and constructed aerosolar sculptures for the last fifteen years. For Saraceno and for this chapter, *aerosolar* has a double meaning: it relates these sculptures' mode of movement and becoming, namely through air and sun, as well as their capacity to gather and attract other entities, like *aerosols* attracting water molecules. In the last decade the aerosolar current of Saraceno's work has gathered around a few main areas of practice and research. One of these is human free-flight in a solar aerostat (balloon) – a type of inflatable that gains buoyancy by trapping solar energy in hot air inside an absorbent envelope. Saraceno is among a handful of people, including the world record-breaking balloonist Julian Nott, who have flown in a solar balloon.⁴⁶ Through an ongoing residency at the Centre National D'Etudes Spatiales (CNES), also known as the French Space Agency, Saraceno is investigating solar balloon technology with the aim of staging the first round-the-world flight by a solar aerostatic sculpture.⁴⁷ As evidenced in launches at White Sands, New Mexico, Saraceno has already staged the first flight of a fully certified, fuel-free solar powered sculpture – the *D-OAEC Aerocene* (that lifted human passengers for three consecutive hours over the white dunes in November, 2015). Another gathering point for Saraceno's research is the participatory project *Museo Aero Solar*: an inflatable envelope made of reused plastic bags. Although Saraceno was among the founding members of *Museo Aero Solar*, the project has gained its own momentum, and is now performed and exhibited by volunteers around the world, from Medellin, Columbia to the United Arab Emirates.⁴⁸ Yet this project has also resurfaced in Saraceno's own exhibitions, recently as a proposal for a "Monument to the Anthropocene" at Les Abattoirs, Toulouse in October 2014, in the exhibition *Tomás Saraceno: Becoming Aerosolar* at the 21er Haus, Vienna in June 2015, and in a workshop as part of the *Aerocene* exhibition at the Palais de Tokyo, Paris in December 2015. A third focus of experiments is found in the

⁴⁶ However, in contrast to Saraceno's experiments, previous solar flights involved burners or other devices to pre-heat the air in envelopes.

⁴⁷ I participated in Saraceno's residency with CNES, accompanying him to interview engineers responsible for CNES' Montgolfière Infra-Red (MIR) balloons. Together with Saraceno I visited labs in Toulouse, helped to interview MIR experts, and toured the CNES headquarters in Paris. This residency has partially informed the display of aerosolar sculptures at the Grand Palais in Paris, on the occasion of the COP21 climate conference from November 29 – December 10th, 2015.

⁴⁸ For more information on this project see: www.museoaerosolar.wordpress.com

myriad prototypes of air-surfing entities with which Saraceno is engaged: “wind-catchers” and “solar bells” – tetrahedrons and ultra-light sculptural constellations. Although these aerodynamic sculptures are intriguing, they will not figure strongly in this chapter. For the following discussion, *aerostatic* objects will be the primary focus.

As I alluded in the opening query, aerosolar sculptures develop a relationship to the flows of matter moved by the Sun. Following Pasquinelli (2015), we might also think of these sculptures as “solar databases,” or, objects whose molecular composition is a derivative of petrol that was refined from the raw material of ancient peat bogs whose molecular bonds were “hooked” long ago (Serres, 2000).⁴⁹ In this sense, an aerosolar sculpture like *Museo Aero Solar* already contains within its molecular signature the history of solar sequestration in organic fiber and tissue. However removed from these Earthly solar reserves, this sculpture is able to intensify the heat and light of the solar precisely because it already did exactly this, as other forms of life. My point here is not to draw a direct line between ancient coniferous trees and the multicolored plastic bags that make up a sculpture like *Museo Aero Solar*. Rather, following the work of architectural theorist Sanford Kwinter, I advocate that the “whorls” and “matrices” of materials like plastic should be considered in an account of how aerosolar sculptures translate light in feats of aerial buoyancy (Kwinter, 2002; 2007).

This chapter considers the shaping, forming and flying of aerosolar sculptures – namely several made by students I co-instructed over one year with Tomás Saraceno and Jol Thomson at IAK, TU Braunschweig – as particular kinds of *device*. I wish to position them as devices not only because of the recognizable obligations they summon from practitioners and technologies, but also because they perform an *anexact* solar geometry (Deleuze and Guattari, 1980/1987), quite different from other creative experiments in representing, marking or tracing the sun (Marres, 2012; Engelmann and McCormack, under review). The Deleuze-Guattarian term “anexact” refers to objects and practices that

⁴⁹ There is some marginal debate about the origins of hydrocarbons – Thomas Gold has argued persuasively that the reserves of hydrocarbons buried in the Earth are actually upwelling from a “deep, hot biosphere” as far as 10km below the surface (Gold, 1972). In this chapter, however, I will work with the most widely accepted theory about where hydrocarbons originate: from the decayed bodies of ancient organic life forms.

are qualitative and nomadic, yet consistent. They are, “...neither inexact like sensible things nor exact like ideal essences, but *anexact yet rigorous*” (emphasis in original; Deleuze and Guattari, 1980/1987: 367). This term has purchase for understanding the morphological qualities of aerosolar sculptures since, as we will encounter in the descriptions of aerosolar workshops, aerosolar sculptures do not have a defined geometry, yet they tend toward similar “morphological essences” (Deleuze and Guattari, 1980/1987: 367). *Anexact* is also an interesting concept to read with the associations between geometrical forms and elemental matter, found in Plato’s *Timaeus* and Serres *Birth of Physics* as well as Kwinter’s writings on materiality, flow and form.

As Deleuze and Guattari underline, to be *anexact* is still to be technically and conceptually rigorous. The performance of aerosolar workshops and launches transmits precise knowledge of materials and technical assemblages, including the porosity and malleability of surfaces, as well as aesthetic information of the energetic cascades that animate these forms. This chapter is organized around two cosmological aerosolar events, illustrated with vignettes, images, verse and video selections. This material relates the spectrum of modes in which aerosolar sculptures transmit the phenomena of energetic cascades to practitioners and sensors. In this way, aerosolar sculptures force thought toward plural-poetic materialisms of the elemental and the solar by intensifying encounters with the fluid media in which we live and move.

II. Aerosolar Attractors

It is important that you understand that when we fly aerosolar sculptures, we are flying without helium, without hydrogen, without burning... the burner is the sun, that's the image that I want to give you. – Tomás Saraceno⁵⁰

⁵⁰ Tomás Saraceno in a public conversation with Bronislaw Szerszynski in the evening event *A Matter Theatre*, at the Haus der Kulturen der Welt, Berlin, 21st August, 2014. Recording and transcription by author.

[Tomas] is of course interested in electro-magnetics and [other] energies... the grand-daddy of materials for him is energy... in the strictly materialist sense but also in the more metaphorical sense. – Jol Thomson, personal communication, 2014c

An aerosolar sculpture is much more than a balloon. It is a *device* since it is both an object and an apparatus: an entity, and an assemblage of practices. One cannot be dissociated from the other. These sculptures, “articulate actions, they act or make others act” (Callon et al. cited in Lury and Wakeford, 2013: 9). This capacity to motivate, organize and articulate actions is certainly not unique. We can think of most experimental subjects – like Barbara McClintock’s corn cells (Stengers, 1989/1997) or Anna Tsing’s *matsutake* mushrooms (Tsing, 2015) – as attracting the organizational attachments of humans, nonhumans and technical objects. However, the making and launching of aerosolar sculptures is an example of what Gabrys and Yusoff (2012) have termed a, “collective experiment” or what Noortje Marres (2012) has called an “experiment in living” whose qualities depend on the basic proposition that solar energy intensified in hot air will generate lift. Given that it unfolds with the forceful relations between air and sun, the event of an aerosolar launch embodies a different “thermodynamic imaginary” – an alternative to the dominant one of extraction, refinement and combustion of hydrocarbons driving contemporary human life (Moe, 2014; Turpin, 2015). Instead of combustion, aerosolar imaginaries foreground conduction, dissipation and release. In addition, this collective experiment is an endeavor that places human skillfulness in a wider context – one of working with inorganic matter and elemental media under conditions of heat and force (Clark, 2015).⁵¹ And it is an artisanship or artistry that takes the atmosphere, and even the climate, as a collaborative agent in the making process (Galaragga and Szerszynski, 2012; Saraceno and Engelmann, 2014).⁵² Such an

⁵¹ As Nigel Clark has written, this kind of skillfulness might be traced back to the transmutations and alchemies that first occurred in the warm, sheltered spaces of kilns in the Neolithic era (Clark, 2014; 2015).

⁵² Tomas Saraceno and I gave a presentation on the concept of making in relation to new proposals to engineer Earth’s climate at the world’s first conference on climate engineering (CEC14) in Berlin in August 2014. We employed Saraceno’s work on aerosolar sculptures and Galaragga and Szerszynski (2012) paper on the “climate artist” to challenge what the term “climate design” could potentially mean.

experiment in aerosolar craft opens a space of inescapable contingency of the human with elemental happening, spacing and politics.

But let us first address the various ways aerosolar sculptures capture the light of the sun, and in doing so, think through what this means for a physics and philosophy of aerial forms. As mentioned previously, an aerosolar sculpture gains buoyancy by enveloping air that is warmed when light energy meets an absorbent membrane and is transferred to air molecules. This is a process that is modeled by the ideal gas equation: $PV = NRT$ where P = Pressure, V = Volume, N is a constant, and T = temperature; and a standard lift calculation: with a twenty degree difference in temperature between inside and outside the envelope, one can predict 80 grams of lift per cubic meter of air. These simple principles model a thermodynamic process whereby entropy and *negentropy* run parallel. In other words, photons of light are “captured” in electron energy states of chlorine and hydrogen atoms of molecules making up the envelope, and as these energy states are passed to air molecules, the heat inside the membrane increases. However, energy is also lost to the surrounding atmosphere. This is a process that represents constantly shifting relations between light energy, surface materials, and bodies of air.



Figure 2: Testing aerosolar sculptures in the Studio Tomás Saraceno, Berlin, 2015

© Studio Tomás Saraceno, 2015

In practice, the transformation of a lifeless envelope into a buoyant object has fascinating, even magical qualities. After a presentation from Saraceno inside *Museo Aero Solar* at the occasion of a colloquium organized by Bruno Latour and Bronislaw Szerszynski at Les Abattoirs, Toulouse, one of Latour's students commented: "it sounds like magic... to me... but I'm not a scientist" (Latour et al., 2014: np). During an aerosolar sculpture workshop in November of that year, Saraceno commented: "when you see the Sun coming up from the horizon and you see your own [sculpture] going up into the air, there is something, which is truly for me, the magic moment" (Saraceno, personal communication, 2014). Indeed, as McCormack (2008; 2009) has also articulated, such comments may relate to the mesmerizing event of seeing any kind of aerostatic object become airborne. But what is particular about the becoming-buoyant of aerosolar sculptures is that they establish palpable relations to the way matter flows, spins, organizes and disperses based on the input of energy from our nearest star.

The notion that matter flows – that it has vortices, spirals, and hydraulic qualities – is one that Serres draws back to the Greek atomist philosopher Lucretius whose long poem *De rerum natura* posits

the universality of laminar flow translated into turbulence (the minimum angle of which Serres names the *clinamen*) (Serres, 2000). Indeed Lucretius' poem begins with an image of ocean waters troubled by winds (*ibid*). But *tourbillon* – translated into English as *vortex* – denotes the seemingly unruly yet coherent structures that form in fluids (see for example Figure 3). This, for Serres, forms a somewhat overlooked basis for contemporary physics: “Everything flows, turbulence appears, temporarily retains a form, then comes undone or spreads. Physics is entirely projected on the current events of hydraulics in general” (Serres, 2000: 82). For Serres, a physics adequate to the expressiveness of all matter – aerial, fluid or earthly – would reject static flow or stable equilibriums and re-embrace the vortex.



Figure 3: Aerosolar Sculpture Launch, 2015
Fusion Festival, Germany. With Sasha Engelmann and Jol Thomson. Aerosolar sculpture constructed by Tomi Soletic and Alexander Bouchner.
Photography by Sasha Engelmann.

Launching an aerosolar sculpture means attending to the inclinations, declinations, spins and vortices of air warmed by the sun and enveloped by a flexible membrane. The more turbulent the surrounding atmospheric conditions are, the more difficult such a launch will be. As pictured in the above images, attempting to launch an aerosolar sculpture in June 2015 on a moderately breezy field demanded the attentions and labor of up to ten people, including myself, who held the sculpture in place as its volume increased, positioned it against the wind, and fixed any sudden tears. But even under relatively still conditions, the membrane of an aerosolar sculpture reacts to the way energy is intensified

and distributed in the body of air inside the envelope. The object folds, twists, doubles back on itself, darts, hovers, rolls up, flattens, shoots up into the air, and crashes down to Earth again. All of these movements are effects of interior and exterior convection (wind), and the consequent principles of thermodynamics, performed by a simple but highly conductive object. As I will show in the following accounts of two aerosolar workshops and launches, the quality of cascades of photons through a plastic membrane has a range of physical and affective consequences that are registered among the participants animating the event's ecology of practice.

Cascade Experiments

...like electrons

vanishing on one side

of a wall and appearing on the other

without leaving any holes or being

somewhere in between...

~ excerpt from 'Cascade Experiment', by Alice Fulton

How do electrons cascade into the life of organisms? Here we might briefly consider what a cascade means. A cascade is generally a phenomenon in scientific literature in which a series of events unfold relationally, sequentially, and rapidly. A cascade is a trace of the passage of energy through an environment, and as such it is a figure of the time such passage takes. But equally, and paradoxically, it is the trace of the decay of energy, or the release of energy that had previously been contained in a specific vector or object.

The cascade has a conceptual as well as scientific value. Both Bataille and Serres have attended to the qualities of cascades: the former as a unit of description for the ceaseless movement of energy through Earth's surficial economies, and the latter as a process whose interruption holds the key to understanding humans as parasitic beings. For Bataille, "The solar energy *that we are* is an energy that

loses itself. And undoubtedly we can delay it, but not suppress the movement that demands that it lose itself" (Bataille cited in Kendell, 2013: 35; emphasis added). On the other hand, according to Serres: "What passes might be a message but parasites... prevent it from being heard, and sometimes, from being sent" (Serres, 1982: 11). Serres' emphasis on interruption has been read as an explicit critique of the unfettered economies theorized by Bataille. However, resonant in the work of both writers is that a cascade is a specific kind of passage: it relates a rapid durational sequence, for which interception has important consequences. And whether it is explicitly solar, or takes the form of information, a cascade is inseparable from the energy that produces it, and the time it takes such energy to decay.

To carry out a "cascade experiment" is either to instigate, or to sense (or both) the qualities of a cascade. One famous cascade experiment is the collision of atomic nuclei carried out by the Large Hadron Collider at CERN. The purpose there is to study the succession of secondary particles produced from high-energy event of two atoms smashing into each other. But there are also more sensually available examples of cascade experiments. Speaking of her collection of poems by the same name, Alice Fulton describes a "cascade experiment" as: "A domino effect, *a waterfall of causality* in which one event triggers and affects the next" (emphasis mine; Fulton cited in Rooney, 2004: 176). According to critic Kathleen Rooney, the kinds of cascade experiments in Fulton's poems are about, "the feeling of falling into awareness" (Rooney, 2004: 176). The aerosolar workshops and launches that comprise the empirical material of this chapter are cascade experiments insofar as they intervene in, and make sensible, the solar energy "that we are," so that it "falls into [the] awareness" of a group of participants. The sculptures themselves are aesthetic devices for carrying out such experiments since they have formal and design-based qualities that articulate, "not only the flux and the fleeting play of light... but the passage of warmth and light from one being to another" (Bataille, 1988: 94). Just as scientific practices and Fulton's poems experiment with the qualities of rapidly unfolding, causal, relational passages, the aerosolar sculptures and events in this chapter experiment with cascades of warmth and light implicated in the phenomenon of aerial buoyancy. Still, the experiment of aerosolar flight is as much about an

object that can fly with the sun, as it is about the material and durational process of making, preparing and launching.

Making Aerosolar Sculptures

What does this mean then, if, at nine o clock, we imagine, the sun is really low, the air is still cold, the sun is shining, will it be able to warm the plastic? – Bronislaw Szerszynski⁵³

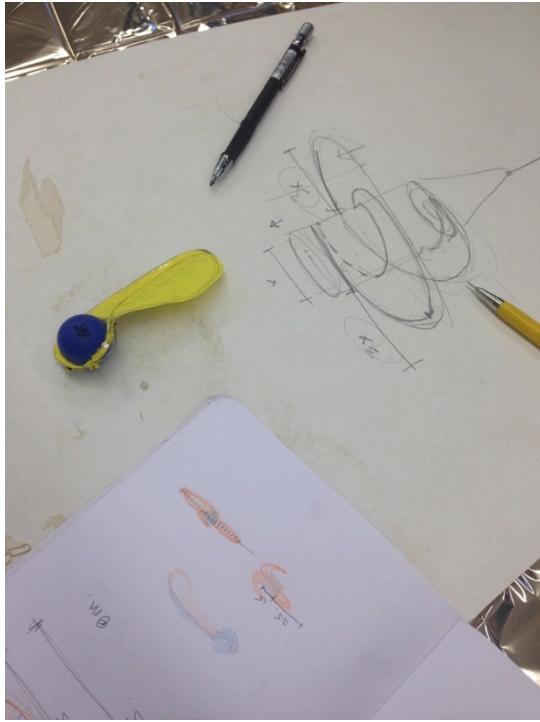
What are the attachments, responsibilities and practices called forth in the making and launching of aerosolar sculptures? How do such events reposition bodies and knowledge practices in relation to the energetic cascades and material hydraulics of sunlight and air? I will explore these questions through vignettes from aerosolar sculpture workshops in Braunschweig and Vienna over the course of Autumn 2014 to Summer 2015, during which I participated actively in Saraceno's long-term art project *Becoming Aerosolar*, now more frequently called the *Aerocene*. During the course of my involvement in *Becoming Aerosolar*, I witnessed over a dozen test-launches of aerosolar sculptures, and on a few occasions, co-taught aerosolar sculpture workshops. There were occasions when the aerosolar sculptures came nowhere near flying, and others at which they soared above rooftops. On some occasions, such sculptures reached 10,000 meters in altitude, traveling with GPS tracking devices and radar reflectors across international borders.

The first workshop I witnessed in Germany occurred in the framework of a graduate seminar titled “Becoming Solar” taught by Tomas Saraceno, Natalija Miodragovic, Jol Thomson and myself, at the IAK, TU Braunschweig. Throughout the winter semester in 2014, our work with twelve graduate students involved, “imagining alternative futures in which society is truly ‘solar powered,’ but not using solar panels or batteries – by harnessing the energy already circulating in air” (Engelmann and Thomson, 2014: 1). Each week we discussed topics in atmospheric science, physics, utopian architecture and the

⁵³ Bronislaw Szerszynski in conversation with Tomás Saraceno, author, and students at IAK, 21st November, 2014.

aesthetics and politics of air. The aerosolar sculpture workshop midway through the semester was intended as a stimulus into thinking about how certain shapes of envelopment gather and intensify solar energy.

Before the workshop, each of the students in the seminar contributed one potential design. After sharing their ideas, they formed small groups. They were provided with reused plastic shopping bags, and a few one-meter wide roles of PVC (black and transparent), as well as scissors, tape, pencils, paper and razor cutters. The workshop included an eclectic mix of various specialists. Adrian Krell, a long-time collaborator and aerosolar sculpture expert from Studio Saraceno, offered advice on the designs and their viability. Jannik Heusinger, a climatology PhD student at TU Braunschweig, brought an infrared camera and sensor, and offered his advice on the surface albedo, interior convection, and material absorption of each envelope. Sven Steudte, a radioamateur, telecommunications specialist and a tracking enthusiast, gave a demonstration of the Arduino programmed micro-controller computer he had built. When attached to a flying object, this micro-computer would transmit location data to radio receivers as well as take pictures. According to Saraceno and Krell, a standard lift calculation of 80 grams per cubic meter of air (with a temperature difference of twenty degrees) could be used to calculate the necessary volume for an aerosolar design to become buoyant. The students quickly realized that the more complex models would be either too difficult to construct in the space of one day, and / or would require too much material (and weight) with respect to volume and lift. This was the first major lesson: given the relative difficulty of generating lift simply by trapping solar energy across a membrane, the aerostatic solar sculptures had to have large volume-to-surface-area ratios.



Figures 4 and 5: Aerosolar Sculpture Workshop, 2014
 Institut für Architekturbezogene Kunst | TU Braunschweig
 Becoming Aerosolar Seminar | Tomás Saraceno, Professor
 With Sasha Engelmann and Jol Thomson
 Photography by Sasha Engelmann.

After some discussion, the students decided to construct several shapes of envelopment: a torus, a klein bottle, a long cylinder, a diamond, a bi-pyramidal tetrahedron and a sphere. Once the dimensions were decided, the physical work began (Figures 4 and 5):

Spreading out sheets of PVC; cutting and taping plastic; kneeling hour after hour on the concrete floor, shoes off, two people together at a time, one person holding the tape and pulling it across the meeting point of two surfaces, watching for tears or wrinkles (figure); smoothing the folds; folding surfaces over each other again; cutting excess material with razors. (Excerpt from field notes, 21st November 2014)

This work continued from early afternoon until long after the sun had set. The students worked in pairs or small groups, spread around the four-story former-concrete-factory building that is the IAK. As it was winter in the middle of the north German woods, the air inside the building was freezing. Then, a

series of tests occurred. Testing an aerosolar sculpture involves opening its “mouth” toward a fan or ventilator, to blow air into the structure. Sometimes an extra tube has to be fashioned from cardboard or plastic in order to direct the fast-moving air into the inner space. Testing helps to show if the sculpture is strong, flexible and spacious enough to harbor enough warm air to fly.

Ripples moving and creasing, undulating in the plastic membrane as the entity inflates. The material snapping back and forth as it is pulled and pushed by the currents of air. (Excerpt from field notes, 21st November, 2014)

A structure shaped like a Klein bottle was inflated around 10pm. Quickly it became apparent that the narrow curving “tail” of the sculpture would not allow easy circulation of air and energy – so this sculpture was abandoned. The second sculpture was tested close to midnight; it was a multicolored tetrahedron made of many reused bags; and it was extremely fragile due to its many taped seams. Small rips and tears opened immediately, and students rushed around the sculpture brandishing roles of scotch tape, applying it liberally (Figures 6 and 7).

However, once the structure appeared stable, one student moved the fan to one side and crawled through the mouth. Several students followed. Before long, everyone present at the workshop was inside the membrane, talking excitedly, exclaiming, and soon dancing. The fluorescent light shone through the white, pale colors and shiny, taped seams creating a shimmering interior. The tediousness of the labor was forgotten as a new social space came into formation and the creators of the membrane became its inhabitants.



Figures 6 and 7: Aerosolar Sculpture Workshop, 2014
 Institut für Architekturbezogene Kunst | TU Braunschweig
 Becoming Aerosolar Seminar | Tomás Saraceno, Professor
 With Sasha Engelmann and Jol Thomson
 Photography by Macarena Cerdá.

Since the tetrahedron sculpture was inflated without bursting and was large enough based on estimates from a standard lift equation, this design was deemed viable to launch. But the number of seams and taped edges raised concern that the membrane was too heavy. This was a point of debate:

Adrian Krell: The joined plastic bags are more heavy than thought. At the moment for example the form that we wanted to do with Max is not flying, because it's too heavy. And for you (pointing to Sara) I didn't do the calculation but we have to think it's not twenty or thirty grams per square meter, but it's more like seventy grams per square meter...

...

Tomás Saraceno: It's not so easy you cannot fly everyday... and Adrian and Sven are really keen on trying to do it. At the same time, of all of the designs we have so far, it seems none of them are going to fly so far. They are all too small. This is what Adrian's, and what my experience is, none of them will, even if we have sun tomorrow, nothing will happen...(Saraceno and Krell, personal communication, 2014)

The discussion continued for some minutes, and it was decided that the most likely shape to fly was a long black cylinder. Another point of discussion was the weather:

Sasha Engelmann: So guys, we have to decide whether we're going to go for this launch tomorrow

Sven Steudte: [showing weather forecast map] So, that's Saturday at 6am.... 9am... 12 noon....

Tomas Saraceno: Again?

Bronislaw Szerszynski: Show 9am again?

SS: At 9am it is sunny, just a bit cold

TS: Sunny with [some] clouds or how is it? (Saraceno, Steudte and Szerszynski, personal communication, 2014)

It was finally established that the sun would probably come out between 7am and 9am, although the forecast seemed to change hourly. From this early stage, a relation to the time of sunrise, and to the time of likely launch, was established. The group decided to keep working on their designs, but with the understanding that only one would stand a chance to "free fly" in the morning. A couple hours later, the large black cylinder was ready for testing. The sculpture was spread out on the floor of the institute and air was blown into the tube. Soon, students began to enter this sculpture as they had done the tetrahedron, checking for tears and feeling the surface (Figures 8, 9, 10).

Initially the air inside this sculpture smelled strongly of chemicals, but the material allowed a surprising amount of light inside. Most surprisingly, rather than a uniform black surface, there were threads and stripes of lighter and darker consistency illuminated, as well as surprisingly strong shades of yellow and blue. The experience of being inside was immediate and contagious:

The rhythm of fast music, rippling air moving the envelope, the tearing is fixed, a collective exuberance. Chants of "Sun! Sun! Sun!" repeating. The music through the envelope and through moving bodies. Vibrations of the concrete floor felt in the plastic (Excerpt adapted from field notes, 21st November, 2014)

We ran our hands over the membrane that had, moments before, lain idle and lifeless on the concrete.



Figures 8, 9, 10: Aerosolar Sculpture Launch, 2014
 Institut für Architekturbezogene Kunst | TU Braunschweig
 Becoming Aerosolar Seminar | Tomás Saraceno, Professor
 With Sasha Engelmann and Jol Thomson
 Above: Photography by Sasha Engelmann.
 Below: © Photography by Studio Tomás Saraceno.

I will return to the particular affective qualities of inflating aerosolar sculptures in the following chapter. Here it is important to emphasize that in order for the two larger sculptures to be inflated and readied for launch, twelve people worked almost continuously for fourteen hours. They sketched, calculated, predicted, modified, kneeled, organized, cut, taped, smoothed, re-taped and repaired a series

of plastic surfaces. They ran their hands on the textures of PVC and reused plastic bags, many of which had been touched by other hands in their previous lives as shopping vessels. They breathed the strong chemical smells of these “raw” materials, reminiscent of petrol (Marcinek, 2015). They folded them carefully into bundles and stacked them neatly for transport. This process, while sometimes tedious, was important to the experiment. As Erin Manning has described in relation to the collaborative stitching of garments, the students were folding *time* into the objects (Manning, 2012-2013). As Bronislaw Szerszynski commented during the course of the evening:

The thing I will take away from today which I will never forget, is the amount of care, and preparation, that you all did, to create these membranes, these dwelling places for air, the air that isn't even in it yet... seeing all your hands clutching the seams and taping them up, and lifting them up in the air, all this kind of care that had to take place in order to prepare these membranes for the living air, that I will never forget, it was wonderful. (Szerszynski, personal communication, 2014)

We woke at 5am the next morning, piled into a few cars, and chased the rising sun down ghostly highway roads. At 7am, the sculptures were unfolded on a hilltop in Wolfenbüttel, North Germany. This was the place where Steudte and Krell had arranged an agreement with local air traffic control. The array of sculptures (two large and five small) looked like colorful, beached sea creatures sprawled on the dewy grass, beginning to breathe again. It was an icy cold morning; teachers and students hopped in place or huddled near open car doors. As the sun rose, the mouths of the sculptures were alternately held open to the wind, and then closed so that the air inside could warm. And as they inflated, and their shapes gained definition, an increasing tension and urgency passed through the group.



Figures 11 and 12: Aerosolar Sculpture Launch, 2014
 Institut für Architekturbezogene Kunst | TU Braunschweig
 Becoming Aerosolar Seminar | Tomás Saraceno, Professor
 With Sasha Engelmann and Jol Thomson
 Photography by Sasha Engelmann

Although the sunlight was relatively weak, the air was so cold that the black membrane could warm faster than the air outside. A series of events then unfolded quite rapidly. In particular, the experience of attempting to launch the largest aerosolar sculpture was thrilling:

As I find myself near the black cylinder nicknamed “Frankie” someone hands me the radar reflector and the GPS tracking device, attached with tethers to its mouth. Macarena and Wanda are holding the mouth shut so that the air inside will warm and expand. It is making a lot of noise, flapping and snapping in the wind and undulating back and forth. Sven is speaking in German to air traffic control, listening for an official ‘OK’ ... Adrian and Tomás are running around spotting rips and yelling instructions. We wait. I can feel the thing pulling...⁵⁴

⁵⁴ The following series of excerpts are adapted from the author’s field notes, made on 22nd November, 2014.



Figures 13 and 14: Aerosolar Sculpture Launch, 2014
Institut für Architekturbezogene Kunst | TU Braunschweig
Becoming Aerosolar Seminar | Tomás Saraceno, Professor
With Sasha Engelmann and Jol Thomson
Photography by Sasha Engelmann

Air traffic control (via Sven) says OK. Tomas and Adrian motion to release. We retreat from the black membrane and let it rise. It levitates. As it floats over the grass, Tomas, Adrian and I jog with it. It is moving quickly, lifting upward, expanding. I can feel the pull of the thing in my whole body. It is several times my height. The mouth of the balloon yawns. I look upward, directly inside. The colors are golden, gray, brown and blue. It moves, creature-like, with complicated folds and twists. Amplifying eddies and vortices in the air, lines waving and bending through the medium and membrane, joining and spinning away.



Figures 15 and 16: Aerosolar Sculpture Launch, 2014
Institut für Architekturbezogene Kunst | TU Braunschweig
Becoming Aerosolar Seminar | Tomás Saraceno, Professor
With Sasha Engelmann and Jol Thomson
Photography by Sasha Engelmann

*As my gloved hand is raised to let go of the ropes there is a slash - a rip opens on the back,
letting the pale blue sky show through for an instant before closing as the entity becomes a kite,
gliding down to the grass at the bottom of the hill...*



Figures 17 and 18: Aerosolar Sculpture Launch, 2014
Institut für Architekturbezogene Kunst | TU Braunschweig
Becoming Aerosolar Seminar | Tomás Saraceno, Professor
With Sasha Engelmann and Jol Thomson
Photography by Philip Dreyer

The sculpture launch failed. In fact we did not succeed in launching any of the designs that day, due to the strength of the wind on that hilltop, the weak degree of sunlight, and the weight and relatively small volume of the sculptures. But the experience of running-with the largest aerosolar sculpture – an entity that had gathered force from the energy of the sun’s rays – was unforgettable. Later that day, in a conference room at the Haus der Kulturen der Welt (HKW) in Berlin, having not slept in two days, I told the story to a group of participants in the Anthropocene Campus, and was given an unexpected round of applause. As I later came to understand, the event had not ended with the fall of the aerial sculpture; there was a “reverberation” or “cosmicity” (Bachelard, 1943/1988) to this experience that was as much

about the configuration of entities, relations and circumstances that had brought it into being, as the aesthetics and poetics of air warmed by the sun ventilating and lifting an envelope of ordinary plastic. Indeed, this had all been prefigured by Saraceno's elegant comments the previous evening:

There is nothing like tomorrow, seeing something coming up from the horizon, which is not only the sun but is your own sculpture, and I tell you look: today was beautiful, but if the sun is there tomorrow... (Saraceno, personal communication, 2014)

The sun had been there. But the intensity of this event was not only a product of the presence of the sun, weakly peaking out between cloud banks, but also the extended collaboration between people, materials and technologies, preparing and organizing conditions for such energetic cascades to be felt – a collaboration that extended back to the previous afternoon. Even though it had not flown far, the experience of this object lifting off the ground and hovering over the grass, going at the exact speed of the wind on the hilltop like a cosmic ghost, was registered acutely in my body and the many others participating in the launch. The different speeds and slownesses of this experiment – from the tedious taping at IAK in the middle of the night to the swiftness of the inflation and launch – were intrinsic to its being felt.

This launch can be understood through a philosophical-empiricist account of the perception of elemental matter and media. According to Ingold (2009), to perceive the world is not to isolate and interpret, but “to feel the currents of air as it infuses the body, and the textures of the earth beneath one’s feet” (Ingold, 2011: 88). It is to literally feel bound up in the changes of animate and inanimate matter. Ingold writes of the “world of fluid space”:

...there are no objects of perception. They are rather what we perceive with. In short, to perceive the environment is not to look back on the things to be found in it, or to discern their congealed shapes and layouts, but to join with them in the material flows and movements contributing to their – and our – ongoing formation. (Ingold, 2011: 88)

The characterization of the process of perception as a joining in “material flows and movements” resonates with the event of the aerosolar launch. Ingold adds that a, “skilled practitioner is one who can

continually attune his or her movements to perturbations in the perceived environment without interrupting the flow of action” (Ingold, 2011: 88). Jogging alongside the expanding aerosolar sculpture was a challenge in matching my gait to the aerial thing as it was “perturbed” by the sun and air (see also Ash (2013) and Engelmann (2015) on solar balloons and perturbation). Therefore it was a durational experience and exercise – not only “aerostatic spacing” (McCormack, 2009) but also what we might call *aerostatic timing*. By joining the airborne thing as it entered the flow of the morning breeze, I was able to perceive not only the qualities of the object but the sensual and temporal relations between this object, my body, and the mediations of air.

In such an account, matter cannot be dissociated from the energies that animate it. In other words, running with the sculpture was a challenge in feeling energy’s intensity and thermodynamic potential: the transactions between electrons, photons, and an elemental body of air in an ultra-light structure. As Beresford-Kroeger suggests, an energetic cascade is a swing, a curve, *a kind of a dance*. The aerosolar launch was not only one of following a sculpture, but also of joining in a choreographic relationship with it, of matching the movement of my body to something that was happening on both a concrete and cosmological level.

In the following vignette, adapted from notes from an aerosolar launch in Vienna in June 2015, energetic cascades and elemental mediations occurred and were sensed very differently. The qualities of the transmission of solar-cosmic energy in this next account produced a different experience of duration or aerostatic timing. I aim to convey this different aesthetic texture in the way the following account is written, and to further establish zone(s) of relationality between the cascades of energy, an ecology of practices, and the cosmological aesthetics of Saraceno’s aerosolar sculptures.

Becoming Aerosolar

In the Summer Semester of 2015, Tomás Saraceno, Jol Thomson and I taught a graduate seminar named *Becoming Aerosolar* at IAK, TU Braunschweig. However, as Saraceno made clear from the beginning of our work at the IAK, the aim of the *Becoming Aerosolar* seminar was to push the project

along further, to join in the work already being done at Studio Saraceno and to challenge the students to activate it in new ways. Instead of meeting each week to give lectures and hold discussions, we held the seminar in a “block” format. The students were asked to prepare theoretical material on their own (which included texts from Saraceno’s library and additional readings from authors like Peter Sloterdijk, Amy Balkin, Derek McCormack, Pete Adey and Bronislaw Szerszynksi). We met in three 2-day long periods. The aim of the seminar from the beginning was to establish and develop a body of work that could be presented alongside Saraceno’s in a new exhibition called *Tomás Saraceno: Becoming Aerosolar* at the 21er Haus, Vienna, opening on June 21st, 2015. In addition, they were expected to present in a symposium on the occasion of the exhibition opening, which would include interventions by Saraceno, Derek McCormack, Nigel Clark, Bronislaw Szerszynksi, Sanford Kwinter, Mario Codognato and artists including Helga Esner who had been launching aerosolar sculptures to map oil spills in the Peruvian rainforest.

The first block meeting comprised a brainstorming session on what the students could accomplish in the framework of the semester. Over several hours, a few areas of research and interest took shape. It was clear that the students had a strong interest in aerial mapping and charting (one student, a sailor, was fascinated by the challenge of creating maps that expressed the contingencies of aerosolar flight) as well as aerial law (one student was a gliding pilot who downloaded local airspace maps and codes) and altitude control or “cut down mechanisms” (another student wanted to “make the sculpture intelligent”). Saraceno guided the students’ interests in the direction of research that could further the aerosolar project. Thomson and I offered our experiences but also played mediating roles in inviting the students to shape their own questions. From this initial brainstorming session, the plan for the following aerosolar workshops was formulated.

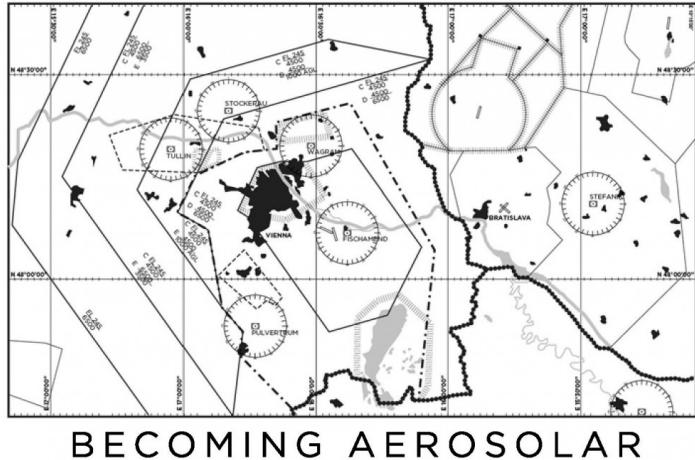
In the following month, we met twice at the IAK and worked for one whole day and night to make sculptures that we could test the following morning. Although it was summer semester, the weather only allowed for one test launch. However, the students quickly formed groups and carried out additional research outside of the frame of the workshops. Two students came to Studio Saraceno for

one whole week to work on altitude control mechanisms with specialists like Adrian Krell and Sven Steudte. Others designed and constructed a *Manual for Becoming Aerosolar* (Figure 20), in which the research from the semester could be shown and distributed.



Figure 19: Aerosolar Sculpture Launch, 2015
Institut für Architekturbezogene Kunst | TU Braunschweig
Becoming Aerosolar Seminar | Tomás Saraceno, Professor
With Sasha Engelmann and Jol Thomson
Photography by Sasha Engelmann

A MANUAL FOR



BECOMING AEROSOLAR

Figure 20: *A Manual for Becoming Aerosolar*

Institut für Architekturbezogene Kunst | TU Braunschweig

Becoming Aerosolar Seminar | Tomás Saraceno, Professor

With Sasha Engelmann and Jol Thomson

With the help of eight seminar students, especially Tomi Soletic and Alexander Bouchner.

Photography by Sasha Engelmann



Figure 21: display of the Manual in *Tomás Saraceno: Becoming Aerosolar*

21er Haus, Vienna. Curated by Mario Codognato.

Photography by Sasha Engelmann.

Although the intensity and qualities of the three-day excursion to Vienna would take much longer to relate, it is sufficient here to write that the students did well in the *Becoming Aerosolar* symposium; the event continued into the evening, until the museum had to close. The next day at the opening, a large number of visitors entered Saraceno's large-scale aerosolar sculptures, and examined the graduate students' manuals and workstation tables. After an evening celebrating the successes of the weekend, Thomson and I left Vienna's city center with a small group of students. The sky was just beginning to lighten. It transpired that one of our students had an extra aerosolar sculpture rolled up in his backpack. Without any hesitation the group decided to find a place to launch it. We wandered across empty streets and parks, misty gardens and squares, until we happened upon what at first appeared to be an ancient arched stone walkway overlooking a deep cement-walled canal. Almost without speaking, we arranged ourselves on a stone balcony, unrolled the small transparent plastic sculpture and inflated it with cold air.

Thomson and one student filmed these moments. Watching them again weeks and months later, I was struck by the overwhelming stillness, and by the sense that everyone's body was trained and turned toward the sun, aware of the fragile, faintly rustling sculpture. For a while, all six of us had our eyes closed, feeling the growing warmth on our faces and hands, listening to the sculpture. It occurred to me at the time that if a stranger happened upon us in this way, they might think we were praying. But maybe this is not so far from the truth. If praying can be conceived as a quieting of one's body and intellect, and an attunement to the influence of forces outside of one's ordinary experience, we were indeed praying. We were praying, also, in a far more ancient sense. This is a sense of prayer as intense focus on astral bodies that have direct influence on one's immediate environment – astral bodies that correlate with warmth, rain, flood and tide.

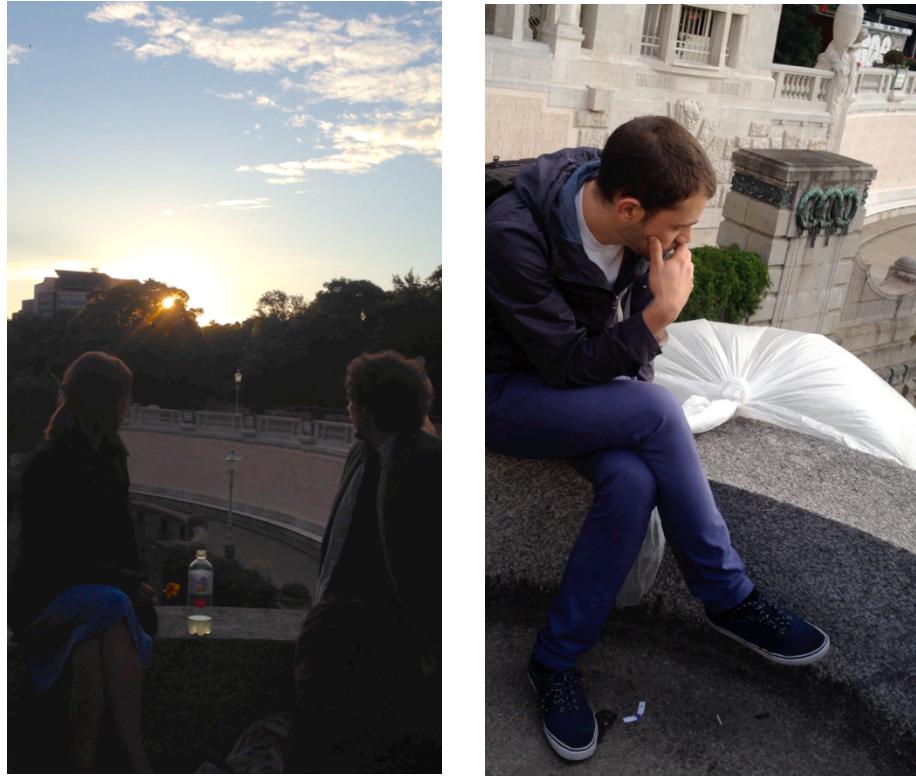


Figure 22-30: The figures in the following section are still images from video footage taken by Tomi Soletic and Jol Thomson, 2015.
Courtesy of Soletic and Thomson.

*Leaning on granite rock faces, steps and balustrades,
we overlook a steep walled canal
Birdsong rings
across the vessel-like space.*

*Light intensifies
over distant branches of
trees and other airy creatures.⁵⁵
Every surface is ambitious.
Some of us light a cigarette.*

⁵⁵ This line is borrowed from Lisa Robertson's book of poems, *The Weather*.



The clouds are pale-patterned gray.

*A transparent plastic object held in one's hand,
emits a tremulousness.*

*Feeling small breaths of air reaching over
our shoulders, diving over stones.*

*We taste of aerial fluids;
we have nothing concrete.*

*Primed to the same cue,
We mediate an affect.*



*Granite is a shimmering material,
there are curious crystallizations.*

*There goes the sun, still;
we feel we have influence, still.*

*A will at least, for energies to express.
Lungs that were tightened now relax.
A passer-by makes sharp footsteps.*

Our senses are slow enough to be accurate.⁵⁶



The wind has lulled, and we have proven inexhaustibility,

It was still only 7 o'clock when

The sky closed in.

We speculate.

⁵⁶ This line is paraphrased from Lisa Robertson's *The Weather*.



There has been nothing like this, we agree,

But it's cold in the shadow.

A rustling of plastic in returning winds,

and clumsy hands.

Our limbs begin to loosen

as eyes turn away...

* * *

As we waited for the sun to activate the sculpture, perched on the granite balcony, our bodies registered increasingly fine and minute details about the light, the surfaces of the environment and of the plastic sculpture, as well as the stillness of our companions. If the aerosolar sculpture launch in

Wolfenbüttel had been tense and exhilarating, this one was profoundly meditative. It was punctuated only by birdsong, the flutter of the plastic object, or the rustle of tobacco in thin paper.

The affective qualities of both aerosolar sculpture launches – which I have called “cascade experiments” – could be described as “the feeling of falling into awareness” (Rooney, 2004). In the first anecdote, the unfolding, inflating, tethering and organizing process escalated into the experience of running down a hill holding the buoyant black object as it moved with the light. In Vienna, each participant fell into his or her own quietness as the sun produced incremental changes in the sculpture. The line – *our senses are slow enough to be accurate* – conveys the change of pace that was required for each of us to attune our bodies to the sculpture and to each other. It was under a certain threshold of speed and stillness that this event could occur.

This experiment made explicit the duality of the cascade, as something that is not only related to energetic intensification, but also energy’s decay. What was expressed at the launch site in Vienna was the simultaneous accumulation and dissipation of light energy; in this case, dissipation eventually overcame absorption. This was likely due in part to the fact that the outside air was much warmer than on the field in Wolfenbüttel, and therefore the sculpture could not generate enough difference in heat and pressure; in addition, the transparency of the material was not as absorbent as the black plastic we had used before; and the small size of the object meant that it had a relatively low volume to surface area ratio. The flux of energy into the object, the energetic conditions of the site, the materials of construction, the reflection of surfaces, and the duration of the experiment produced an experience of energy’s amplification, dispersal and release. This experience mixes both the physical and affective; these are cascades of both energy and affect. In the following section, I will think further from these vignettes to draw wider conclusions about the cosmological aesthetics of aerosolar sculptures.

The Cosmological Aesthetics of Aerosolar Sculptures

The aerosolar sculptures launched in Wolfenbüttel and Vienna gave tangible, sensible qualities to the cascade of solar energy into the vortices of elemental matter. As I related in the two vignettes, a

major aspect of these performances was the relation between the light of the Sun, the convection of air, and the shapes expressed by these sculptures. If, following Ingold (2009), we understand the Sun to be, “not... an object that moves across the sky. Rather... the path of its movement through the sky, on its daily journey from the eastern to the western horizon” (Ingold, 2011: 72), then, we might speak of a relational dialogue between the Sun and an Earthly-elemental *spacing* and *timing*. Moreover it is worthwhile to note that the kind of spacing and timing demonstrated by aerosolar sculptures differs from that of other artistic experiments with the solar.

For example, Marres addresses *Spiral Drawing Sunrise*, an outdoor installation artwork by artists Esther Polak and Ivar van Bekkum composed of a robot translating sunlight into a curving trajectory etched in the ground. Marres writes that this work is “performing geometry”:

The geometric shape of the spiral here came about through the movement of the sun shedding its light on the car’s solar panels, and the car depositing sand. And we might say that, in its spiraling movement, *the robot car made room for the sun to exert its capacity to choreograph entities in time and space*. (emphasis mine; Marres, 2012: 89)

Spiral Drawing Sunrise choreographed solar energy in the shape of a continuous curve – a kind of frozen vortex. Similarly, the various aerosolar sculptures I described “made room for the sun... to choreograph entities [including bodies, envelopes, GPS trackers, reflectors] in time and space” (*ibid*). However, if *Spiral Drawing Sunrise* traced a discrete solar geometry with the use of various sensors, the aerosolar sculptures in Wolfenbüttel and in Vienna performed other geometries with much more fragile and contingent qualities. These aerosolar forms shivered and rippled into being; they gained consistency as sunlight intensified; but they were easily deflated and flattened. In short, they were temperamental. In contrast to a spiral of sand traced in the earth, the aerosolar sculptures performed an *anexact* solar geometry that was proportional to cascades of photons as they swung into molecules of plastic and air inside and outside the envelopes. Since elemental and energetic conditions played such an important role in whether or not the sculptures could fly, these entities are dependent not only on the solar-driven meteora of a specific site, but on cosmological conditions far beyond it.

To think of an aerosolar sculpture less as an object, and more as a felicitous convergence of materials and processes, is to think of it as something that *radiates* into its environmental milieu. Ingold would no doubt think of such sculptures as tissues and surfaces that weave the air into “their very texture,” and are in turn woven by air into its eddies and vortices (Ingold, 2007). An aerosolar sculpture *radiates* because it transmits the same dancelike cascades of photons and electrons that Beresford-Kroeger (2013) describes in relation to chlorophyll and quercetin. It transmits these cascades to the sensibilities of human practitioners, and to the registers of technical objects like tracking devices, cameras or sensors. As I related in the two aerosolar sculpture launches, the performance of this transmission has powerful affective influences. The entanglements and contingencies between the flux of solar energy, absorbent surfaces, air masses, weather conditions, designed elements, atmospheric laws, technologies of tracking and sensing, and a group of invested practitioners – all of this generates a particular “structure of feeling” (Williams, 1961) entangled with light’s expression in matter.



Figure 31:
Aerosolar Sculpture Launch, 2014
Institut für Architekturbezogene Kunst | TU Braunschweig
Becoming Aerosolar Seminar | Tomás Saraceno, Professor
With Sasha Engelmann and Jol Thomson
Photography by Philip Dreyer

The cosmological aesthetics of aerosolar sculptures has as much to do with the context-specific, sensed relations between solar energy, volumetric design and buoyancy, as it does a wider experience of the hydraulics of elemental media, and the ecology of practices that is necessary for aerosolar events to take place. In this way the experience of making and launching aerosolar sculptures is a form of intervention and experiment with cosmic energies and Earthly materials that opens out onto more granular and empiricist conceptions of energy and physics. In the great dialogue *Timaeus*, Plato wrote of the relations that different geometric forms have with the four classical elements: the octahedron is allied with air, while the dodecahedron is associated with a fifth element, which Aristotle interprets as *Äther*.

This is the same kind of material intuition and imaginary that informs Serres' (2000; 2002) writing on atomistic philosophy and physics:

The hardest [materials] like diamond, stone, iron or bronze, owe their solidity to the fact that their atoms are tangled, branching, knotted into a tightly-packed fabric. As we move towards the fluids and gases, the atoms are rounder and smoother rather than hooked, of course, but in particular they are less tangled among themselves. (Serres, 2000: 5)

It is once again productive to read such material-philosophical statements with those made during an aerosolar experiment. As Szerszynski articulated during the first aerosolar workshop:

Of all the kind of forces of the Earth of rock and water and life and society and technology and language, it's the most forgetful, it's the most fragile, the air, because it's so thin, because it can't form structures, it can't remember what it was doing from one minute to the next, but to enclose the air in a membrane is to give it this new kind of intelligence, this new kind of life, so we in a sense lend our intelligence to the air. (Szerszynski, personal communication, 2014)

As these accounts convey, a material imagination of air suggests hydraulic and hydrostatic smoothness, rotation, and symmetry. There are relations, both empirical and imaginative, between the sensed qualities of matter and its capacities to “perform geometry”. The geometries of aerosolar sculptures – dodecahedrons, rounded cylinders, bi-pyramidal – do not necessarily define the materials to which they correspond, but serve as diagrams for a relation between the elemental, the physical and the sensual. As Kwinter writes, there is, “an invisible matrix, a set of instructions, that underlies – and most importantly, organizes – the expression of features in any material construct... it is, in short, the motor of matter” (Kwinter, 2006: 12-13). Aerosolar sculptures are one among many aesthetic devices that render explicit such material matrices.

The experience of making and launching an aerosolar sculpture, then, is not only valuable for the ways in which it sensitizes human practitioners to the media of air and atmosphere, or the ephemera of weather and climate. This is indeed true, but it does not account for the scope and intensity of these events, of which only two are related in this chapter. Rather, aerosolar sculptures act as aesthetic devices

and diagrams for a relation to the cascading passage of energy through materials: energy that we often forget is cosmic in origin, energy that has particular patterns of circulation and movement, energy that cannot be taken for granted. In a world where the infrastructure of energy production and distribution is disturbingly oriented around the availability of diminishing “hooked” hydrocarbons, indeed hydrocarbons which are less and less adequate to our gripping addiction to combustion, creative practices that involve learning a relation to energetic passages, and to the thermodynamics of envelopment and buoyancy, present not only an unusual aesthetic project, but also an ethical one.

What thermodynamic imaginaries do such aerosolar cascade experiments call into being? There is surely more than one answer to this question. For Kwinter, the process of combustion implies an “unfolding of geometry that previously was either held in exquisite or frozen suspense” (Kwinter, 2006: 14). In contrast, “Anyone who discovers a middle ground, *a rhythm of unfolding that delivers the geometries of matter to the senses* in the form of properties, qualities, or affects *in real time*, endows the world with novelty” (emphasis mine; Kwinter, 2006: 14). This discovery of another logic of unfolding, for Kwinter, can only be achieved through practices that access matter’s patterns *in situ* (*ibid*). An aerosolar sculpture is one type of device that accesses this material and temporal specificity: the swings of photon-cascades, the eagerness of plastic surfaces and the hydraulics of air. Such sculptures, as devices, cannot be separated from the collaborative attunement between material practices, the media in which they move, and the assemblage of humans and technologies who design, make, inhabit, nurture, care for, transport and release them. The process of *endowing the geometries of matter to the senses* is a project that unfolds across the human, nonhuman, technical, elemental and the atmospheric. Thus, the new *thermodynamic imaginary* materialized with aerosolar sculptures is one that requires not only changing our relation to sunlight, plastic or petrol, but also proposes a more *exotic* model for such relations: a model that implicates a cosmological constellation of material practices in dispositions to energy. Such an imaginary of energy would be synonymous with the shared sensation of a feeling, and a falling, into awareness.

First meeting of the Open Space Agency:

Present: Tomás Saraceno, Trevor Paglen, Bronislaw Szerszynski, Jol Thomson, Sasha Engelmann

Studio of Trevor Paglen, Torstraße, Berlin.

October 2015.

Notes:

To give permission to think beyond what it means to be human.

In other words, the Alien Alien.

Solving big problems for no reason.

Sun-synchronicity.

Tardigrades.

Being halfway through the history of a planet that will be swallowed by its nearest star.

For all these reasons, it matters how we get to space.

Agreements:

1. Space is not for extraction
2. Bring space closer
3. Distributed agency
4. Celebrate uselessness

Decentering the human and decentering the Earth.

Doing things for ambiguous ends.

A skeptical space agency. The necessity of embroidered badges.

The work of Malevich after the Russian Revolution.

Don't instrumentalise before you put in practice!

Spaceflight is art, let's embrace it.

The future: more conversations, a Manifest, presentations, artworks, a fashion show?

Interstice VI: First meeting of the New Space Agency. Present: Tomás Saraceno, Trevor Paglen, Bronislaw Szerszynski, Jol Thomson, Sasha Engelmann. Studio of Trevor Paglen, Torstraße, Berlin. October 2015. Transcription by Sasha Engelmann.

The Interstitial Politics of the *Aerocene*

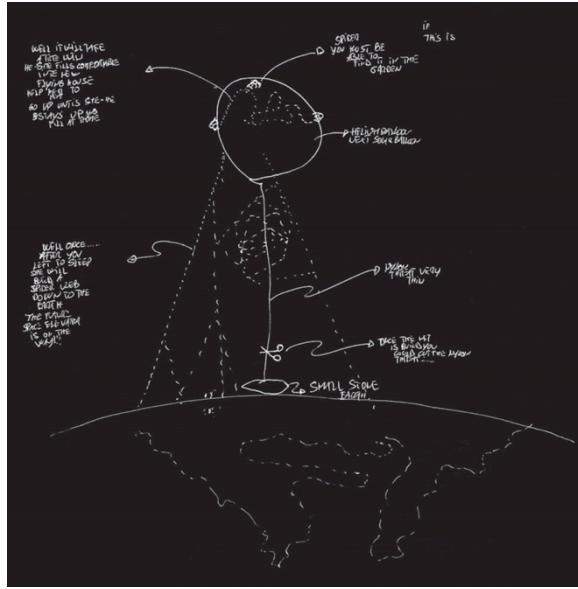


Figure 1: Drawing by Tomás Saraceno in Saraceno, 2015: 174.
Exhibition catalogue published on the occasion of *Tomás Saraceno: Becoming Aerosolar*,
at 21er Haus Vienna, curated by Mario Codognato.
Courtesy the artist.

...the real test of becoming aerosolar is not, or not only, artistic but becoming-collective: prototyping designs for payloads, instrumentation, and navigation; advancing strategies to challenge the legal limitations of aeronautics under petrocapitalism; coordinating data through open systems; and enabling a proliferation of experimentation with aerosolar structures and their occupation that defies containment—these are *world-making activities*, the stuff of polities who have moved beyond the sad passion of territorial skirmishes to the joy of over-coming as a practice of world-making. (emphasis mine; Turpin, 2015: 183)

In this dissertation we have encountered membranous spaces of in-dwelling, multi-species milieus, and workshops of more-than-human and more-than-technical achievement. In this final empirical chapter I will address the becoming-collective of aerosolar practices as they create a

cosmological frame in the broadest sense. The conceptualization of worlds has always been part of Tomás Saraceno's artistic endeavor, from *Air-Port-Cities* to *Cloud Cities* to the *Aerocene*. The argument of this chapter is that there is a specific quality of cosmological thought and experiment emerging in recent projects like *Becoming Aerosolar* and the *Aerocene* that are compelling because of their *interstitial politics*. Interstitial politics, or what I have also called a “politics of associative elementalism” (Engelmann, McCormack and Szerszynski, 2015) is a phrase borrowed from Pignarre and Stengers (2011) denoting a political capability that emerges in situations where *re*-working a material becomes a way of working through new relations to air, atmosphere and energy. In other words, aerosolar practices are interstitial because, at the moment of writing, they continuously convene different communities of design, philosophy and experiment.

The collective, participatory work *Museo Aero Solar* co-founded by Tomás Saraceno, Alberto Pesavento and the Isola Arts Center in Italy in 2007 exemplifies a cultural-material arrangement that fosters a particular interstitial politics. The re-use of plastic bags that would ordinarily be directed toward landfills or oceans brings specific materialities and practices together to foster haptic connections to plastic, air and energy. This project conveys the fact that potent possibilities for material politics are located within forms of work and collaboration that transform everyday practices in unusual, slow and surprising ways. This chapter therefore employs Pignarre and Stengers's (2011) notion of “the interstice” to speak to the ecology of practices inspired and sustained by aerosolar entities like *Museo Aero Solar*, and the degree to which these entities alter the affective spacetimes of practitioners. Aerosolar sculptures like *Museo Aero Solar* shift and intensify encounters with the chaotic, cosmic, and elemental media in which we live and move (Grosz 2008). Also, and equally, they conjure an interstitial politics that resonates across increasingly diverse “enunciative territories” (Guattari, 1989/2000) of design, making and launch, enveloping and exposing bodies in the “spell of new inventions” (Pignarre and Stengers, 2005/2011), as well as in temporal “spells” of weather and climate.

Such affective space-times and spells are not opposed to the technical. According to Etienne Turpin, the “becoming-collective” of aerosolar practices is a layered, infrastructural affair, involving the

becoming-aerostatic of communication and expertise. It is this infrastructural potential of Saraceno's aerosolar practices that may hold the most promise for its broader cosmological-aesthetic propositions about how we may live, move and collaborate with Earth's atmosphere. It is also this aspect that is the most challenging for Saraceno's practice, since the logic of infrastructure is antipodal to the logic of the artist's studio. In this chapter I will note how Studio Tomás Saraceno sometimes hinders the political potential of aerosolar practices by harnessing them to a specific discourse on hope, while at the same time, aerosolar practices threaten to make public some of the unique experiments and innovations of the studio, thereby decreasing their marketability as art objects. As these developments have occurred late in my time as a researcher in Berlin, this chapter is not meant to be conclusive – rather it suggests some trajectories that aerosolar practices are moving, to cast a last, but not final, thread into the air. The concepts generated and mobilized here are useful not only for their manifestation in Saraceno's practice, but also as they articulate novel political coalescences around the airy, the atmospheric and the elemental.



Figure 2: *Museo Aero Solar* in Prato, Italy
Photography by Janis Elko
Museo Aero Solar, 2009
www.museoaerosolar.wordpress.com

Museo Aero Solar

Museo Aero Solar is an important departure for aerosolar practices and politics since it is an object whose interstitial qualities demand the attention of many bodies, attachments and forms of expertise. It is therefore a vibrant metonym for a collective atmospheric investment and politics. One specific event epitomizes the kinds of political and affective intensities generated by this object. In December of 2014, Saraceno traveled to Lima, Peru, to participate in the D&C (Development and Climate) Days, on the occasion of the twentieth Conference of the Parties (COP) UN Climate Talks, prior to the larger Paris Convention in late 2015. In Lima, Saraceno was commissioned by the Red Cross to stage an artistic event. The invitation came about after Pablo Suarez, Associate Director for Research and Innovation at the Red Cross, saw a joint presentation that Saraceno and I gave at the Institute for Advanced Sustainability Studies' Climate Engineering Conference (CEC14) earlier that

summer (Saraceno and Engelmann, 2014). The presentation ended with an image of *Museo Aero Solar*; we suggested that “climate design” could mean a style of collective, vernacular architecture with an eye for beauty. The allure and social nature of *Museo Aero Solar* immediately resonated with Suarez; he believed it was a productive artistic intervention for the COP20 conference in Lima.

How exactly might we describe this artistic intervention? Here it is best to turn to the collaborative articulations of the group itself. *Museo Aero Solar* is, “[a] flying museum, a solar balloon completely made up of reused plastic bags, with new sections being added each time it travels the world, thus changing techniques, drawings and shapes, and growing in size every time it sets sail in the air” (*Museo Aero Solar*, 2011). What distinguishes *Museo Aero Solar* from the other aerosolar sculptures is its constraints in materials (only reused plastic bags are employed) and its particular status as a collectively made and owned, nomadic work. According to the *Museo Aero Solar* community, “*Museo* contributes to an archeology of the daily life of contemporary society, in working as a conservatory of plastic bags and the memories related to them” and, “it stands as an exercise in the reduction of boundaries between everyday people and technical and physical devices” (*Museo Aero Solar*, 2011). In essence, *Museo Aero Solar* reduces boundaries and invents *interstices*.

The first *Museo Aero Solar* sculpture was created in 2007 in the United Arab Emirates, on the occasion of the 8th Sharjah Biennale, where Saraceno presented a Cloud City “Still Life”. But it wasn’t until Saraceno was invited to the Isola Arts Center in Milan in 2007 that the idea, “took the form of [the] collective project that it is today” (*Museo Aero Solar*, 2011). There, Saraceno met with Alberto Pesavento and a diverse group of local volunteers in the Art and Neighborhood Center in Isola: “It was like a sewing class, and the aim was, as it continues to be, to spend some time with other people” (*Museo Aero Solar*, 2011). At the same time, a number of “tasks” began to differentiate. Some people organized the collection of plastic bags, putting boxes and A4 posters in the neighborhood; others organized children’s workshops, making smaller balloons; still others were interested in, “studying a functional shape for the balloon, and a way to inflate it in order to fly” and another group “discussed its meanings” (*Museo Aero Solar*, 2011). They discovered that the best way to inflate the envelope was to

channel warm air from urban vents leading from underground transportation systems. Rather poetically, one of the first *Museo Aero Solar* sculptures was inflated with the pneumatic capacities of an urban domain. The first launch of *Museo Aero Solar* took place in the gardens of the Isola neighborhood, which had particular significance as an area that had been impacted by rapid gentrification, and symbolized a space of social and economic struggle. *Museo Aero Solar* states: “*Museo Aero Solar* had its first flight in this very highly charged situation, even if on the day of the flight, there was a really friendly and spontaneous atmosphere” (*Museo Aero Solar*, 2011).

As is clear from this story, and from accounts by members of Studio Saraceno, this first launch in Isola produced a momentum that continued for the following two years. Later in 2007, *Museo Aero Solar* was invited to the Encuentro Internacional event in Medellin, Colombia. On this occasion Saraceno and Pesavento again worked with local people and many children; they conducted all of the workshops outside. There, children began to draw on the plastic canvas, beginning what would become a palimpsest of messages and sketches. The following two flights, however, were not as “pivotal” as those in Sharjah and Medellin (*Museo Aero Solar*, 2011). In Tirana and Israel in 2008, *Museo Aero Solar* was again presented as a collective endeavor, but in both cases there was less time to engage with the local community, and consequently the sculpture seemed at first to be a “space invader” (*Museo Aero Solar*, 2011). Then, in 2009, an invitation from the Walker Arts Center brought Saraceno and Pesavento to Minneapolis, where they not only organized community workshops, but conducted experiments with the students of the Aerospace Engineering and Mechanics Department of the University of Minnesota. These experiments involved: “the ideal temperature and weather conditions to let Museo fly; the dimensions requested from Museo to raise up a human being; the temperature and the movement of hot air inside Museo” (*Museo Aero Solar*, 2011). In addition, they investigated the use of a camera with a GPS tracking system to measure the distance traveled by the object if it flew; and they constructed another smaller balloon made of black plastic. Saraceno and Pesavento applied for permission from the US Air Force to let *Museo Aero Solar* free-fly, but perhaps unsurprisingly, this request was denied.



Figure 3: Testing aerosolar sculptures near Minneapolis, USA, 2008.
© Photography by Tomás Saraceno, 2008

After further workshops and launches in Frankfurt and Prata, Italy, the decision was made to “start another balloon” in order, “not to mythologize the one single object, and to give new energies, new collections, new shapes and new possibilities,” and furthermore, “to physically represent the manifold nature of Museo – that it is more like an action, a multiform concept, an instrument to gain other imaginaries” (*Museo Aero Solar*, 2011). There was also the fact that the growing size of the object made it difficult to transport. So, in Arnsberg, Germany, another sculpture was begun; since then, the number of sculptures or “Museos” in existence has fluctuated. The point, according to Saraceno, Pesavento and other members of the community, is that *Museo Aero Solar* is not a prototype, or even a movement, but “*a sharable action that everyone could do, start, diffuse*” (*Museo Aero Solar*, 2011). It is fundamentally about sharing practices, and with these, technical knowledge. These practices have unfolded in many

other places: during my time at Studio Saraceno alone, we received news of a workshop in Pristina, Kosovo, and I participated in *Museo Aero Solar* workshops in Toulouse, Berlin, Vienna, Paris and Braunschweig. In December 2014, during his time in Lima, Saraceno renamed the *Museo Aero Solar* sculpture constructed there to: “*Intiñan... ‘the way of the sun’*” (see Figure 4).



Figure 4: Tomás Saraceno
Becoming Aerosolar, 2014

Installation View of Country Club Lima, Perú
Hosted by Development & Climate Days, 2014: Zero poverty, Zero emissions, Within a generation.
© Photography by Studio Tomás Saraceno, 2014

Interstitial Practices

Museo Aero Solar, and its incarnation in Lima as *Intiñan*, is an object of *interstices*. This is part of what makes it a multifaceted, experimental object: “the notion of the interstice calls for the plural” (Pignarre and Stengers, 2005/2011: 111). This aerial work is animated by a design, a concept and a way of practicing that is about connection and tension applied to a raw material – that of thousands of ordinary plastic shopping bags. The process and materiality of *Museo* suggests that, “knowing what a material is capable of when a tension is applied to it – recovering its original form, remaining folded,

breaking – depends on interstices, but no interstice has in itself the power to cause anything” (Pignarre and Stengers, 2005/2011: 111). In the case of *Museo Aero Solar*, it is the collective strength and consistency of plastic bags and their connecting edges that determines the envelope’s capacity to become airborne. But the interstices are not only those of bag-to-bag seams and edges, but also those of hand-to-hand and body-to-membrane. The participants who construct *Museo Aero Solar* are, “obliged by a relation whose existence depends on them, as operating the co-production both of themselves in relation and of what links them together” (Pignarre and Stengers, 2005/2011: 118).

What kinds of affective spacetimes are generated and communicated by *Museo Aero Solar* sculptures and interventions? Such affective spacetimes are not reducible to the terms of the physical or the emotional. The affective capacities of this object are better articulated using concepts from affect theory and non-representational geographies. One notion with which we might come to grasp the potency of *Museo Aero Solar* is that of, “inorganically organized affect” proposed by James Ash (2014) following the work of Bernard Stiegler. Such a theory attempts to articulate how affects might be mobilized and set into circulation by the work of nonhuman entities, devices or assemblages. However, *Museo Aero Solar* complicates this notion insofar as the process and materiality of this type of sculpture is predicated on re-purposing and re-mapping the relations between humans and manufactured entities, or, “matter that has been shaped by human beings for some human purpose” (Ash, 2014: 86). Ash explains further: “objects carry a series of somatic prompts in their material structure as to how they should be used” (Ash, 2014: 86). While I have done conceptual and practical work to dispel the notion that *Museo Aero Solar*, or any aerosolar sculpture for that matter, can be defined as an *object*, Ash’s theory is useful to the extent that it leads us to understand that anything beyond the employment of plastic bags for transportation of goods or shopping – and certainly the cutting, washing and taping of plastic bags to construct a solar-powered flying sculpture – means that a re-shaping and re-defining of the bags’ properties has taken place. In the construction of *Museo Aero Solar*, bags are stripped of their prompts and limits as discrete bag-objects, and become units of flexible matter.

For Martina Marciniak, an architecture student and former Studio Saraceno assistant who participated in many of the aerosolar sculpture workshops in Germany, plastic bags are precisely an ideal “raw” material for building entities that are lighter-than-air. She relates that the homogenous units of plastic bags generate interesting possibilities for experimentation with light, adaptive structures, so that these structures are “effortless” (Marciniak, 2015). What happens when human participants collect, cut, wash and tape plastic bags together to form a membrane is an intentional modification of the “material thresholds” of the individual plastic bags (Ash, 2014). But as Marciniak suggests, this modification is not one of “forcing” a change on the material, but of shifting and actualizing a potential that is already there (Marciniak, 2015). In the film *American Beauty*, a plastic bag dances elegantly with the smaller currents and eddies in air. When connected to form a continuous membrane, however, plastic bags react and move with larger, stronger forces. This different mode of atmospheric mediation has different affective consequences. As Ash explains: “Material components and thresholds can be reworked, modified or simply broken down, which in turn generates a whole new set of thresholds within which affects can operate” (Ash, 2015: 87). What are the new sets of thresholds invented by *Museo Aero Solar*?

In the construction of *Museo Aero Solar*, or *Intiñan*, as in that of other aerosolar sculptures, the goal is to create an enclosure. But the participatory nature of the work, and the fact that the entity is often constructed outside, means the design and rendering of the enclosure cannot be too complex. Therefore, Saraceno has helped to produce three common “templates” for such enclosures: *Tetro*, *Chico* and *Alto*. These show different ways to create a three dimensional envelope with minimal measuring and folding. The template for Tetro can result in a tetrahedron or a leaf-like diamond. But no matter what final form is achieved, there is a change that results as the membrane extends and takes shape. In one particular timelapse video of this process, the membrane is laid on a grassy field; as it grows in surface area, it begins to react very differently to movement in the air around it. As human participants circle the edges, adding more length and breadth, ripples run along the lengthening surface, very much like on the surface of a pond, and then more like waves of larger amplitude.

The creation of an enclosure for air as a space of affective potency resonates with Pignarre and Stengers's elaboration of the "pragmatic technique" of witchcraft: "the casting of the circle, the creation of the protective space necessary to the practice of that which exposes, of what puts at risk in order to transform" (Pignarre and Stengers, 2005/2011: 132). The process of fabricating an enclosure, "the space of an experience," is that, "all those who are brought together... are in the first place all 'infected' or 'poisoned' equally, although in different modes, and all equally need what none among them is able to produce alone" (Pignarre and Stengers, 2005/2011: 138). If we consider a *Museo Aero Solar* workshop, in which participants labor for hours and even days to create the envelope, the word "infection" is strangely apt. How else could an object composed of what is normally regarded as a waste material demand such intense and long-term commitment? Indeed, in the words of the sculpture collective, the central proposal of *Museo Aero Solar* is, "to diffuse, *like a virus*, the action of working on the construction of future Museo(s)" (emphasis mine; *Museo Aero Solar*, 2011). Again, Pignarre and Stengers elaborate:

Every circle is the exploration of a modus vivendi, which permits the situation to be lived in such way that if it comes undone, those who will have participated in the weaving come out of it more alive, having learned and become capable of teaching others what they have learned, capable of participating in other circles, other weaving processes. (Pignarre and Stengers, 2005/2011: 140-141)

Whether the circumstances, conditions and solar-cosmic energies align in such a way that the final sculpture can fly, or whether they do not, participants nevertheless learn how to fabricate an envelope that can be activated by the sun and air. Our seminar students at IAK anticipated and hoped for, "other circles, other weaving processes" as did the volunteers at COP20 in Lima who wished to keep augmenting the sculpture after Saraceno had returned to Berlin. This is summed up in a line from a presentation Saraceno and Pesavento gave at the Walker Arts Center in the early days of *Museo Aero Solar*: "We think there's more inventive potential among a group of people *gathered in a circle* than in any governmental research agency. The *spread of an invention* is more decisive than the invention itself"

(emphasis mine; Saraceno and Pesavento, 2009: np). The following sections will continue to think with an inorganically organized affective account of *Museo Aero Solar* to address aerosolar practices and politics.

Inflation

If the growth of the membrane changes the threshold of the material's reactions to air currents, it also shifts the gestures of humans to the material. This is most evident during the process of testing or inflating the structure. As I described in the case of the aerosolar sculpture workshop at IAK, TU Braunschweig, the inflation and inhabitation of aerosolar sculptures has an intensity that is contagious. One six minute long video of the *Museo Aero Solar (Intiñan)* inflation in an interior courtyard of the COP20 D&C Days conference building in Lima depicts this striking occurrence. The membrane is spread on the lawn of the courtyard, and is inflated with the use of a large fan. The person filming circles the structure and frames the three students holding the membrane open to the surge of air from the fan. They laugh and talk excitedly. Very soon the object rears up in a large mosaic of plastic several meters high. A crowd of conference delegates has formed; people are recording the event with their mobile phones. Many young people dash around the flapping object holding it in place; it is clear the object is straining with the pull of the air. The camera shot is shaky and jerky, suggesting that the person filming is moving. The filmmaker points the camera inside the mouth of the structure and the noise of the fan and the snapping and rolling plastic drowns out all other voices. Inside a space is opening. The structure has become quite large, towering over the human participants, folding back over itself like a curling, cresting wave.



Figures 5 and 6: Tomás Saraceno
Becoming Aerosolar, 2014
 Installation View of Country Club Lima, Perú
 Hosted by Development & Climate Days, 2014: Zero poverty, Zero emissions, Within a generation.
 © Video by Studio Tomás Saraceno, 2014

Saraceno enters the camera frame, attempting to hold the corner of the envelope with a hand that is in a blue cast (he had sustained an injury to tendons in his right hand in November 2014). He kneels near the mouth of the envelope where there are several students and young people crowded around, laughing and smiling. There is the loud snap and ripple of plastic. Then he orders the fan to be turned off and (speaking in Spanish) he communicates to those present that they can go inside. One person crawls through the opening, then another; then Dr. Chris Field, chairman of the IPCC, follows suit, along with Pablo Suarez. The camera's view points toward the floor as the person who is filming also enters. Inside, a handful of people are standing, arms at oblique angles to the floor, palms up in gestures of disbelief, not trying to repress their smiles as they gaze around at the pastel, rippling, multi-colored dome. Dr. Chris Field is wearing an uncharacteristically wide grin. Scattered words are heard. Then there is a ringing exclamation, from somewhere behind the camera:

“This is the best thing that has ever happened to politics!”

Stengers writes, “I think there may be elation, and laughter, when you feel an ‘event’, and it makes you alive” (Stengers in Zournazi, 2002: 269). Even when watching the video many months later, the affective texture of this event is palpable. *Intiñan* had succeeded in radically shifting the affective spacetime of a temporary assemblage of humans, technical devices and materials, indeed also that of a

conference. It is perhaps the unexpected autonomy of a sculpture like *Museo Aero Solar* – the way it begins to move, shape and react in ways irreducible to those of individual bags – that is partly responsible for the excessive moment of the event of inflation. Each time I participated in, or heard an account of a *Museo Aero Solar* workshop or launch, I was impressed by the affective texture that was emotional, even hysterical. The spontaneous exclamation – “*This is the best thing that has ever happened to politics!*” – could be brushed off as a carefree hyperbole. But an attention to the affective qualities of this event would take such hyperbole seriously.



Figures 7 and 8: Tomás Saraceno
Becoming Aerosolar, 2014
 Installation View of Country Club Lima, Perú
 Hosted by Development & Climate Days, 2014: Zero poverty, Zero emissions, Within a generation.
 © Video by Studio Tomás Saraceno, 2014

An initial consideration of the aforementioned video of *Intiñan* might postulate that it is the feeling of being-within, or being-enveloped, which constitutes its primary affective interstice. One could also read the collective intensity of being-enveloped as a manifestation and performance of Sloterdijk’s spherical intimacies (Sloterdijk, 2004; 2010). But *Museo Aero Solar* (*Intiñan*) had an affective “mass” that worked independently from the affective “weight” of envelopment (Anderson and Ash, 2015). Luckily, *Intiñan*’s capacity to fly with solar energy (without human passengers) was also captured on film. This film came to my attention weeks after the event, when Helga Elsner, an artist who was present at the event in Lima, came to Berlin and showed these materials to me at Saraceno’s Studio. In

this second, and much shorter film, the camera is angled from the outside of the courtyard to include the semi-inflated composite sculpture. *Intiñan* is hovering above the grass. Then, slowly at first, it begins to lift. When it is a few feet off the ground there are a few whistles and shouts, and as it rises even higher a scattered, halting applause breaks out. Then, there is a moment, when the sculpture is about two or three meters off the courtyard grass, when all of a sudden its velocity changes. It switches from a slow, hesitant, upward drift, to an accelerated ascension: a palpable line of flight (Figure 9). As this occurs there is resounding applause, punctuated with yells, shouts, exclamations, whistles and cheers. The sculpture quickly reaches the end of its tether, and the point of its tetrahedron shape turns skyward. As the tether holds it fast to the earth, it shimmers and glistens like an otherworldly banner or flag (Figure 10).

The event of this interstitial object taking to the air spontaneously generated a public animated by a shared attunement to the solar and the atmospheric. Outbursts of emotion, excitement, hyperbole, elation and surprise – these are all part of the public experience of this aerosolar sculpture’s flight. And it can hardly be otherwise: the object harnesses within it such capacities to move, to excite, in effect, to *rupture* the everyday, “ordinary affects” (pace Stewart, 2007) of conferences and public parks. As such, the repetition of such events is a refrain that circulates particular collective sensations and investments in atmospheric life. This is not only a politics of air and atmosphere, but also an interstitial politics that enfolds social investment in air and atmosphere that are animated by events, but also ripple out from the events themselves. The next section attends more to the qualities of these interstices and ripples.



Figures 9 and 10: Tomás Saraceno
Becoming Aerosolar, 2014
 Installation View of Country Club Lima, Perú
 Hosted by Development & Climate Days, 2014: Zero poverty, Zero emissions, Within a generation.
 © Video by Studio Tomás Saraceno, 2014

The Interstitial Politics of *Museo Aero Solar*

An interstice... creates its own dimensions starting from concrete processes that confer on it its consistency and scope, what it concerns and who it concerns. (Pignarre and Stengers, 2005/2011: 110)

The interstice, according to Pignarre and Stengers, “generates new questions”: “...it is opposed to the a priori judgments that would dismember minoritarian dynamics under the blows of unavoidable dilemmas ‘ether... or...’ To pose such questions is to learn to think ‘by the middle’” (Pignarre and Stengers, 2005/2011: 111). For Pignarre and Stengers, a “politics of the interstice” is about finding fissures in unilateral or majoritarian thinking; and it is about, “being *infected* by the precarious sense of the possible” (emphasis mine; *ibid*). In the making and launching of aerosolar sculptures, affective politics literally happens in the interstices. The shift of the material threshold of the plastic bag demands a different affective position in relation to this material. The sight of many people on their hands and knees, eyes squinting, smoothing out the folds in plastic edges, characterizes the majority of this labor, and is radical in its demonstration of contact and care between humans, plastic and air. In turn, a

collective affective experience – one inflected with both excitement and humility – inspires the process of labor. The dimensions of this attention to materiality, and the corporeal gestures it propagates, changes the form(s) of relation, communication and togetherness involved.

A return to the definition of Saraceno's aerosolar sculptures is helpful: the affective politics of *Museo Aero Solar* and *Intiñan* emerges from the posing of a problem. This problem is whether an entity composed of simple, everyday materials, can become buoyant using only solar energy. It is a problem that is at once familiar and extraordinary; most people have had contact with plastic materials, but few have thought about their properties of lightness, flexibility and thermal conduction. Even fewer have participated in events whose success is so tangibly related to energetic relations among molecules of air and plastic. The problem therefore directs and motivates the assemblage of actions and attachments that unfold in the design and construction of aerosolar sculptures. If a specific sculpture does not seem likely to engage the problem, actions and attachments must be rearranged (e.g. our seminar students at TU Braunschweig abandoned sculpture designs that were too small in volume to capture enough warm air, and instead collaborated on simpler, larger designs). Pignarre and Stengers write, “there is nothing more demanding, intellectually, affectively and imaginatively, than the process of creating a problem, above all if this process is political, that is to say, collective” (Pignarre and Stengers, 2005/2011: 144).

What I have (following Guattari, 1992/1995) called the “enunciative territory” of aerosolar sculptures is one way to articulate the notion that the collective posing of the problem of solar-powered flight, with a certain set of constraints, has a qualitative consistency across time and space (see also Gerlach, 2015). The unfolding and refolding of actions and attachments in aerosolar sculpture workshops is so remarkably similar whether in the United Arab Emirates or Germany or South America because of the universality of this physical problem. The consistency of this task is also related to the ubiquity of the “raw” material of plastic bags, and the simplicity of the process of cutting, taping and connecting. This refrain of interstitial politics achieves something much stickier, and more coherent, than is immediately apparent from simple accounts of these activities. It also has to do with the way the practices involved in such workshops become caring practices that enable hopes for the future.

However, not all forms of caring and hope are equally potent, or equally ethical, in their positions toward alternative futures (van Dooren, 2015). Pignarre and Stengers highlight this nuance: “Interstices need to be protected against the posturing of a hope that lends them a role *in search of an actor*, and constitutes them as the *hostages of this role*” (emphasis mine; Pignarre and Stengers, 2005/2011). The degree to which actors like the organizers of CEC14, the Red Cross, and even Tomás Saraceno invent a specific role for *Museo Aero Solar* that alters its politics is a point that I will address here, before moving further to the collectivities and publicities of a widespread aerosolar infrastructure.

In my experience, *Museo Aero Solar* solicits and emboldens a modest, grounded, care-in-practice (de la Bellacasa, 2012), oriented toward materials, technical objects, atmospheres and human beings. As I have described, these practices are animated and motivated by the hope that the object in question will fly using the force of the sun and the air. But what of care and hope for other, more distant environments and futures? Can the act of flying an object composed of ordinary plastic bags call into being a future that is less wasteful, less chained to materials like plastic, or less hungry for fossil fuels? As many have asked Saraceno: is the construction and flight of *Museo Aero Solar* a benign, hopeful practice, or one that reifies and glamorizes the material that is the emblem of capitalist wastefulness in the Anthropocene?

Since I was not present at the UN Climate Talks in Lima, I cannot address the dimensions with which the Red Cross may have enrolled *Museo Aero Solar* for its own purposes within the activist community, although an article published the week of the conference stated, “the [artistic] experiment is intended to encourage a strengthened focus on *Zero poverty, Zero emissions, Within a generation* – the 2014 D&C Days theme” (Red Cross Climate Centre, 2014). However, I have witnessed, and been a participant in, a chapter of Saraceno’s engagement with *Museo Aero Solar* as an interstice that is relevant for negotiating conversations on Anthropocenic and post-Anthropocenic futures. This occurred in one instance at a colloquium co-organized by Bruno Latour and Bronislaw Szerszynski at the opening of the exhibition “Pour un monument à l’Anthropocène” at Les Abattoirs, Toulouse, in October of 2014.

In the exhibition, *Museo Aero Solar* was exhibited in the central “nave” or arched hallway several stories high, so that visitors to the museum could view it immediately upon entering (Figure 11). Plaques accurately identified the sculpture as that of the community of *Museo Aero Solar* (Les Abattoirs, 2014). Immediately next to the inflated sculpture was a smaller room where a series of tables showcased Saraceno’s ongoing research with engineers at CNES and scientists at MIT (to be further detailed in the following section) (Figure 12). There were also hanging prototypes and instruments that contributed to presenting Saraceno’s interdisciplinary research on lighter-than-air mobility, sociability and technology. On the tables were loose copies of a publication that I had co-edited for the exhibition, including pieces by Derek McCormack, Nigel Clark, Kathryn Yusoff, Jennifer Gabrys, Etienne Turpin, Sria Chatterjee, Pete Adey, Andreas Mihalopoulos and Harriet Hawkins, among others.



Figure 11: *Museo Aero Solar*
Pour un monument à l'Anthropocène, 2014.
Installation view, Les Abattoirs, Toulouse.
Curated by Bruno Latour, Olivier Michelon, Bronislaw Szerszynski
© Photography by Sylvie Leonard at Les Abattoirs - Frac Midi-Pyrénées, Toulouse, 2014

Inside Les Abattoirs, *Museo Aero Solar* was strangely quiet. It did not snap, roll and ripple like it had so many times outside, under the sun. Every morning, before the museum opened, it was inflated with two powerful fans, discretely concealed in two corners of the sculpture. Visitors were invited to take off their shoes and enter a round waist-level door, which had a Velcro flap to stop air escaping. The act of entering – in contrast to the experience in Lima – was more like ducking inside a tent than squeezing into a moving membranous interior. Inside, the atmosphere was cathedral-like. The stillness of the structure enabled viewers to carefully observe the various bags' inscriptions: including trademarks of foreign companies or the drawings of children and other participants from around the world. The space could hold dozens of people. As a “monument for the Anthropocene”, *Museo Aero Solar* contrasted with Adam Lowe’s somber vitrines of distorted, 3D maps of Earth’s surface slowly filling with water; Amy Balkin’s wall-mounted template classifying “technosols”; or Yesenia Thibault-Picazo’s library of “future fossils” (Les Abattoirs, 2014).



Figure 12: Museo Aero Solar
Pour un monument à l'Anthropocène, 2014.
Installation view, Les Abattoirs, Toulouse.

Curated by Bruno Latour, Olivier Michelon, Bronislaw Szerszynski
© Photography by Sylvie Leonard at Les Abattoirs - Frac Midi-Pyrénées, Toulouse

Throughout the two-day opening colloquium organized by Bruno Latour and Bronislaw Szerszynski, a series of debates about the nature of the Anthropocene took place. Jan Zalasiewicz, head of the Anthropocene Working Group for the International Stratigraphic Society, gave a striking presentation on the difficulty of attributing a geological name to a new stratum on Earth's surface. I cannot account for the breadth of the many other conversations here, but what struck me (and others) about Saraceno's contribution was the way he reacted to the notions of doom and despair about the advent of the Anthropocene invoked by the other scholars and artists alike. Instead, Saraceno insisted on hope. He used the term "Solarcene" to refer to a new age in which human ingenuity and collaboration would result in better ways of employing solar energy, citing Nikolai Kardashev's "scales" of super-civilizational development. And he played several bright, sun-lit videos of himself flying aerosolar

sculptures during his presentation to the colloquium participants. For Saraceno, the Anthropocene (if this was its name) had to be an epoch of opportunity for collaborative inventions.

Although *Museo Aero Solar* was unusually still and lifeless inside the exhibition hall, it was enrolled as a lively, central part of the hopeful aura of Saraceno's practice. Indeed it was by far the most hopeful and magnetic contribution to the series of Anthropocene monuments in the exhibition. It came as no surprise to me that the final performance – Bronislaw Szerszynski's long poem *Onomatophore of the Anthropocene* – was held inside of *Museo Aero Solar*, with all of the colloquium attendees crowding around in a half-circle, and Bruno Latour helpfully holding a megaphone to Szerszynski's mouth (Figure 13). In the course of the poem, Szerszynski painted a stark, foreboding scene of a hearing at the "Commission of Planetary Ages" and alluded to an accelerating epoch of machinic phyla. Having seen Szerszynski perform the piece twice previously, and having witnessed the meditative, even somber qualities of these previous events, I was interested to note that on this occasion audience members were at ease, even half-smiling. Inside the glimmering, multi-colored dome of *Museo Aero Solar*, the poem's verse, which mirrored the legal language of dictates from the European Commission, seemed playful, even whimsical. As the poem ended, a resounding applause echoed through the chamber, and the colloquium adjourned.



Figure 13: Bruno Latour, Bronislaw Szerszynski, Performance of Szerszynski, "The Onomatophore of the Anthropocene", Toulouse, France, 2014. Photography by Studio Tomás Saraceno, © Museo Aero Solar, 2014

In the space of Les Abattoirs, then, *Museo Aero Solar* fully supported Saraceno's insistence of hope in a “charming” (Buck, 2015) or “good Anthropocene” (Marris et al., 2014). This alone does not alter its politics. The potential shift posed by this exhibition to the interstitial politics of *Museo Aero Solar* is that it is given a “role” within a discourse of Solarcenes, *Aerocenes*, *Cloud Cities*, and *Becoming Aerosolar* that is inseparable from the work of Tomás Saraceno. *Museo Aero Solar* is a potent Stengerian interstice because it is at once concrete and abstract, grounded and transforming, mundane and speculative. Its resonance in myriad places and social situations is due to the malleability of its physical and conceptual form, as well as the different kinds of labor and imaginaries it gathers together. The style of work and thinking carried out by Studio Saraceno, although diverse, has a specific tenor and aesthetic, and depends fundamentally on the vision of a hopeful future untethered from Earth’s surface.

Given this context, we must accept that there is some degree of risk that *Museo Aero Solar*'s politics could be altered or vacated if it continues to be enrolled (however carefully) in a cluster of work near the exuberance of Saraceno's project.

However, I wish to stress that if *Museo Aero Solar* and *Intiñan* have indeed been enrolled by certain actors (like CEC14, COP20, the Red Cross and Saraceno) in certain specific situations, this is also an inevitable part of their lives and stories as political entities. Moreover, it does not necessarily diminish their potency as Stengerian interstices with an infectious politics. This is because the constraints, consistency and problematics of aerosolar sculptures make them slow, indeterminate and inventive. There is no single “solution” to solar aerostatic flight; these practices never unfold the same way twice. Therefore they sidestep the great danger that Pignarre and Stengers (2011) argue threatens political interstices: that of proposing a *solution* to the problem they themselves have invented. Equally, in relation to the optimism conveyed by Saraceno in Toulouse and elsewhere, the politics mobilized by *Museo Aero Solar* might have a different, complicated texture, one that involves the connotations of plastic – a material that is simultaneously responsible for the deaths of countless beings but will also play an unavoidable part in the new assemblages of the Anthropocene, and may in fact be our primary future-fossilized “monument”. Perhaps the reading of Szerszynski’s somber poem *Onomatophore of the Anthropocene* inside the multicoloured space of *Museo Aero Solar* in Toulouse is precisely the disjunctive, aesthetic situation that the politics of the sculpture engenders.

As novelist China Miéville writes, “There is hope. But for it to be real... we cannot just default to it. We have to test it, subject it to the strain of appropriate near-despair” (Miéville, 2015: np). In other words, for Miéville, strands of perfect optimism and pure pessimism must hold up to rigorous testing. Hope and despair are not abstract terms, but contain within them diverse taxa of hope-despair, or as Miéville puts it, “utopalypse” and “apocatopia” (Miéville, 2015). The best kinds of hope we might mobilize are emergent from conflict, in other words, through tension. The styles of hope expressed in *Cloud Cities* and the *Aerocene* are indeed experimental: these are strains of hope that are tested again and again whenever an aerosolar sculpture takes shape and takes to the air. They are taxa of hope

played-out in practices that extend far beyond Saraceno's studio. This experimental hope is therefore as flexible and nomadic as the sculptures themselves. Allowed to flourish with the sculptures and the publics they spontaneously inspire, these strains of hope may breed into many new species of hope-conflict and hope-despair that are, according to thinkers like Miéville, precisely what is needed to shake free of our service to capitalist profit as well as to combustion, extraction and environmental violence.

Similarly, in the words of Erin Manning, the “craft” and “craftiness” of the politics of aerosolar sculptures like *Museo Aero Solar* is different from the sorcery of “the most tightly woven capitalisms” (Manning, 2005: np). It is a technique, “linked with witchcraft in the sense that it remains associated to a long practice of study, of experimentation and combination of ingredients as heterogeneous as they are potent” (Manning, 2005: np). To design and execute this craft of interstitial politics is to be open to different and older ways of thinking, as well as, “to expose ourselves to the *spells* of other worlds and other combinations” (emphasis mine; Manning, 2005: np). This sentiment echoes in a conversation between Isabelle Stengers and Mary Zournazi regarding the decision-making processes of neo-pagan activists. Stengers asserts:

This is what I would call a ‘spiritual’ invention. And it has strong constraints. For instance, you should never tell anyone that his or her position is wrong – everyone is gathered around the problem, and it is in producing and creating the problem that people can also become. It is possible only because of the hope they share in a consensus-producing process. Such a consensus is what I call an event. It is important to celebrate such events, the demanding achievement they are. So I would say a consensus being created in this way is a cosmic event. It is something new in the cosmos. (Stengers in Zournazi, 2002: 258)

Museo Aero Solar is a “spiritual” invention because of the eventfulness that results when a problem is invented with generative constraints and willing practitioners. Aerosolar sculptures are inventions that breathe, breeding tensions and textures sprung between bodies like an infection or drug. Although I have described them as hyperbolic, elated affairs, there is nothing to say they might not spawn other affects – other conditions of interiority, envelopment or pneumatics that might be alluring in different

ways. For, in the shimmering interior of an aerosolar sculpture, when bodies gesture to the circle around them, there might as well be witchcraft at work. And what emerges from such encirclement might accommodate hues of darkness, a kind of “black magic” that is summoned by the ongoing testing of hopes for post-Anthropocenic and Aerocenic futures. In the following we continue to think of species of hope, and dreams of utopia and utopocalypse, in the consideration of a nascent “aerosolar infrastructure”.

Aerosolar Infrastructure

We should utopia as hard as we can. Along with a fulfilled humanity we should imagine flying islands... (Miéville, 2015: np)

...it is becoming urgent to create a contrast between the earth valorized as a set of resources and the earth taken into account as a set of interdependent processes, capable of assemblages that are very different from the ones on which we depend. (Stengers, 2011: 163)

As Turpin emphasizes in the passage that opens this chapter, the “real test” of aerosolar practices lies not in the terms, codes, markets and spaces of the art world, but in the “becoming-collective” of aerosolar experience and experiment. Emergent from recent conversations with Saraceno, Nick Shapiro (the Open Air Fellow at the non-profit organisation Public Lab), Bill McKenna (a graduate student at MIT), engineers at the Technical University of Braunschweig, Willow Brough at MIT’s Civic Media Center, and stratospheric balloon specialists at CNES, among others, I have witnessed an emergence of trajectories for building-up an aerosolar infrastructure that extends beyond the art world, such as that articulated by Turpin. Such an infrastructure would allow everyday citizens to participate in a collective sensing of atmosphere through the design, construction and launch of aerosolar sculptures. There are several important nodes of development I would like to point out here, which are nicely summed up in the term “calculated submission” invented by Shapiro to denote the more-than-technical achievement of

drift (Shapiro, 2015). Calculated submission is the project of attending to the production of a body of atmospheric data in collaboration with devices that do not fly through the air, but drift with and within it.

In the context of national airspace regulations and jurisdiction, to drift is not to vanquish control (Figure 14). One of the central challenges facing the more frequent and widespread launch of aerosolar sculptures is a mechanism that would allow such sculptures to be effectively deflated in mid-flight should they cross a border that is forbidden, or ascend to an altitude that overlaps unsafely with air traffic. In 2015 and 2016, Sven Steudte, Thomas Krahn and studio-member Stefano Arrighi worked closely with TU Braunschweig student Alexander Bouchner on prototyping a Do-It-Yourself “cut-down mechanism” that could potentially be released as part of an open-source protocol for aerosolar practices. Although such mechanisms have been deployed by CNES for decades to control the flight of their Montgolfière Infra-Red (MIR) balloons, no user-centered, open-source design currently exists. One model that was tested in this time was a radio-triggered hot-wire that would burn a hole in the membrane of the sculpture, causing it to lose air and buoyancy. The tests at TU Braunschweig were many, but often frustrated: the cut-down mechanism would not receive the signal to activate, or the wire would not succeed in burning the plastic or other fabric. These issues would only be exacerbated if the sculpture was flying the air.



Figure 14: A disk holding the micro-controller computer and battery pack for a free flying aerosolar sculpture to be launched from the Salar de Uyuni in Bolivia, January 2016. This technology enables the sculpture to be tracked with GPS coordinates, and also holds a small camera that takes images at certain intervals.

Photography by Sasha Engelmann.

I cannot speak further to the complexities of working DIY cut-down mechanisms, both because of my lack of technical knowledge of the programming and engineering of these devices, as well as the nascent state of these efforts. However, if such important challenges were to be addressed, the legal capacity for launching aerosolar sculptures would be immediately greater. A further stage in the project would be to develop mechanisms that can open or close a valve during flight, causing the aerostatic object to increase or decrease in altitude, depending on the conditions. In the words of Bouchner, such devices would, “make the sculpture intelligent” (Bouchner, personal communication, 2015). Moreover, if the legal limitations of launching drifting objects could be met with adequate DIY modifications, aerosolar sculptures could potentially become more distributed as devices. Shapiro wrote the following in the *Aerocene Newspaper*:

Equipping these balloons with sensors, they could be variously used to monitor stratospheric ozone levels, measure tropospheric particulate matter levels in the cities, trawl the oceans for microplastics, assess methane releases from pipelines, track ocean acidification, or enumerate shale-field flares. (Shapiro, 2015: 21)

Such descriptive passages are decidedly utopic, or rather, utopalyptic. They paint an image of grassroots campaigns in environmental monitoring and remediation that employ aerosolar sculptures as drifting but industrious collaborators. Stengers' work primes us to turn a critical eye to those visions that present technical solutions as swiftly and easily as this. Inscribed in this kind of utopia, however, are indeed notes of despair: evocations of the widespread toxicities and wastes that would make such aerosolar plastic-trawlers necessary. It is therefore also too simple to read such a passage as providing a solution-oriented "blueprint" for future aerosolar practice; rather, it opens up a range of spaces or "footholds" into which aerosolar experiments might grow.

Another important element in an aerosolar infrastructure, and in many ways what would be considered one of the primary goals of such endeavors, is to begin to build up more dense layers of knowledge on the intricacies of Earth's atmosphere – on distribution of pollutants, wind velocity and altitude, and the physics of storms, among other topics. In collaboration with Saraceno, Bill McKenna and a team at Georgia Tech, Shapiro has described an aerosolar forecast visualization in three dimensions, or a "haptic interface" where users navigate the atmosphere using an aerosolar sculpture, the movements of which are registered by a computer's camera and used to steer through an aerial navigation (Shapiro, personal communication, 2016). This kind of navigator for human flight in an aerosolar sculpture could be both playful and also highly sophisticated. The innovation is in bringing global "aerosolar forecast" maps into the public sphere using a real-time API. And, eventually, to be able to build in locally produced data and sensing from aerosolar experiments around the world. This is one example of the kind of work in progress in the space of collaboration fostered by Saraceno's project.

A further challenge is the creation of a flight predictor for unmanned aerosolar vehicles. Currently there are flight predictors for unmanned Helium balloons; these are employed by radio-

amateurs like Steudte and Krahn and a growing community of balloon enthusiasts around the world. However, predicting the flight of a solar-powered aerostat, whose altitude depends on a complex convergence of factors including solar radiation, volume, wind, and the Earth's albedo, is more difficult. To address such a problem, Saraceno and Shapiro together proposed inviting engineers and software programmers to an intensive week-long workshop hosted by Studio Saraceno: a gathering of experts who might, together, solve some of the parameters of the flight predictor.

Interestingly, and somewhat counter-intuitively, for Shapiro, "the point here is not to conjecture technical possibilities but to underline the knowledge infrastructures necessary for *germinal collective dreaming* to take place" (Shapiro, 2015: 21). Phrased differently, the possibility of having an inspired, collective investment in atmospheric experience is at least as valuable as technical innovations. This is a fascinating assertion because, to summon Whitehead, it articulates how an artistic project like the *Aerocene* has gained a "foothold" in the world, and in doing so, has lured a diverse group of artistic, scientific and social-scientific collaborators into different forms of collaborative adventure and experience. There are many highly technical and infrastructural feats that must be addressed for the possibilities of aerosolar flight to be more widespread and accessible, but such capacities are not an end in themselves: rather they establish a platform from which a different collective investment in atmosphere might emerge.

This is precisely where the force of the *Aerocene* lies. The potential of the *Aerocene* is in proposing a series of concrete practices that have a direct relation to a problem engendered by the Anthropocene, yet do not purport to solve it. It is in offering many *footholds* – many kinds and levels of intervention and collaboration – from the highly technical to the speculative-philosophical, to the manual and labor-intensive. If the *Aerocene*, as elaborated by Saraceno, bends too close to utopia, it is a porous and experimental utopia that can be (re)engineered and (re)mapped through different engagements. And through these engagements, as Miéville writes, we can contribute to a doing of utopia that is needed at a time when feelings of powerlessness are so pervasive. This, more than the flight of one single sculpture or the success of an exhibition, is the interstitial politics of the *Aerocene*.

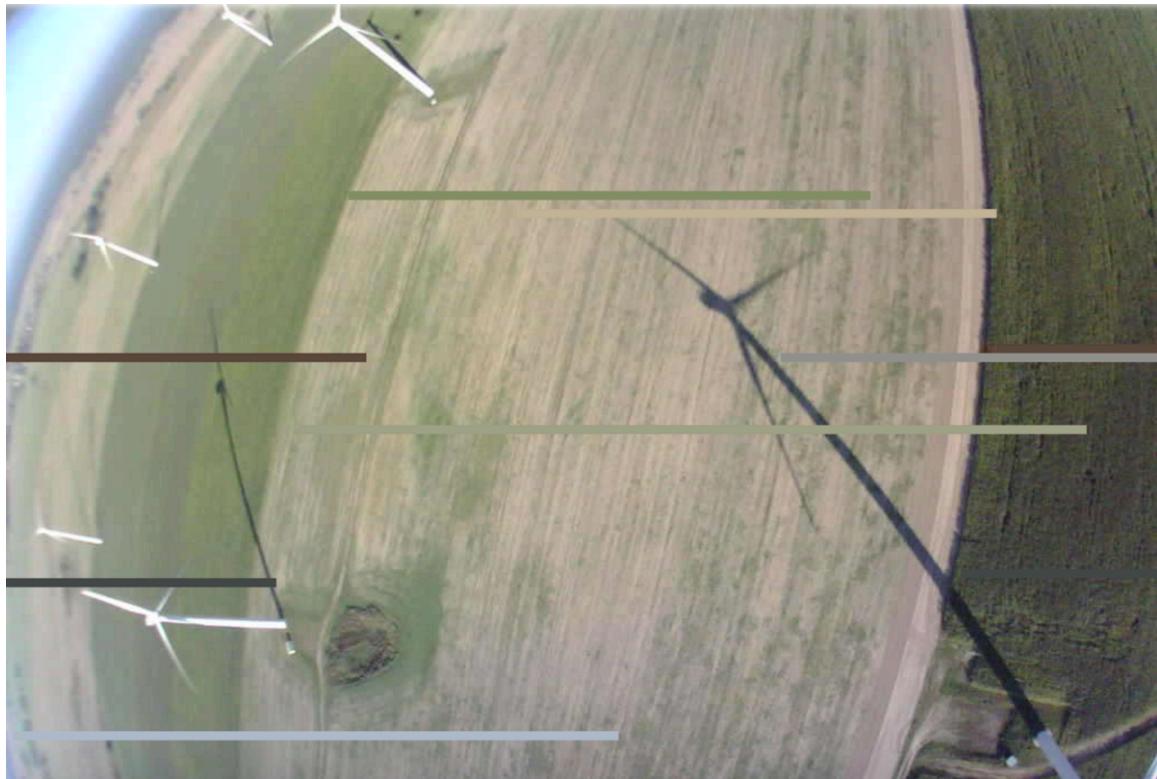
Attuning (to) Atmospheres

This chapter has taken a circuitous route through the publicities and communities of aerosolar sculptures, from Lima to Toulouse. A few chords should be highlighted in this polyphonic coalescence of material, story and argument. First, the kinds of sensing-in-practice summoned by aerosolar sculptures troubles the distinctions between technical data and sensual data. Sensual attunement to the atmospheric is an equal form of digestive work in the labor of interpreting the intangibilities of air, atmosphere and climate. To paraphrase Noortje Marres: atmospheric knowledge is not something that exists in the “vast machines” of computer simulations, integrated satellite systems and design protocols – it also passes through our bodies. The degree to which we can stage collective encounters that facilitate digestion of atmospheric data, the more we are adding density and quality to atmospheric datasets, and the more, to follow Jennifer Gabrys’ reading of Whitehead, we are “creaturing” these datasets – making them actionable and relevant (Gabrys, 2015).

What is the position of an artist who creates a sculpture, a movement, and a discourse, but also an infrastructure and an interstitial politics? Such a position is certainly difficult to sustain in the logics of the art market. What happens when the sculptures exhibited in museums become templates for many other ones, and perhaps inspire more sophisticated models and prototypes made by other people? Given the degree to which Saraceno has welcomed the expertise of collaborators like Nick Shapiro in open-source licensing and development, this is the direction in which the *Aerocene* project is heading. The proposition of the *Aerocene* as a grassroots movement of DIY making and launching aerosolar sculptures for citizen-led researching, monitoring and dreaming in the atmosphere is the most genuinely cosmic and cosmological of Saraceno’s propositions. Yet, it is a proposition that troubles the definition of artist and artist’s studio, necessitating that Saraceno look for other models that can sustain his studio’s involvement in these experiments. This is a story that will unfold in years to come.

We need such cosmological propositions to make us attentive to the interdependent processes that sustain Earthly life, and to reveal to us, as Stengers writes, planetary assemblages other than the

ones on which we currently depend. The attunement to air and atmosphere that is at the heart of Tomás Saraceno's practice is significant for this reason: it creates the space of attention that renders particular qualities of atmosphere available to experience and experiment. As a series of techniques that occur neither in subjects nor in the environmental milieu, but unfold in the choreographic relations between bodies, materials, devices and sites, aerosolar practices collapse the spheres of knowing and feeling, epistemology and aesthetics. Like the islands in the sky that have populated fiction since early written history, the *Aerocene* is a dream. But unlike those islands, the *Aerocene* brings a collective dream into contact with everyday practices. To participate in the cosmological experiment of the *Aerocene* is not only to dream, but also, *to be infected by the precarious sense of the possible.*



Interstice VII: Tomás Saraceno
Aerocene Gemini, Free Flight, 2016

Saturday, August 27, 2016: Aerocene Gemini travels 605 km distance, floats over 12 hours, reaches 16.283 m altitude. All without any carbon, fossil fuels, helium, hydrogen, burners, or engines – using only air currents and the heat of the sun. This photograph was selected and downloaded from a live streaming SSDV page as the sculptures were flying over Germany.

Courtesy the artist; Pinksummer contemporary art, Genoa; Tanya Bonakdar Gallery, New York; Andersen's Contemporary, Copenhagen, Esther Schipper, Berlin.
© Photography by Tomás Saraceno, 2016

In Lieu of Conclusion: The Cosmic Flight of the *Aerocene Gemini*

August 27th, 2016. 7am.

52°27'32.4"N 14°03'15.3"E

Schönenfeld, Germany.⁵⁷

Forecast: The current weather forecast looks very good (sunny). The wind speed[s] are not that high, so it might no fly so far.

We can only Do-It-Together (DIT)!

Plot your prediction on this [map](#).

The transmission will include APRS position messages including inside and outside temperatures (the lifting power of the balloon), humidity, and air pressure.

Callsign: DL7AD-11

Frequency: 144.800 MHz AFSK1200

Packets: Low-duty-cycle APRS/SSDV images, Position packets, Log packets, Software error log packets (for debugging)

We run a special SSDV/APRS service which picks up the packets from the APRS-Igates and send them to Habhub.

Callsign: DL7AD-11

Frequency: 144.860 MHz 2GFSK9600

Packets: High-duty-cycle APRS/SSDV images

For decoding we run a specific Perl Script which work together with a TH-D72.

We would be interested in any ideas how to improve an open source solar flight predictor.

All images will be plotted on the SSDV page: <http://ssdv.habhub.org/DL7AD>⁵⁸

Dear Ballooning Friends...⁵⁹

⁵⁷ The message from Studio Saraceno specified: “The location for this launch was selected because it falls outside the air traffic control zone in Berlin, necessary due to local air traffic regulations.” (Studio Saraceno, personal communication, 2016).

⁵⁸ SSDV stands for “Slow Scan Digital Video” and is a digital form of Slow Scan TeleVision. It can be used to transmit small images along with the telemetry data transmitted by an aerostat’s payload during flight. This definition is borrowed from the UK High Altitude Society – “a loose collection of people who are interested in launching unmanned high altitude balloons into near space” ([ukhas.org.uk](http://www.ukhas.org.uk)).

⁵⁹ Excerpts from an email sent from Studio Saraceno on August 26th, 2016 to “friends of the Aerocene”: in the message, people from many disciplines are invited to follow and track the Aerocene Gemini sculpture by accessing web sites and tracking information as it flew from Germany to an unknown location.

A Chase

The *Aerocene Gemini* (Interstice VII) launched into the air around 7:30am, on a brilliantly sunny Saturday morning in Schönfeld, Germany. There was almost no wind. The sculptures floated a dozen meters high, payloads trailing on ropes below. For some time, nothing happened. The two-part body hung there, like a pair of fragile creatures waiting for change, absorbing the sun's eager rays.⁶⁰ “*We are relearning how to float in the air,*” Saraceno said.⁶¹ Then, almost without warning, they caught a draft. A faster current. A line of flight. And they were off, joined together like the ancient twins Castor and Pollux, the *Dioscuri*, half immortal, bodies whose destinies are fatally joined, making their way steadily toward a line of tall trees in the distance.

In lieu of a conclusion: this chapter follows the flight and fate of the *Aerocene Gemini*, tracing a cosmological and aesthetic account of their aerographic journey. As they soar through the stratosphere, the Gemini will inspire some final reflections on aesthetics, art and subjectivity as they inflect geographic notions of scale, the more-than-human and the social. The Gemini will also be imaginative companions for speculating on the cosmicity of creative practices. This account is a mythopoietic account, a written experiment conveying the drama of an unusual atmospheric event. In doing so, this alter-conclusion does not represent the journey of the Gemini as much as collaborate with its retelling as it brings the concerns of this dissertation into a higher current, a common web.

⁶⁰ The best description of the *Aerocene Gemini* launch was offered by Kotryna Šlapšinskaitė, a studio member who was present at the event, and related the details to me later that day.

⁶¹ This comment was made three days later at an evening presentation at Studio Saraceno at which Saraceno, Daniel Schulz, Sven Steudte, Thomas X and Nick Shapiro (Public Lab) presented the innovations and experience of this Aerocene Gemini launch.



Figure 1: Detail of image from: *Marolles, Michel de, Tableaux du Temple des Muses, Paris, 1655, plate 25.*

The plate carries an inscription in Latin from Homer, Odyssey Bk 11, lines 303-4:

One day both Dioscuri live, one day they are both dead.

Photo Warburg Institute.

Courtesy of Warburg Institute.

As studio assistant Kotryna Šlapšinskaitė related to me, the ascent was gentle; *Aerocene Gemini* approached the tall trees, and as the earthbound humans held their breaths, the sculptures barely cleared the treetops, payloads intact (Šlapšinskaitė, personal communication, 2016; Figure 1). Then they disappeared into blue sky, dissolving into two particles whose presence had been so palpably felt an hour earlier as two membranous bodies hanging motionless over the field, shifting the texture of space-time; two delicate creatures sharing a common filamentary web; two aerosols attracting the assembly of practitioners, technologies, cascades, predictions and hopes in those particular cosmic conditions.

The chase began. A sense of excitement, of thrill, of adventure and equally, of suspense and trepidation. The *Dioscuri* were no longer immediately sensible, yet they communicated vital signs: they transmitted GPS location data, and readings of temperature, pressure and humidity inside and outside the

membranes. They captured and forwarded images of the view from their lofty aerial position to a live website where grounded practitioners could follow along. I was one of these grounded practitioners, constantly refreshing the SSDV website for new images. In this way my sensory realm was cosmologically extended: it was lured toward pulses of information from those distant, airborne twins, twins whose capacity to pulse such information depended on the ecology of practices that had unfolded at Studio Saraceno and on the morning field. This ecology of practices was structured by legal frameworks: it had been organized to meet the guidelines of weight restriction for an aerostatic object launched in the airspace over Germany.⁶² For Tomás Saraceno, the chase team, and many other distant witnesses, *Aerocene Gemini* became a tiny red icon of a balloon on a map of continental Europe (Figure 2). Yet the conjoined sculptures were not reducible to the icon, since they continued to engender affective atmospheres, imaginative journeys, geopolitical questions, and conversations played out in breathless proximity in the swelter of a hot summer day.

⁶² Both Sven Steudte and Thomas Krahn are practiced at the art of launching and chasing balloons via APRS radio transmitters. Indeed there is quite a community of people who do this. It is legal to launch aerostats of a certain weight profile, and even to let them fly with no intention of finding them. However over a certain threshold, the aerostats must be equipped with more advanced transmitters (transponders) and be certified under different insurance schemes.

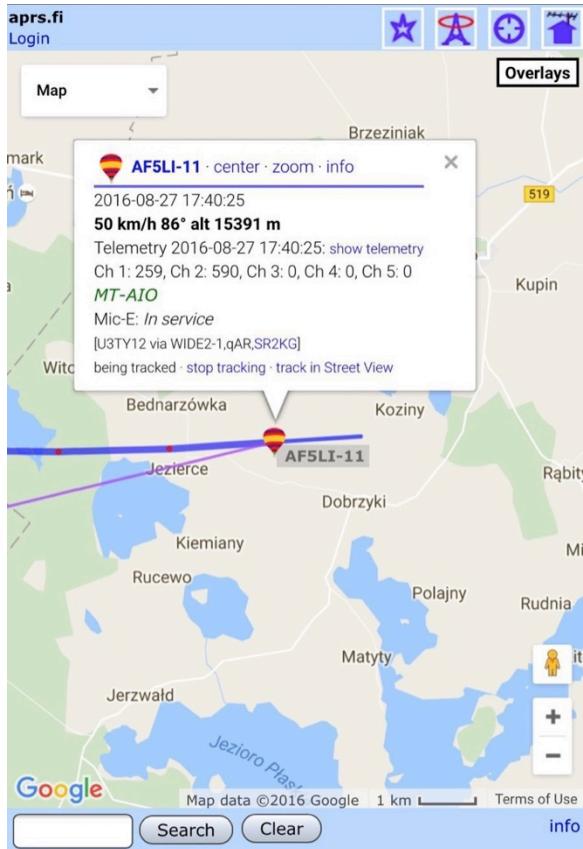


Figure 2: Map of the position of the *Aerocene Gemini* sculpture at 5:40pm at an altitude of 15,391 meters.

Tomás Saraceno. *Aerocene Gemini*, Free Flight, 2016

Courtesy the artist; Pinksummer contemporary art, Genoa; Tanya Bonakdar Gallery, New York;

Andersen's Contemporary, Copenhagen, Esther Schipper, Berlin.

© Photography by Tomás Saraceno, 2016

Aerocene Gemini reached over 16,000 meters in altitude. The twins crossed the border of Germany to Poland, having caught a strong Southwesterly wind. At this point, the images loading on the SSDV page were either neon rectangles, or impossibly granular. I later learned that this was not due to altitude or distance, simply to “software error” (Krahn, personal communication, 2016). Where were they going? What were they seeing? Where would they land? Questions surfaced. Sensations of nervousness and worry intensified, caught up in that small red icon, hovering across the map. Was the flight too ambitious? Would the Gemini cross the border to Lithuania, perhaps even Russia? The regulations governing aerostatic flights over Russia were not known. Would there be consequences of the *Aerocene Gemini* crossing the border?

The Lost Twins

A hopeful morning became a worried evening. The sun had set, therefore the sculptures were surely earthbound in Poland. But the signal was lost. It had faded altogether. The chase team still traversed the dark forests and great lakes of Poland near the province of Augustów. It was likely at that point that the sculptures had fallen into water, irretrievable. The chasers tried desperately to pick up the signal. A chance reception was the last remaining hope.

The far away searching for the sense of the sculpture, the search for a signal pulsing weakly through pine, landform, track, herds of elk, stream, stone and fog, was relayed to those in Berlin via sporadic texts and calls. Bodies formed postures that curled into themselves, or slumped into grass. Attempts to distract, to refocus, to worry a little less. Yet the habit of fixing on the little red balloon on the map, where it had last been sounded. All of this punctuated by animated retellings and glossed-over eyes, imparting how the sculptures had lifted into the air, and the way they had hung, spectre-like, there, until the wind, as in myth, had carried them away.

Many things are lost. Many things find an upward draft out of the lives of creatures and never return again. But there is something particular about the loss of an entity that has woven so tightly into ecologies of practice that enable such adventures in sensing: sensing that engenders investments between humans, nonhumans and airy matter. These are ecologies of practice that inspire collective attachments as powerfully as they invoke collective dreams of how the world and its inhabitants might become. The loss of an entity that is not an entity at all, but a gravitational attractor, a filamentary web, or a more-than-technical device, is a loss that shakes at the filaments of worlds.

The fates of the Gemini were lost in more ways than one. Scholars attest that the destinies of Castor and Pollux were recounted in the *Cypria*, an ancient poem that preceded the *Iliad*, but has long been lost. It is rumoured that one of the *Dioscuri* was mortal, the other immortal; and that upon Castor's fatal injury, Pollux offered him half his immortality, so that they could remain together, sharing their time between Elysium and Hades. In Homer's *Odyssey* is the following line: *One day both Dioscuri*

live, one day they are both dead (Homer cited in Morelle, 1655: 25). In any affair, and in death itself, the Gemini are bonded: two bodies matching their ascent in cosmic adventures with wind and sun.

Circa 11:50pm: a signal emerges. Krell and Krahn hear the sculpture on a hand-held radio receiver. They know they are within 3km. They drive down pitch-dark roads. The signal recedes; they retrace their steps. They turn down another road and the signal grows louder.

Circa 1:18am: the Gemini are found. Krahn had exited the van with the radio antenna, and soon spotted the membrane, slumped over a bush in a field.

This news sparks collective elation. Calls and texts fly among phones at 2am. Some feel intense relief, others pride, and others celebrate into the night. The sculpture is returned via car to Berlin, where it is unfolded at Studio Saraceno. Videos and data are downloaded. Damage is checked. One tiny sensor fell off – probably somewhere over Poland. A few days later, a gathering is called for all friends of the *Aerocene* to hear a presentation of the event. A dozen enthusiasts and friends, in addition to many members of the studio, attend.

Nick Shapiro, a temporary studio resident and collaborator, has brought his expertise on DIY engineering and open-source licensing to the *Aerocene* project. Shapiro says his work aims to “re-enchant devices” to allow non-academics to “creatively render” answers and evidence in their environments (Shapiro, personal communication, 2016). Following this, Sven Steudte and Thomas Krahn present the APRS radio transmitters and camera-boards they invented for the *Aerocene Gemini*. Saraceno interjects often with comments and suggestions. Then Saraceno makes a short presentation of his own. Instead of highlighting the spectacular videos taken from the sculptures in the stratosphere, he speeds through dozens of images showing the long drive to the launch site, the unloading of cars, membranes spread on the field, many smiling faces in various crooked poses, a sunny afternoon at the lake, and a scene of waiting in his apartment, among others. He presents the social-affective texture of the experiment: an equal part of the achievement. *What we are really doing here*, Saraceno says, is *relearning how to float in the air*.

We are (re)learning how to float in the air. Just like the phrase, *You are all vibrating in the same web*, with which this dissertation began, this statement is simple and enigmatic. It is strange and alluring. It begs the question: when did “we” ever float? Perhaps as other forms of life, as bacterial, spore-like, metozoan or amphibian creatures? Saraceno implies that we have lost a collective sense of buoyancy, one that we can re-learn by engaging in atmospheric experiments. And in re-learning this skill, this trait that fell away, we can float ourselves into more alluring futures. The directness of the statement – and the all-encompassing “we” – echoes the tenor of *You are all / vibrating in the same web*. Together, these two statements manifest part of what is so compelling about Saraceno’s practice for geographical thought and experiment, and more broadly, why ecologies of practice reaching for the edges of earthly and cosmic experience are aesthetically, ethically and politically radical. Although they are communicated in words, these poetic statements presuppose nonverbal, nonhuman qualities: web-dwelling and floating. They are enunciations that are not irreducibly human; they emanate from a place beyond human, nonhuman and inorganic distinctions. In light of this, the collective practices of vibrating in the same web, or relearning how to float in the air, are practices founded on sensory extension and amplification that do not remove hierarchy or difference as much as vibrate the threads and interstices among modes of being and becoming. Such sensory extension is ethical in its production of empathy (embodied and otherwise). And it is political in its conjuring of collectives and territories coalescing around the transmission of atmospheric sensing: so many vibrating threads.

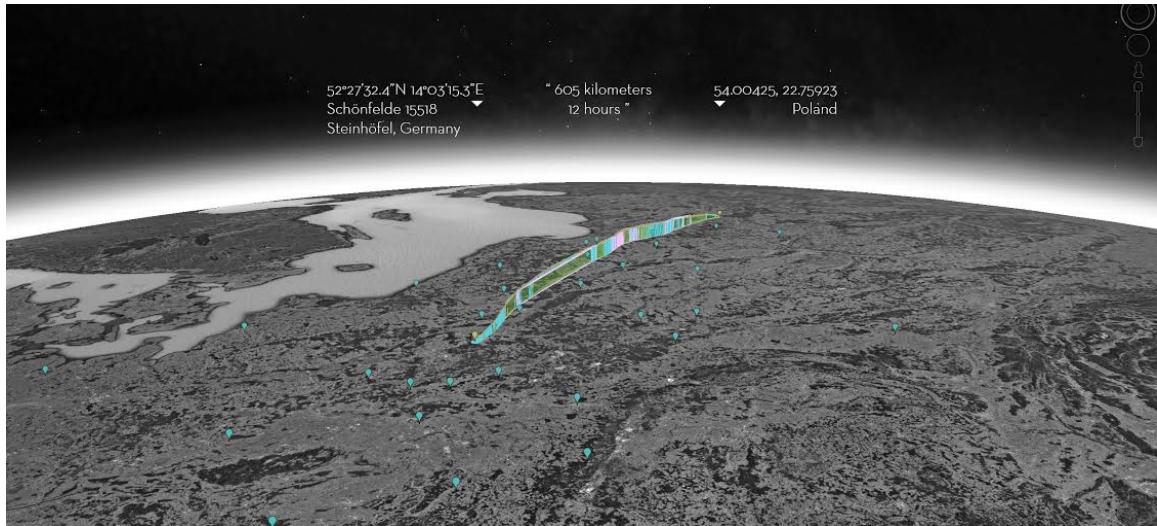


Figure 3: *Aerocene Gemini* flight path. Tomás Saraceno. *Aerocene Gemini*, Free Flight, 2016
 Courtesy the artist; Pinksummer contemporary art, Genoa; Tanya Bonakdar Gallery, New York;
 Andersen's Contemporary, Copenhagen; Esther Schipper, Berlin.
 © Image by Tomás Saraceno, 2016

Art Ruptures

Cosmological aesthetics resonates in the hand-held radio antenna, poised to receive a signal emanating through the thick darkness of the Polish night. Equally it is found in the rough packets of temperature, pressure and image-data transmitting over vast expanses of horizon, atmosphere and landscape in zeros and ones (see Figure 1). And it is also found in the sleepy, strained, and sunburnt bodies of those who launched the sculpture at 7am on a field in Schönfeld, and waited all day for more news of its journey. It exists in all of these places at once because the sounds of the hand-held antenna, the flows of visual data, and the strains in the muscles of practitioners manifest the transmission and distribution of sense and sensing across spaces and scales, from a field in Germany to the stratosphere (Figure 3), yet bound together in an ecology of practices by a common imaginative lure. A lure that is partly localized in the *Aerocene Gemini* sculptures, but traveling far beyond them, in a body of atmospheric adventures that inspire different stances to matter, energy and environment. Cosmological aesthetics accounts for the role of art and imagination in compelling such adventures in sensing: art is a cosmic force that lures and compels such unlikely ensembles of practitioners, devices and media.

In doing so, art is a force of rupture and a site where subjectivities emerge and change. As aerodynamic aeromobility reaches astounding levels of growth, and the market for drone technology (both military and recreational) explodes, the launch of an aerostatic, solar-powered object, and the level of investment and commitment it fosters, is a glitch in the interface of the present. Art also ruptures the space-times, scales and social spheres of those invested in the project: compelling strange sleeping hours (e.g. working towards a launch at dawn), enlarging scales of thinking and experiment (e.g. how to track an entity with GPS over an altitude of 10,000 meters?), and producing novel social arrangements (e.g. the congregation of bodies, devices and materials around a delicate, lively membrane). To be sure, other forces also compel these arrangements: forces of economy, profession, friendship, activism, research, thrill, duty, status, obligation, risk and love. However, the imaginative urgency, cosmicity and refrain of the practices discussed in these pages necessitate that we account for the force of art.

Throughout this dissertation I have repeated Guattari's assertion that art creates ruptures, that it generates specific assemblages that present possibilities and potentials in contrast to the assemblages we find all around us (Guattari, 1992/1995). Guattari would likely add that both art and processes of subjectivization become modes of accessing different speeds and velocities of feeling, thinking and becoming. To reprise the last empirical chapter: "the earth [must be] taken into account as a set of interdependent processes, capable of assemblages that are very different from the ones on which we depend" (Stengers, 2011: 163). The role of art as a rupture from current extractive and fuel-burning assemblages, and a window onto different, inventive assemblages of material collaboration on Earth is, as many have argued, a key to our very survival on this planet (Guattari, 1992/1995; O'Sullivan, 2010). The ruptures created by the launch of an aerosolar sculpture blossom (or fold) into alternative geographic and cosmic subjectivities.

In the spirit of Stengers' definition of a new concept, cosmological aesthetics contributes to how we experience the *Aerocene Gemini*'s launch. Rather than an achievement in buoyancy and measurement, the launch is a feat of imagination and sensing. This difference matters. It matters because the feat of buoyancy taps into a latent well of poetic reverberation, dynamism, cosmicity, and

imagination. This confluence breathes into different modes of being, and into different dreams of the future. Likewise, the *Aerocene Gemini* does not measure the atmosphere. The sculpture participates in a collective sensing that includes numerous “technical” readings but also, and equally, the data passing and digesting through bodies as the sculpture is launched, tracked, chased, sounded, and rediscovered as an echo on a radio antenna in the night.

Birch Seeds

On August 27th, in the forests of Mostówka, Poland, Dr. Bronislaw Szerszynski was experimenting with some birch seeds (Figure 4). He had collected many over the course of the summer, which he spent, as usual, in a drafty family house, a house I had visited the summer before. This summer, he had invented a series of aerial experiments with the seeds: “They incidentally are a brilliant device... for revealing all the aerial eddies around the house and grounds. One just flew over our water pump and followed the tiny bound vortex leeward of the handle. A very elegant move too” (Szerszynski, personal communication, 2016).



Figure 4: Birch Seeds from the forest of Mostówka. Courtesy of Bronislaw Szerszynski.
Photography by Bronislaw Szerszynski, 2016

As this seed followed the vortex in the eddies of the forest, were the *Aerocene Gemini* passing overhead, following so many other vortices and eddies (*an elegant move too*)? Were the birch seeds and Gemini engaging in the same turbulence, resistance, and the same thermodynamic system? It is impossible to know. But here is another salient speculation: can we think of the *Aerocene Gemini* and the *Birch Seeds* in the same web of relations, one that does not produce hierarchies in space or scale, but zones of proximity and synthesis?

On August 27th, Szerszynski was also following the *Aerocene Gemini*, watching the data and the SSDV image-stream as it passed over Poland and sailed to the North. Like those of us in Germany, he was extending himself cosmologically through the airborne sculpture and the practices and imaginaries enfolded within it, practices and imaginaries of which he was familiar. Indeed, Szerszynski's participation in an aerosolar sculpture workshop at the IAK, TU Braunschweig in November 2014 had

inspired a draft paper we wrote together about “elemental dwelling” and aerosolar practices (see Szerszynski and Engelmann, 2015). Whether or not the flight of a *Birch Seed* was contiguous with that of the *Aerocene Gemini* is less likely and less relevant than the notion that the aerosolar experiments in which Szerszynski and I participated inspired attentions and attunements to atmosphere that rippled in various ways in our respective lives and projects. It rippled in the presentations we gave at various conferences, in the “Dust Séance” we performed at the Haus der Kulturen der Welt with Tomás Saraceno, in research questions and conversations with many other people, and in aerial experiments with birch seeds in the forests of Mostówka.

Such ripples of attentiveness –or shifts in atmospheric subjectivity – are aesthetically, ethically and politically important. They shift frames of reference, discipline, labor and invention. They bring the textures of the world to the forefront of scholarship. They propose forms of observation that are ethical in their stance to the patternings of media, materials and phenomena. They convey notions of sense and sensation that are not irreducibly human, nor even within the thresholds of human awareness. These modes of attention and attunement gather publics and polities. Ultimately, the very possibility to tell a story of a balloon and a birch seed in relation to a novel investment in atmosphere implies the web of proximity and synthesis in which they are both entwined.

A Hand to a Photon to the Stratosphere

In telling the story of *Aerocene Gemini*, I need surfaces, webs, envelopes and interstices. In between each of the chapters in this dissertation lies an “interstice” that explores an alternative method in grasping the aesthetics of forms. For example, the second interstice – a drawing of an artwork becoming the Cosmic Microwave Background – expresses an experiment with storytelling that uses a flexible membrane and envelope as protagonist. Another instance of methodological innovation is found in the experiment of cutting and collectively reading *Art in the Anthropocene; Encounters Among Aesthetics, Politics, Environments and Epistemologies* reflected in Interstice V. The violence enacted on the form of the book becomes a way to collectively invent a new form: a poem born of the book and the

apprehensions of two hundred collaborating minds (the full poem is found in Appendix I). In Interstice VI: a transcription of a meeting during which Tomás Saraceno, Jol Thomson, Bronislaw Szerszynski, geographer-artist Trevor Paglen and I outlined the architecture of an Open Space Agency. Each of the Interstices employs different techniques of drawing, diagramming, storytelling, speculating and mediating to experiment with the “energy of the sense-catching” force of forms (Thrift, 2008: 9).

As I have contributed throughout this dissertation, an attention to the patterns and propagations of forms as technologies of cosmo-aesthetic adventures has consequences for notions of scale, the more-than-human, and the social. In particular, the patterning (e.g. hybrid webs) and movements (e.g. architectonic folds) of forms (like surfaces, webs, envelopes and interstices) can render us more sensitive to relations between scalar registers. In the case of webs, for example, the disjunctive synthesis between species-specific projections and those of our own cosmos operates transversal to scales: it highlights emergent qualities that are irreducible to dimension, material, or function. Exploring the ways that forms propagate through materials and bodies does not do away with scale, but attends to the interstices of scalar concepts as relevant for attention, invention and narrative.

In performances such as that of the *Aerocene Gemini*, where do we locate the human and nonhuman, the alien and the cosmic? Is the human found in the frame and muscle of the human body as she bends and stretches the Gemini sculpture, hands smoothing ripples from the warm membrane-surface, readying it for launch? Or is the human in the layers of DIY technologies, tied to the sculpture for the purposes of seeing and sensing further than the first human body could? Or is there a third sense of the human here: the artist, who imagines dream-like worlds that form in the skies, and fashions sculptures that communicate this vision to others? Each of these examples are expressions and modalities of the human. But each of these human figures are fundamentally dependent on other matters, participants and collaborators. The human is extended through the ripples, the data-pulses, the atmospheres and the creativities of myriad earthly and cosmic conspirators.

In light of this, what is more-than-human? Is it an “ecology of selves,” as Eduardo Kohn (2013) writes: selves that use different semiotic modes and signals to flourish with and beyond the

human? Or does this term refer to the excesses of life escaping human awareness: to the vastly underestimated life in the air, in the oceans, and in holes in the ground? In the webs here traversed, and the stories retold, the notion of the more-than-human assumes a more promiscuous definition than is often employed in geography. The more-than-human, in the case of the *Aerocene Gemini*, refers to collectives, to universes, bound together by specific practices, obligations and lures. And it refers to the conditions, forces, and fields that enter into the practices of these collectives. In this dissertation, I have engaged not only with charismatic or monstrous creatures. I have also practiced with the qualities of photons cascading into envelopes and air masses, sensible in their traces, accumulations and decays; with filaments of dark matter that make themselves felt in the space between a spider and the cosmos. This dissertation does not promote an understanding of the human as opposed to such forces and fields, creatures and collectives, but as exuberantly extending through them and with them.



Figure 5: Tomás Saraceno. *Aerocene Gemini*, Free Flight, 2016
Courtesy the artist; Pinksummer contemporary art, Genoa; Tanya Bonakdar Gallery, New York;
Andersen's Contemporary, Copenhagen, Esther Schipper, Berlin.
© Photography by Tomás Saraceno, 2016

In the spirit of holding to such conspirators and collectives, one thematic that has circulated throughout this thesis concerns the social. Can a concept of the social become adequate to irreducible differences: to the ‘Either... or... or,’ (Deleuze and Guattari, 1991/1994: 76)? Can we envision a sociality that is not founded on likeness and similarity, but on distinct contributions to a cosmological experiment, to a collective territory of enunciation? For the *Aerocene Gemini* as for the other encounters in this thesis, the social is a quality of tension, of refraction and disjunction, of holding together without dissolving into another entity’s terms. It is manifest in the methodological challenge of “working knowledges together”. It is performed in the divergent practices that gather for an aerosolar launch, and in the disjunctive synthesis of species-specific spacetimes. However, in fidelity to the philosophy of Whitehead that underpins the arguments throughout this dissertation, the social is not something one can take for granted. Whitehead’s philosophy urges us to be careful that when we develop a notion of the social, or make a social explanation, we assume nothing in advance. To do so would be to mistakenly assume the existence of an abstraction, in the process missing the concreteness and frictions on which any abstraction must always rely. To paraphrase Whitehead, sociality presupposes experience, not the other way around (Whitehead, 1978[1929]).

Here we might reprise one of the primary questions with which this dissertation began: What would the social look like and feel like if wove through a sense of the cosmological? How might it operate in this way, transversal to scale, species and particular social spheres? Here it is fruitful to turn to the experience and story on which this chapter is founded. Perhaps it would look like a pair of fragile, airborne bodies on an upward ascent with the Sun at their backs and the wind flowing with them. These bodies are social not because there are two of them (Figure 5). They are social because they have entered and become the wind, feeling no ripples or tears in their membranes, rotating in perfect symmetry and stillness as they sail over kilometers of Earth’s surface. Such is the disjunctive synthesis (the Either... or... or...) of stillness in motion. But they are also social because however high they drift, they are inseparable from an ecology of practices animated by the unique investments of practitioners, technologies, materials and media. Indeed, they actively participate in this ecology of practices as they

fly. They are participants in a cosmological experiment in sensitivity and attunement to atmosphere and cosmos. In this experiment, the social is not a privilege of the human but pertains to the “really real” (Whitehead, 1978[1929]) cosmological quality of holding together across spaces, species and scales: from a hand to a photon to the stratosphere.

Shaviro writes: “Any theory of beauty is always inadequate to its examples” (Shaviro, 2002: 19). Likewise, any theory of aesthetics is inadequate to the experiments described here. Both Whitehead and Stengers would assert that it should be so. A theory or concept should not fit experience to its dimensions; rather it should emerge from and activate experience, going abroad in the world. There is a difficulty here; it is the same difficulty as that of the definition of art. Aesthetics, for Whitehead and for cosmological aesthetics, emerges freely and spontaneously in lures, vibrations, spatio-temporal fields, movements and prehensions. It cannot be explained away. Art, for Deleuze and Guattari and for this dissertation, is not the province of the artist, or even the human. Aesthetics is attached to art and artistry insofar as art is understood broadly, as the modulation of sensation, the power to lure and to move, and the creation of ruptures or glitches in the texture of the present. Given these conditions, it is impossible to define art or aesthetics. We can only observe and articulate the “expanding territories” of art and aesthetics “wherever they might be encountered” (Zagala, 2002: 36). We can only become sensitive to the pulses of information, of warmth and vibration, of echo and frequency, and the subjectivities and futures they enlarge. To do only this is no small task. It is to account for the spectacular patterns and formings of art and aesthetics, lures and sensibilities, as they compel sensual and imaginative extensions to worlds at the fringes of our own.

The Lure of a Geographical Humanities

The journey of the *Aerocene Gemini* is a geographical journey insofar as it recalls the history of aerostatic excursions for the purpose of geographical exploration, especially those that extend further than they expected (McCormack, 2008). It is also a geographical journey insofar as *aerographies* have become a disciplinary concern (Jackson and Fannin, 2011; Olwig, 2011). In a third sense, the *Aerocene*

Gemini are ideal companions to think-with in this dissertation's conclusion because they exemplify the interstices of geography and the arts, ones that I aim to elaborate here.

Each of the four empirical chapters of this dissertation has explored ecologies of practice that shift notions of aesthetics, scale, the more-than-human, and the social. It is important to emphasize that not all ecologies of practice have such consequences. Some are sticky and infectious, resilient and compelling, and likely to resonate in silhouettes and dreams, while others do not. Some ecologies of practice mobilize the imagination and art as a cosmic force that obligates practitioners to each other and to nonhumans, materials and technologies, in the same way that other cosmic forces give a spider web its orientation, or dance a photon around quercetin in a leaf. For this dissertation, as for Saraceno, the power of art as a force that compels, attracts, radiates and lures is a fact animating the invention of practices that have cosmological scope.

The intersection of geography and art is one space where such ecologies of practice might be recognized and cultivated – and one space where cosmological aesthetics might be put into practice. One term we might use for the syntheses of geography and the arts is *GeoHumanities*. This is a term elaborated in the launch of the new *GeoHumanities Journal* co-edited by Tim Cresswell and Deborah Dixon. Harriet Hawkins and Phil Crang also invoke it in their establishment of a new Center for GeoHumanities at Royal Holloway University in London. I interpret this term in the following way: as describing the particular intellectual spaces opened by joint ventures in geographical and artistic research, spaces that cultivate ecologies of practice motivating alternative dispositions toward environment, atmosphere and energy. Such a statement recalls Meinig's assertions on the stakes of a humanistic geography. As I elaborated earlier, the doing of art together with geography would have consequences not only for the disciplinary framings of geography and the arts; such work would trouble ingrained relations between practitioners and environments, and the myriad tacit orientations and habits caught up in them.

If such a definition were to be actualized, students of GeoHumanities would be trained not only in critique and ethnography, analysis and argument, but also in filmmaking, drawing, diagramming and

sound. They would be encouraged to write poems, choreograph concepts, socialize sculpture, and produce diverse kinds of media. They would meet with artists and artist-geographers. But more important than having training in creative techniques, such scholars would be skilled in recognizing the poetic reverberation and cosmicity of practices – the stuff of obsessions, dreams, silhouettes, and stories. They would be trained in sensing cosmicity like dancers sense a great rhythm (Henriques, 2010). The GeoHumanities would therefore become an intellectual site for recognizing those “expanding territories” of art and aesthetics “wherever they might be encountered” (Zagala, 2002: 36). And as such, the GeoHumanities could become a space in which such territories are invented and mobilized, traveling far beyond the geographic academy or institutionalized art.

A discipline of GeoHumanities would participate in the development of research imaginaries and ethnographies that do not reproduce the “double edged” habits of thought that place the human sensory apparatus at the center of analysis. On this, Eduardo Kohn writes the following:

As we learn to attend ethnographically to that which lies beyond the human, certain strange phenomena suddenly come to the fore, and these strange phenomena amplify, and in the process come to exemplify, some of the general properties of the world in which we live. If through this form of analysis we can find ways to further amplify these phenomena, we can then cultivate them as concepts and mobilize them as tools. (Kohn, 2013: 22)

We must move from aesthetics to concepts, from amplification to exemplification. Encouraged and emboldened by such an account, and Whitehead’s pragmatic philosophy, practitioners of the GeoHumanities would be sensitive to the amplifications, perturbations (Ash, 2013) and vibrations of “strange phenomena”. Such attunements might lead, as Kohn suggests, to an ability to participate in the amplifications themselves. And in doing so, such projects would answer Whitehead’s call to invent techniques, practices, methods and experiments that allow new abstractions to announce themselves: abstractions that are generous to the living, the material and the physical, and also muster full, yet critical accounts of the contemporary world.

This dissertation has emerged from an ethnography, it has proposed an aesthetics, and in the ethos of the web we have woven, it ends with a lure. This is the lure of a humanistic geography that attunes with art's cosmic force to attract, to move and to rupture. It does not instrumentalize art; such an approach is incompatible with the ways in which art and aesthetics shimmer across assemblages and territories. Rather, a humanistic geography, or GeoHumanities, nurtures the kinds of experiments that form symphonies with spiders, and make myths of the atmospheric, the solar, the dark and the cosmic. In resonance with art, this geography is decadent, one in which the performance and presentation of an idea is as important as its conception. And in the move, or the spindly-legged steps, toward this humanistic and geographic lure, cosmological aesthetics shimmers, "at points, on the edges, and under glimmerings which never have the uniformity of a natural light"...

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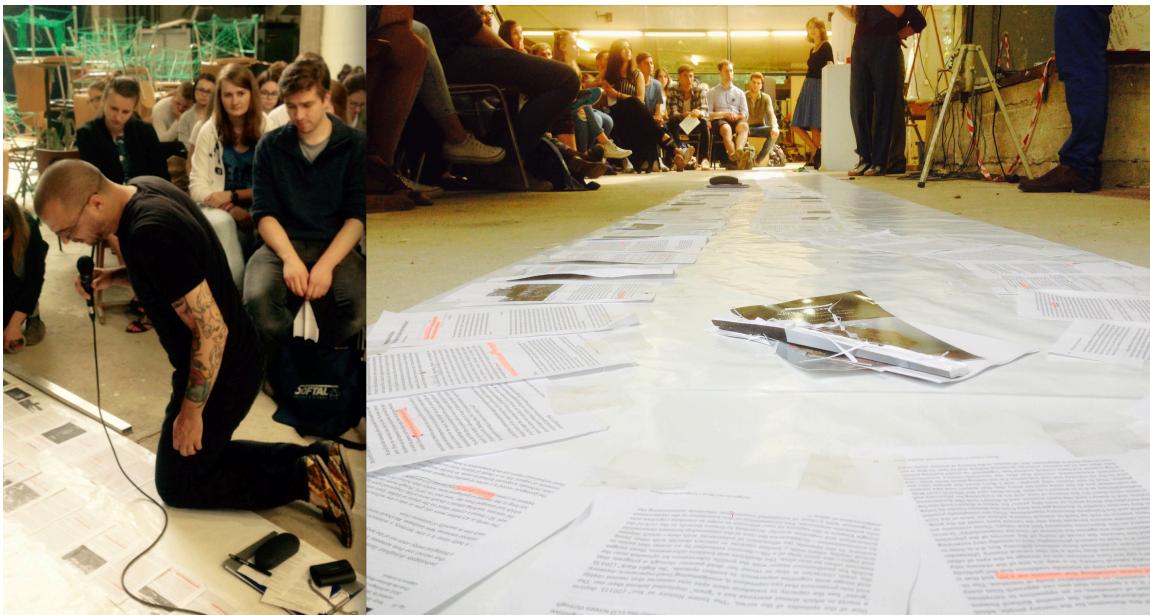
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Appendix I

A Reading of *Art in the Anthropocene*: an experiment in social intelligence initiated by Tomás Saraceno.
Performance by Etienne Turpin with Anna-Sophie Springer, Tomás Saraceno, Sasha Engelmann, Jol Thomson and the students of the Institut für Architekturbezogene Kunst (Braunschweig, Germany)

Instruction:

1. obtain a printed matter copy of *Art in the Anthropocene* and a razor blade.
2. cut the book into pieces with the blade & disseminate the book to a group of readers.
3. search the pages you receive to find meaningful turns of phrase, conceptual affinities, or words that are important to you.
4. in random order, read the found passages or words out loud, with the group repeating each phrase together.
5. paste the pages in the order of their reading on the floor. once you have read.
6. once completed, the text will be read aloud again by an elected member as the statement of the group.



Outcome:

The sky is bright blue
as long as there is life there is hope
images and texts—both written and spoken
too early is too late
we centralize and organize the flows of energy
black plastic balls
& why does it create such generalized panic if they can't figure out the cause?
You start writing because you exist only in the phrase
public smog is public atmosphere
reanimating dead objects
science is not about an abstract idea of data

the permanent decolonization of thought
the first man-made disaster
the challenge of addressing how we are to live with our own impact
flooding is a geologic event
coming face to face with tigers; in the town there are tigers which can assume a human form
we have become tourists in a waste wilderness
all at once
by connecting objects and subjects
(that is basically true)
a luxury we cannot afford—the Anthropocene—by this definition, is the era of colonial genocide
urban space is the product of conflict
of the citizens of Earth in human and nonhuman forms
the object affords what it does because it is what it is
art is not merely a conservation of *what we were*
on the ground?
in the air?
Singapore is synonymous with excess and artifice
the Anthropocene is a way of framing time
to remain attentive to the continuously shifting boundaries of clouds
bags fluttering in the wind
you meet a strange forest in the middle of an old apartment complex
it is the act of preparing to live in an unknowable future
learn to see
nurdles easily escape the corporate borders of the plastic empire
plastisphere insects are key players
invisible operations are made situationally present
so we believe it can be seen
Where is Kathleen?
head up and down in a fixed position
what might be a wonderful figure in one context might not work
the whole idea behind synthetic biology is that we look at living things through
the eyes of an engineer
sense is made by constructing the ocean as a mythological space
a void between us and history
all power to the imagination
too many things changed and you are lost in your memory
I'm interested in airplane crashes and nuclear weapons
we still do it
but who is this *Man*?
my mother's garden was a space where we could talk
the plastic future would be shiny and bright
we prefer not to be told
first of all
fuck all y'all
mountains can be like clouds

we are back
triangle of truth
travel mentally
the world is all, that is the case
the study of science is of course something that interests me a lot

rapid modifications of the receptive fields of the visual cortex
a person can form
we are not free as we like to think but lost
the resonances between image-making organisms
there is no harmony in the universe
submit to the Earth's atmosphere
it is here that art enters the equation
ice crystals in the sky
of critical art
inspired by the Ishihara color test
promised to speak back, reshape, and change
fresh water from the Athabasca River is used to boil the black sediment
development always generates more development
rhythms of non-human and human matter
the ocean has turned into plastic soup
excess death caused by plastic pollution
compost is so hot
far from any continent
sterile lands are turned into field labs
of which she is a part
in a way, I've been trying to figure out this spectrum—
P-plastoceptors are named after their physical appearance
you encounter a tree that took root in a collapsed wall
we must finally break free of the logic of plastic because
the sense of nature is changing.