# TRANSMATERIALITIES

## Trans*/Matter/Realities and Queer Political Imaginings

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Lightning is a reaching toward, an arcing dis/juncture, a striking response to charged yearnings.[1]

A dark sky. Deep darkness, without a glimmer of light to settle the eye. Out of the blue, tenuous electrical sketches scribbled with liquid light appear/disappear faster than the human eye can detect. Flashes of potential, hints of possible lines of connection alight now and again. Desire builds, as the air crackles with anticipation. Lightning bolts are born of such charged yearnings. Branching expressions of prolonged longing, barely visible filamentary gestures, disjointed tentative luminous doodlings—each faint excitation of this desiring field is a contingent and suggestive inkling of the light show yet to come. No continuous path from sky to ground can satisfy its wild imaginings, its insistence on experimenting with different possible ways to connect, playing at all matter of errant wanderings in a virtual exploration of diverse forms of coupling and dis/connected alliance. Against a dark sky it is possible to catch glimmers of the wild energetics of indeterminacies in action.

Like lightning, this article is an exploration of charged yearnings and the sparking of new imaginaries. It is an experimental article about matter's experimental nature—its propensity to test out every un/imaginable path, every im/possibility. Matter is promiscuous and inventive in its agential wanderings: one might even dare say, imaginative. Imaginings, at least in the scientific imagination, are clearly material. Like lightning, they entail a process involving electrical potential buildup and flows of charged particles: neurons transmitting electrochemical signals across synaptic gaps and through ion channels that spark awareness in our

*GLQ* 21:2–3
DOI 10.1215/10642684-2843239

brains. This is not to suggest that imagination is merely an individual subjective experience, nor a unique capacity of the human mind. Nor is it to rely soley on a scientific imaginary of what matter is, nor a materialism that would elide questions of labor. Nor is the point to merely insist on an accounting of the material conditions of possibility for imagining, though this is surely important. Rather, what is at issue here is the nature of matter and its agential capacities for imaginative, desiring, and affectively charged forms of bodily engagements. This article explores the materiality of imagining together with the imaginative capacities of materiality—although it does so less by linear argumentation than by the zigzagged dis/continuous musings of lightning. Electrical energy runs through disparate topics in what follows: lightning, primordial ooze, frogs, Frankenstein, trans rage, queer self-birthing, the quantum vacuum, virtual particles, queer touching, bioelectricity, Franken-frogs, monstrous re/generations.

This is an experimental piece with a political investment in creating new political imaginaries and new understandings of imagining in its materiality. Not imaginaries of some future or elsewhere to arrive at or be achieved as a political goal but, rather, imaginaries with material existences in the thick now of the present—imaginaries that are attuned to the condensations of past and future condensed into each moment; imaginaries that entail superpositions of many beings and times, multiple im/possibilities that coexist and are iteratively intra-actively reconfigured; imaginaries that are material explorations of the mutual indeterminacies of being and time.[2]

## Electrifying Origins/Flashes of Things to Come

"During this short voyage I saw the lightning playing on the summit
of Mont Blanc in the most beautiful figures."
—Mary Shelley, *Frankenstein*

Lightning is an energizing play of a desiring field. Its tortuous path is an enlivening exploration of possible connections. Not a trail from the heavens to the ground but an electrifying yearning for connection that precedes this and that, here and there, now and then.[3]

Lightning is a striking phenomenon. It jolts our memories, flashing images on the retina of our mind's eye. Lightning arouses a sense of the primordial, enlivening questions of origin and materialization. It conjures haunting cultural images of the summoning of life through its energizing effects, perhaps most memorable in the classic films *Der Golem* (1920) and *Frankenstein* (1931). And it brings to mind

credible (if not uncontroversial) scientific explanations of the electrifying origins of life: nature's fury shocking primordial ooze to life, an energizing jump start. Lightning, it seems, has always danced on the razor's edge between science and imagination.

Working with his mentor, the Nobel laureate Harold Urey, in 1953, the chemist Stanley Miller began a series of experiments that would lend support to Alexander Oparin and J. S. B. Haldane's hypothesis that primitive conditions on earth would be favorable for the production of organic molecules (the basis for the evolution of life) out of inorganic ones.[4] Miller used a sparking device to mimic lightning, a crucial ingredient in this genesis story. Filling a flask with water, methane, ammonia, and hydrogen, Miller sent electrical currents through the mixture. Analyzing the resulting soup of chemicals, he found the evidence that he was looking for: "a brown broth rich in amino acids, the building blocks of proteins."[5] "It was as if they were waiting to be bidden into existence. Suddenly the origin of life looked easy."[6]

Marking the beginning of experimental research into the origins of life, the Miller-Urey experiment did not seal the deal, but it was powerfully evocative of what might (yet) have been. The theory of the electrical origins of life—inorganic matter shocked into life's organic building blocks by an electrifying energy (whose own animacy seems to belie the alleged lifelessness of so-called inanimate matter)—is a controversial piece of science that created a fair amount of heat during Miller's lifetime. But no matter how many times skeptics claim to have put it to rest, it continues to be revived.

Miller's latest experiment was completed in 2008. He was dead by then. The experiment had begun fifty-five years earlier. Miller's intellectual offspring discovered, after his death, that he had not analyzed all his data. Opening the well-marked vials that lay dormant for decades, the researchers performed the analysis. They were shocked and delighted to be able to draw a significantly more compelling result from a once-dead experiment that would breathe new life into the theory: Miller's data revealed not five but twenty-three amino acids!

Characterizing Miller's experimental apparatus as a "Frankensteinesque contraption of glass bulbs," *Scientific American* completes the electrical circuit of cultural associations.[7]

Shocking brute matter to life. What makes us think that matter is lifeless to begin with?

Lightning mucks with origins. Lightning is a lively play of in/determinacy, troubling matters of self and other, past and future, life and death. It electrifies our imaginations and our bodies. If lightning enlivens the boundary between life and

death, if it exists on the razor's edge between animate and inanimate, does it not seem to dip sometimes here and sometimes there on either side of the divide?

It was in witnessing lightning's enormous power that Victor Frankenstein took upon himself the mantle of science.

> When I was about fifteen years old, . . . we witnessed a most violent and terrible thunderstorm. . . . As I stood at the door, on a sudden I beheld a stream of fire issue from an old and beautiful oak which stood about twenty yards from our house; and so soon as the dazzling light vanished, the oak had disappeared, and nothing remained but a blasted stump. . . .
>
> Before this I was not unacquainted with the more obvious laws of electricity. On this occasion a man of great research in natural philosophy was with us, and excited by this catastrophe, he entered on the explanation of a theory which he had formed on the subject of electricity and galvanism, which was at once new and astonishing to me.[8]

And thus Victor Frankenstein was converted to galvanism.

Galvanism inspired both Mary Shelley and her famed protagonist. Shelley was fascinated by the experiments of her contemporary, Luigi Galvani, an eighteenth-century physician, anatomist, and physiologist who, while preparing dinner on his balcony one stormy night—the atmosphere crackling with electrical buildup—noticed something uncanny that would change the course of his scientific studies. As he touched the frog legs—strung out on a line before him—with a pair of scissors, they twitched. Thereafter, he took it upon himself to study in a systematic fashion the application of electricity—the "spark of life," as Shelley referred to it—to frog legs and other animal parts. Galvani concluded that electricity was an innate force of life, that an "animal electricity" pervaded living organisms. As Jessica Johnson writes, "Galvani proved not only that recently-dead muscle tissue can respond to external electrical stimuli, but that muscle and nerve cells possess an intrinsic electrical force responsible for muscle contractions and nerve conduction in living organisms."[9]

It was a short leap from there to consider that if dead frog legs could be animated by electricity—the secret of life—the harnessing of nature's fury might be used to resurrect the dead or even give life to a creature made of human parts gathered from an array of different corpses. In the introduction to *Frankenstein*, Shelly writes, "Perhaps a corpse would be re-animated; galvanism had given token of such things: perhaps the component parts of a creature might be manufactured, brought together, and endured with vital warmth." Galvani's experiments

sparked the interest of other scientists, and soon severed limbs and an assortment of dissected and expired animals and animal parts were animated by electrical impulses. Perhaps most (in)famously, his nephew, the physicist Giovanni Aldini, stimulated animal parts like those of cows, dogs, horses, and sheep.

Electrified by galvanism, Aldini was ready to shock nearly anything, alive or dead, that he could get his hands on. He was among the first to use electroshock treatment on those deemed mentally ill, and reported complete electrical cures. Not satisfied with his experiments on animal corpses, he performed his shock treatments on executed criminals. He recorded the findings of his 1803 experiment on the executed body of George Foster:

> The jaw began to quiver, the adjoining muscles were horribly contorted, and the left eye actually opened. . . . The action even of those muscles furthest distant from the points of contact with the arc was so much increased as almost to give an appearance of re-animation. . . . vitality might, perhaps, have been restored, if many circumstances had not rendered it impossible.[10]

It is not difficult to complete the circuit of sparking disjuncture between Aldini's ghoulish experiments and those of Dr. Frankenstein.

Even while Shelley labored to write *Frankenstein*, the scientific atmosphere crackled with controversy over the nature of the relationship between life and electricity.

Bioelectricity was in the air, sparking the imagination of nineteenth-century scientists. As Cynthia Graber reports, "Many efforts, including using electricity to treat hysteria and melancholia, amounted to little more than quackery."[11] But some explorations gained scientific credibility and established the basis for current medical practices. For example, a textbook published in 1816 suggests the use of electric shock to revive a stopped heart.[12]

## Monstrous Selves, Transgender Empowerment, Transgender Rage

The monster always represents the disruption of categories, the destruction of boundaries, and the presence of impurities and so we need monsters and we need to recognize and celebrate our own monstrosities.
—Judith Halberstam, *Skin Shows*

Electricity can arrest the heart. It is also capable of bringing a heart back from a state of lifelessness. It can animate its rhythmic drumbeat—the periodic pulsing of life's electrical song—in once arrested or arrhythmic hearts. Monstrosity, like electrical jolts, cuts both ways. It can serve to demonize, dehumanize, and demoralize. It can also be a source of political agency. It can empower and radicalize.

In an unforgettable, powerful, and empowering performative piece, "My Words to Victor Frankenstein above the Village of Chamounix," Susan Stryker embraces the would-be epithet of monstrosity, harnessing its energy and power to transform despair and suffering into empowering rage, self-affirmation, theoretical inventiveness, political action, and the energizing vitality of materiality in its animating possibilities.[13] Remarking on her affinity with Frankenstein's monster, she writes:

> The transsexual body is an unnatural body. It is the product of medical science. It is a technological construction. It is flesh torn apart and sewn together again in a shape other than that in which it was born. In these circumstances, I find a deep affinity between myself as a transsexual woman and the monster in Mary Shelley's *Frankenstein*. Like the monster, I am too often perceived as less than fully human due to the means of my embodiment; like the monster's as well, my exclusion from human community fuels a deep and abiding rage in me that I, like the monster, direct against the conditions in which I must struggle to exist.[14]

Making political and personal alliance with Frankenstein's monster, she intervenes in naturalizing discourses about the nature of nature, an emphasis that resonates with themes in this essay.

> Hearken unto me, fellow creatures. I who have dwelt in a form unmatched with my desire, I whose flesh has become an assemblage of incongruous anatomical parts, I who achieve the similitude of a natural body only through an unnatural process, I offer you this warning: the Nature you bedevil me with is a lie. Do not trust it to protect you from what I represent, for it is a fabrication that cloaks the groundlessness of the privilege you seek to maintain for yourself at my expense. You are as constructed as me; the same anarchic womb has birthed us both. I call upon you to investigate your nature as I have been compelled to confront mine.[15]

This passage speaks with razor-sharp directedness to those who would position their own bodies as natural against the monstrosity of trans embodiment: examine

your own nature, stretch your own body out on the examining table, do the work that needs to be done on yourself (with all this charge's intended multiple meanings), and discover the seams and sutures that make up the matter of your own body. Materiality in its entangled psychic and physical manifestations is always already a patchwork, a suturing of disparate parts.[16]

Toward the end of the piece, Stryker embraces the fecundity of the "chaos and blackness"—the "anarchic womb"—as the matrix for generative nonheterosexual-reproductive birthing, "for we have done the hard work of constituting ourselves on our own terms, against the natural order. Though we forgo the privilege of naturalness, we are not deterred, for we ally ourselves instead with the chaos and blackness from which Nature itself spills forth."[17] This is a reference to the entangled birthing story that Stryker tells. She begins by sharing with the reader the joys and the pain of being in intimate connection with her partner while she was giving birth. This is a birth born of queer kinship relations: not the product of a heteronormative coupling, but a phenomenon rich with multiple entanglements, including a markedly nonnormative delivery room support team. Stryker is attuned to her partner during the birth, bodily and emotionally, yet she is also painfully aware that the physicality of birthing a being from her own womb is denied to her by the specificity of her constructed enfleshment. She describes the raw pain of being part of a process that she could not bring to fruition in the bodily way that she yearns for. This gives way to a painful birthing of transgender rage that becomes, in turn, the womb through which she rebirths herself. This radically queer configuring of spacetimemattering constitutes an uncanny topological dynamic that arrests straight tales of birthing and kinship, and gives birth to new modes of generativity, including but not limited to the generativity of a self-birthed womb. It is nearly impossible not to feel the tug of other entanglements in this queer origin story. In particular, this story reverberates with a queer reading of the Genesis moment when the earth emerges out of the chaos and the void, from a chaotic nothingness, an electrifying atmosphere silently crackling with thunderous possibilities. Nature emerges from a self-birthed womb fashioned out of a raging nothingness. A queer origin, an originary queerness, an originary birthing that is always already a rebirthing. Nature is birthed out of chaos and void, *tohu v'vohu*, an echo, a diffracted/differentiating/différancing murmuring, an originary repetition without sameness, regeneration out of a fecund nothingness.

## Quantum Field Theory: Nothingness as the Scene of Wild Activities

Physicists . . . took the vacuum as something substantial . . . the scene of wild activities.
—Cao and Schweber

Nothingness. The void. An absence of matter. The blank page. Utter silence. No thing, no thought, no awareness. Complete ontological insensibility.[18]

From the viewpoint of classical physics, the vacuum is complete emptiness: it has no matter and no energy. But the quantum principle of ontological indeterminacy calls the existence of such a zero-energy, zero-matter state into question or, rather, makes it into a question with no decidable answer. Not a settled matter or, rather, no matter. And if the energy of the vacuum is not determinately zero, it is not determinately empty. In fact, this indeterminacy not only is responsible for the void not being nothing (while not being something) but may in fact be the source of all that is, a womb that births existence.

Birth and death, it turns out, are not the sole prerogative of the animate world; so-called inanimate beings also have finite lives. "Particles can be born and particles can die," explains one physicist. In fact, "it is a matter of birth, life, and death that requires the development of a new subject in physics, that of quantum field theory. . . . Quantum field theory is a response to the ephemeral nature of life."[19]

Quantum field theory (QFT) was invented in the 1920s, shortly after the development of (nonrelativistic single-particle) quantum mechanics. It is a theory that combines insights from the classical theory of electromagnetic fields (mid-nineteenth century), special relativity (1905), and quantum mechanics (1920s). QFT takes us to a deeper level of understanding of quantum physics.[20] It has important things to say about the nature of matter and nothingness and the indeterminateness of their alleged distinguishability and separability. QFT is a call, an alluring murmur of the insensible within the sensible to radically work the nature of being and time. According to QFT, the vacuum cannot be determinately nothing because the indeterminacy principle allows for fluctuations *of* the quantum vacuum. How can we understand "vacuum fluctuations"? First, it is necessary to know a few things about what physicists mean by the notion of a *field*.

A field in physics is something that has a physical quantity associated with every point in space-time. Or you can think of it as a pattern of energy distributed across space and time. It may be difficult to grasp this notion without specific examples. Consider a bar magnet with iron filings sprinkled around it. The filings will quickly line up in accordance with the strength and direction of the magnetic

field at every point. Or consider an electric field. The electric field is a desiring field born of charged yearnings.[21] When it comes to mutual attraction the rule is opposites (i.e., opposite charges) attract. The notion of a field is a way to express the desires of each entity for the other. The attraction between a proton (a positively charged particle) and an electron (a particle with negative charge) can be expressed in terms of fields as follows: the proton emanates an electric field; the field travels outward in all directions at the speed of light. When the electric field of the proton reaches the electron, it feels the proton's desire pulling it toward it. Likewise, the electron sends out its own field, which is felt by the proton. Sitting in each other's fields, they feel a mutual tug in each other's direction.[22]

Now we add quantum physics and special relativity to classical field theory. Quantum physics enters into QFT most prominently in terms of the discretization of physical observables (quantizing or making discrete physical quantities that classical physics assumed were continuous), and the play of indeterminacy in energy and time. And special relativity speaks to matter's impermanence: matter can be converted into energy and vice versa. Putting these ideas together, we get the following. Fields are patterns of energy. When fields are quantized, the energy is quantized. But energy and matter are equivalent. And so an essential feature of QFT is that there is a correspondence between fields (energy) and particles (matter). The quantum of the electromagnetic field is a photon—a quantum of light. And electrons are understood to be the quanta of an electron field. (There are many other kinds of quanta. For example, the quantum of the gravitational field is a graviton.)

Now let us return to our question: what is a vacuum fluctuation? When it comes to the quantum vacuum, as with all quantum phenomena, ontological indeterminacy is at the heart of (the) matter . . . and no matter. Indeed, it is impossible to pin down a state of no matter or even of matter, for that matter. The crux of this strange non/state of affairs is the so-called energy-time indeterminacy principle, but because energy and matter are equivalent we will sometimes call it the "being-time" or "time-being" indeterminacy principle. The point, for our purposes, is that an indeterminacy in the energy of the vacuum translates into an indeterminacy in the number of particles associated with the vacuum, which means the vacuum is not (determinately) empty, nor is it (determinately) not empty. These particles that correspond to the quantum fluctuation of the vacuum, that are and are not there as a result of the time-being indeterminacy relation, are called "virtual particles." *Virtual particles are quantized indeterminacies-in-action*. Virtual particles are not present (and not absent), but they are material. In fact, *most of what matter is, is virtual*. Virtual particles do not traffic in a metaphysics of presence. They do not

exist in space and time. They are ghostly non/existences that teeter on the edge of the infinitely fine blade between being and nonbeing. Virtuality is admittedly difficult to grasp. Indeed, this is its very nature.

Virtual particles are not in the void but *of* the void. They are on the razor's edge of non/being. The void is a lively tension, a desiring orientation toward being/becoming. The void is flush with yearning, bursting with innumerable imaginings of what might yet (have) be(en). Vacuum fluctuations are virtual deviations/variations from the classical zero-energy state of the void. That is, *virtuality is the material wanderings/wonderings of nothingness; virtuality is the ongoing thought experiment the world performs with itself.* Indeed, quantum physics tells us that *the void is an endless exploration of all possible couplings of virtual particles, a "scene of wild activities."*

The quantum vacuum is more like an ongoing questioning of the nature of emptiness than anything like a lack. The ongoing questioning of itself (and *itself* and *it* and *self*) is what generates, or rather *is*, the structure of nothingness. The vacuum is no doubt doing its own experiments with non/being. In/determinacy is not the state of a thing but an unending dynamism.

*Pace* Democritus, particles do not take their place in the void; rather, they are constitutively inseparable from it. And the void is not vacuous. It is a living, breathing indeterminacy of non/being. The vacuum is an extravagant inexhaustible exploration of virtuality, where virtual particles are having a field day performing experiments in being and time.[23]

## Electric Interlude: Virtual Touch

Touch, for a physicist, is but an electromagnetic interaction.[24]

A common explanation for the physics of touching is that one thing it does not involve is . . . well, touching. That is, there is no actual contact involved. You may think that you are touching a coffee mug when you are about to raise it to your mouth, but your hand is not actually touching the mug. Sure, you can feel the smooth surface of the mug's exterior right where your fingers come into contact with it (or seem to), but what you are actually sensing, physicists tell us, is the electromagnetic repulsion between the electrons of the atoms that make up your fingers and those that make up the mug. (Electrons are tiny negatively charged particles that surround the nuclei of atoms, and having the same charges they repel one another, much like powerful little magnets. As you decrease the distance between them—say, between the electrons that constitute the outer edges of the atoms of your fingers and those of the mug—the repulsive force increases.) Try as you might, you cannot bring two electrons into direct contact with each other.

The reason that the desk feels solid, or the cat's coat feels soft, or we can (even) hold coffee cups and one another's hands, is an effect of electromagnetic repulsion. All we really ever feel is the electromagnetic field, not the other whose touch we seek. Atoms are mostly empty space, and electrons, which lie at the farthest reaches of an atom, hinting at its perimeter, cannot bear direct contact. Electromagnetic repulsion: negatively charged particles communicating at a distance push each other away. That is the tale physics usually tells about touching. Repulsion at the core of attraction. See how far that story gets you with lovers. No wonder the Romantic poets had had enough.

## Lightning: Responses to a Desiring Field

Lightning is an energizing response to a highly charged field. The buildup to lightning electrifies the senses; the air crackles with desire.[25]

By some mechanism that scientists have yet to fully explain, a storm cloud becomes extremely electrically polarized—electrons are stripped from the atoms that they were once attached to and gather at the lower part of the cloud closest to the earth, leaving the cloud with an overall negative charge. In response, the electrons that make up atoms of the earth's surface burrow into the ground to get farther away from the buildup of negative charges at the near edge of the cloud, leaving the earth's surface with an overall positive charge. In this way a strong electric field is set up between earth and cloud, and the yearning will not be satisfied without the buildup being discharged. The desire to find a conductive path joining the two becomes all-consuming.

The first inklings of a path have a modest beginning, offering no indication of the lightning bolt to come. "It begins as a small spark inside the cloud five miles up. A spurt of electrons rushes outwards, travels a hundred meters then stops and pools for a few millionths of a second. Then the stream lurches off in a different direction, pools again, and again. Often the stream branches and splits. *This is not a lightning bolt yet*" (my emphasis).[26] These barely luminous first gestures are called stepped leaders. But the buildup of negative charges (electrons) in the lower portion of the cloud does not resolve itself by a direct channel of electrons making their way to the earth in this fashion. Instead, *the ground* responds next with an upward signal of its own. "When that step leader is within ten or a hundred meters of the ground, the ground is now *aware* of there being a big surplus" of charge, and "certain objects on the earth respond by launching little streamers up toward the stepped leader, weakly luminous plasma filaments, which are trying to connect with what's coming down." This is a sign that objects on the ground are attending to the cloud's seductive overtures. When it finally happens that one of the upward

responses is met by a downward gesture, the result is explosive: a powerful discharge is effected in the form of a lightning bolt. But even after a connecting path has been playfully suggested, the discharge does not proceed in a continuous fashion: "The part of the channel nearest the ground will drain first, then successively higher parts, and finally the charge from the cloud itself. So the visible lightning bolt moves up from ground to cloud as the massive electric currents flow down."

An enlivening, and indeed lively, response to difference if ever there was one. The lightning expert Martin Uman explains this strangely animated inanimate relating in this way: "What is important to note . . . is that the usual stepped leader starts from the cloud without any 'knowledge' of what buildings or geography are present below. In fact, it is thought . . . that the stepped leader is 'unaware' of objects beneath it until it is some tens of yards from the eventual strike point. When 'awareness' occurs, a traveling spark is initiated from the point to be struck and propagates upward to meet the downward moving stepped leader, completing the path to ground."[27] What mechanism is at work in this communicative exchange between sky and ground when *awareness* lies at the crux of this strangely animated inanimate relating? And how does this exchange get ahead of itself, as it were?[28] What kind of queer communication is at work here? What are we to make of a communication that has neither sender nor recipient until transmission has already occurred? That is, what are we to make of the fact that the existence of sender and receiver follows from this nonlocal relating rather than preceding it? What strange causality is effected?

A lightning bolt is not a straightforward resolution of the buildup of a charge difference between the earth and a storm cloud: a lightning bolt does not simply proceed from storm cloud to the earth along a unidirectional (if somewhat erratic) path; rather, flirtations alight here and there and now and again as stepped leaders and positive streamers gesture toward possible forms of connection to come. The path that lightning takes not only is not predictable but does not make its way according to some continuous unidirectional path between sky and ground. Though far from microscopic in scale, it seems that we are witnessing a quantum form of communication—a process of iterative intra-activity.[29]

## Back to Quantum Field Theory: A Touchy Subject

When it comes to quantum field theory, it is not difficult to find trouble—epistemological trouble, ontological trouble, a troubling of kinds, of identities, of the nature of touching and self-touching, of being and time, to name a few.[30] It is not

so much that trouble is around every corner; according to quantum field theory, it inhabits us and we inhabit it, or rather, trouble inhabits everything and nothing—matter and the void.

How does quantum field theory understand the nature of matter? Let us start with the electron, one of the simplest particles—a point particle—a particle devoid of structure. Even the simplest bit of matter causes all kinds of difficulties for quantum field theory. For, as a result of time-being indeterminacy, the electron does not exist as an isolated particle but is always already inseparable from the wild activities of the vacuum. In other words, the electron is always (already) intra-acting with the virtual particles of the vacuum in all possible ways. For example, the electron will emit a virtual photon and then reabsorb it. This possibility is understood as the electron electromagnetically intra-acting with itself. Part of what an electron is, is its self-energy intra-action.[31] But the self-energy intra-action is not a process that happens in isolation either. All kinds of more involved things can and do occur in this frothy virtual soup of indeterminacy that we ironically think of as a state of pure emptiness. For example, in addition to the electron exchanging a virtual photon with itself (that is, touching itself), it is possible for that virtual photon to enjoy other intra-actions with *itself*: for example, the virtual photon can metamorphose/transition—change its very identity. It can transform into a virtual electron-positron pair, that subsequently annihilate each other and morph back into a single virtual photon before it is reabsorbed by the electron. (A positron is the electron's antiparticle—it has the same mass but the opposite charge and goes backward in time. Even the direction of time is indeterminate.) And so on. This "and so on" is shorthand for an infinite set of possibilities involving every possible kind of intra-action with every possible kind of virtual particle it can intra-act with. That is, there is a virtual exploration of every possibility. And this infinite set of possibilities, or infinite sum of histories, entails a particle touching itself, and the particle that transmits the touch transforming itself, and then that touching touching itself, and transforming, and touching other particles that make up the vacuum, and so on, ad infinitum. (Not everything is possible given a particular intra-action, but an infinite number of possibilities exist.) Every level of touch, then, is itself touched by all possible others. Particle self-intra-actions entail particle transitions from one kind to another in a radical undoing of kinds—queer/trans*formations.[32] Hence *self-touching is an encounter with the infinite alterity of the self. Matter is an enfolding, an involution, it cannot help touching itself, and in this self-touching it comes in contact with the infinite alterity that it is.* Polymorphous perversity raised to an infinite power: talk about a queer/trans* intimacy!

What is being called into question here is the very nature of the "self," and in terms of not just being but also time. That is, in an important sense, *the self is dispersed/diffracted through time and being.*

Commenting specifically on the electron's self-energy intra-action, the physicist Richard Feynman, who won a Nobel prize for his contributions to developing QFT, expressed *horror* at the electron's monstrous nature and its perverse ways of engaging with the world: "Instead of going directly from one point to another, the electron goes along for a while and suddenly emits a photon; then (horrors!) it absorbs its own photon. Perhaps there's something 'immoral' about that, but the electron does it!"[33] This self-energy/self-touching term has also been labeled a perversion of the theory because the calculation of the self-energy contribution is infinite, which is an unacceptable answer to any question about the nature of the electron (such as what is its mass or charge?). Apparently, touching oneself, or being touched by oneself—the ambiguity/undecidability/indeterminacy may itself be the key to the trouble—is not simply troubling but a *moral* violation, the very source of all the trouble.

The "problem" of self-touching, especially self-touching the other, is a perversity of quantum field theory that goes far deeper than we can touch on here. The gist of it is this: this perversity that is at the root of an unwanted infinity, that threatens the very possibility of calculability, gets "renormalized" (obviously—should we expect anything less?!). How does this happen? Physicists conjectured that there are two different kinds of infinities/perversions involved in this case: one that has to do with self-touching and another that has to do with nakedness. That is, in addition to the infinity related to self-touching, there is an infinity associated with the "bare" point particle, that is, with the metaphysical assumption we started with that there is only an electron—the "undressed," "bare" electron—and the void, each separate from the other. Renormalization is the systematic cancellation of infinities: an intervention based on the idea that the subtraction of (different size) infinities can be a finite quantity. Perversion eliminating perversion. The cancellation idea is this: the infinity of the "bare" point particle cancels the infinity associated with the "cloud" of virtual particles; in this way, the "bare" point particle is "dressed" by the vacuum contribution (that is, the cloud of virtual particles). The "dressed" electron—the electron in drag—that is, the physical electron, is thereby renormalized, that is, made "normal" (finite). (I am using technical language here!) Renormalization is the mathematical handling/taming of these infinities. That is, the infinities are "subtracted" from one another, yielding a finite answer. Mathematically speaking, this is a tour de force. Conceptually, it is a queer theorist's delight. It shows that all of matter, *matter in its "essence" (of*

*course, that is precisely what is being troubled here), is a massive overlaying of perversities: an infinity of infinities.*[34]

To summarize, quantum field theory radically deconstructs the ontology of classical physics. The starting point ontology of particles and the void—a foundational reductionist essentialism—is undone by quantum field theory. According to QFT, perversity and monstrosity lie at the core of being—or rather, it is threaded through it. All touching entails an infinite alterity, so that touching the other is touching all others, including the "self," and touching the "self" entails touching the stranger within. Even the smallest bits of matter are an unfathomable multitude. Each "individual" always already includes all possible intra-actions with "itself" through all possible virtual others, including those (and itself) that are noncontemporaneous with itself. *That is, every finite being is always already threaded through with an infinite alterity diffracted through being and time.* Indeterminacy is an un/doing of identity that unsettles the very foundations of non/being.

Electrons, for example, are inherently chimeras—cross-species cross-kind mixtures—made of virtual configurations/reconfigurings of disparate kinds of beings dispersed across space and time in an undoing of kind, being/becoming, absence/presence, here/there, now/then. So much for natural essence. The electron—a point particle without structure—is a patchwork of kinds sutured together in uncanny configurations. Trying out new appendages made of various particle-antiparticle pairs, producing and absorbing differences of every possible kind in a radical undoing of "kind" as essential difference: its identity is the undoing of identity. Its very nature is unnatural, not given, not fixed, but forever transitioning and transforming itself. Electrons (re)birth themselves in their engagement with all others, not as an act of self-birthing, but in an ongoing re-creating that is an un/doing of itself. Electrons are always already untimely. It is not that electrons sometimes engage in such perverse explorations: these experiments in intra-active trans*material performativity are what an electron is.[35]

Ontological indeterminacy, a radical openness, an infinity of possibilities, is at the core of mattering. How strange that indeterminacy, in its infinite openness, is the condition for the possibility of all structures in their dynamically reconfiguring in/stabilities. Matter in its iterative materialization is a dynamic play of in/determinacy. Matter is never a settled matter. It is always already radically open. Closure cannot be secured when the conditions of im/possibilities and lived indeterminacies are integral, not supplementary, to what matter is. *In an important sense, in a breathtakingly intimate sense, touching, sensing, is what matter does, or rather, what matter is: matter is condensations of responses, of response-ability.*

Each bit of matter is constituted in response-ability; each is constituted as responsible for the other, as being in touch with the other. *Matter is a matter of untimely and uncanny intimacy, condensations of being and times.*

## The Body Electric: Regenerating What (Never) Was and Might Yet (Have) Be(en)

"It's alive!"[36] Galvanism is alive and well in Medford, Massachusetts, where the biologists Michael Levin and Dany Adams of Tufts University have taken up the mantle of Dr. Frankenstein, or if not that of the good doctor's, then surely that of famous frog electro-animator Luigi Galvani. Wedding galvanism to more mainstream contemporary biological endeavors like gene therapy, Levin and Adams have performed a series of experiments with electrifying results for understanding developmental and regenerative biological processes.[37]

Regeneration is a capacity shared by all living creatures, but not equally. Planarian flatworms can regenerate their entire bodies (including their brains) from a small bit of the original animal. Liver tissue regeneration is one of the few regenerative talents that humans have. Ecosystems can regenerate if they are not too badly damaged. Brittle stars, salamanders, lobsters, and other critters are famous for their ability to regenerate lost limbs. But something quite different is happening in the Tufts University lab, where regeneration has taken on uncanny new shapes. Let us take a tour through some of Levin and Adam's key laboratory experiments.

Like Galvani, Levin and Adams have a fondness for frogs. There are solid scientific reasons for choosing this favored organism. For example, the African clawed frog, *Xenopus laevis*, or *Xenopus* for short, an aquatic native of sub-Saharan Africa, holds the honor of being a model organism in developmental biology, cell biology, toxicology, and neuroscience because of its "relative evolutionary closeness" to humans and laboratory cooperativeness.[38] It does not hurt that the embryos are transparent and that they are prolific reproducers. *Xenopus* is not only evolutionarily close to humans, relatively speaking, it is directly entangled in human kinship relations. "It is an invasive species all over the world because it was used in human pregnancy tests in the 1940's. When more effective means of pregnancy tests were made available, many *X. laevis* were released all over the world."[39] Furthermore, "*Xenopus* oocytes are a leading system for studies of ion transport and channel physiology."[40] All in all, a mixture of human and *Xenopus* reproductive capacities led to its employment in developmental biology laboratories. Levin happened to conduct his doctoral studies in one such lab. *Xenopus*'s entanglement with heteronormative reproduction notwithstanding, Levin

and Adams have found themselves entranced by its regenerative, rather than reproductive, capabilities.[41]

Much like the way that human children have the ability to grow back a severed fingertip until the age of seven, *Xenopus* tadpoles can regenerate their tails, provided these are lost during the first seven days of life. By day eight—right around the time the tadpole begins to metamorphose into a frog—it begins to lose that capacity, and at ten days the ability has gone completely. Growing back a tail is different than regrowing skin at the site of an injury. "A tail is a complex organ containing multiple cell types: muscle, peripheral nerves, spinal cord, notochord, skin, and vasculature."[42] In a breakthrough series of studies on the effects of electricity on regeneration, Levin and colleagues showed that it was possible to get tadpoles to regenerate their tails outside the specified time frame by manipulating the electric field around the missing tail.

What accounts for this success? In a world where molecular biology rules, it is unusual to find a scientist willing to align himself with the field of bioelectricity, with all its troubling and spotted past, littered with charges of charlatanism and quackery. But as much as Levin likes to fancy himself a scientific maverick, he has strategically hitched the old wagon of bioelectricity to the brand-new, shiny, high-powered machinery of molecular biology. The techniques of molecular biology are key to his exploration of bioelectrically controlled regeneration. Levin's approach is "to understand the genetic components that underlie bioelectrical events during development and regeneration."[43] Make no mistake: this is not an Aldini performance; this is galvanism with a contemporary face. One science writer explains it this way:

> In a paper that could help bring the study of bioelectricity into the mainstream of 21st century science, [Levin and colleagues] . . . identified a protein that serves as a natural source of regenerative electricity. By manipulating the protein, an ion transporter, they were able to induce frog tadpoles to regrow tails at a stage of development when such regrowth is typically not possible. . . .
>
> What had been missing from studies until now is an understanding of how electricity—the flow of charged particles—works at a molecular level to bring about regeneration.[44]

Levin and his colleagues have provided evidence that large-scale electrical patterning of bodily morphology plays a causal role in embryonic development and regeneration. This is surely not the conventional approach to follow in this age

of genomics, where all causes are molecular and things are built from the bottom up. This bioelectrical approach is unique and producing some electrifying results. So while the majority of biologists focus on stem cells and other biochemical and genetic factors, the dynamic duo are intent on cracking the "bioelectric" code of the body. As Levin explains, "All cells, not just nerve cells, use bioelectrical signals to communicate pattern information to each other. . . . you can tweak those signals artificially to get them to do what you want them to do."[45]

Trying out their exciting understandings of the linkage between bioelectric fields and regeneration, researchers in Levin's lab took on the challenge of seeing if they could get body parts that are not normally capable of regeneration to regenerate by using the same techniques of molecularly producing electrical fields that would induce the appropriate regeneration. "Dr. Levin and his colleagues have been able to stimulate the regeneration of complete frog legs. Frog legs don't usually grow back (or regenerate) like salamander legs. But by providing appropriate electrical gradients at the frog's wound site, these researchers stimulated the growth of an entirely new limb."[46]

Regeneration is one thing, but what about stimulating the growth of limbs, organs, and other body parts that have never been? Manipulating the bioelectric fields by changing various ion channels, the researchers were able to use the bioelectric fields to monstrous effect, growing extra heads, limbs, and eyes. Four-headed planaria, six-legged frogs, two-tailed worms, and one bioelectrical mutation really caught the imagination of science reporters.

An article titled "'Franken-Tadpoles' See with Eyes on Their Backs" reports that "using genetic manipulation of membrane voltage in *Xenopus* (frog) embryos, biologists at Tufts University's School of Arts and Sciences were able to cause tadpoles to grow eyes outside of the head area."[47] Vaibhav P. Pai, a postdoc fellow working in their lab, explains, "This suggests that cells from anywhere in the body can be driven to form an eye."[48] Not only that, it turns out that some of these monstrous eyes can see![49]

This is rather dramatic evidence in support of epigenetics. Clearly, there is more at work biologically speaking than a genetic code: bioelectrical signaling evidently plays a significant role in the determination of bodily morphology. But perhaps the most striking finding was the result of a combination of serendipity and Adams's scientific instincts.

Adams had hooked up her research camera to a microscope to film the early stages of *Xenopus* tadpole development. Having achieved an image of remarkable clarity (which is particularly difficult when imaging tiny critters), Adams decided to leave the camera on overnight, for the heck of it, anticipating that the images

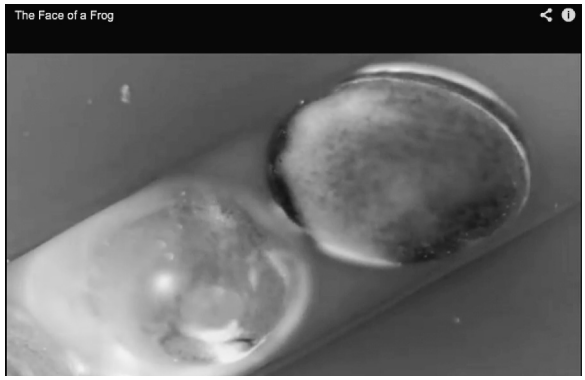


Figure 1. Still from *Electric Face*. Courtesy Dany Spencer Adams

would blur as the embryos moved. When she returned to her lab she did in fact find that the images were blurry, but she was able to get surprisingly clear images after computer processing. She developed a time-lapse video using a sequence of photographs, and the result was "jaw dropping." The video, she says, was "unlike anything I had ever seen. I was completely blown away."[50] (Fig. 1 is a still from the video. I strongly encourage the reader to stop reading and watch the video. It has to be seen to be fully appreciated. The image shows two frog embryos. The light flashes on the left embryo indicate the electric potential as it traces out a face to come—a face that does not yet exist but only exists in potential for a brief moment and then vanishes!)

"The images show an embryonic frog 'light show' in fast forward," Adams said. "When a frog embryo is just developing, *before it gets a face*, a pattern for that face lights up on the surface of the embryo. . . . We believe this is the first time such patterning has been reported for an entire structure, not just for a single organ. I would never have predicted anything like it" (my emphasis).

The face-to-come of the embryo flashes in electrical patterns across the surface of the embryo.[51] It is important to take in the fact that the "electric face" appears and disappears *before* any actual features develop, that is, prior to cell differentiation! For example, the "eye field" electrically paints out the location and structure of the eye and vanishes *prior* to differentiation. "To assess whether this bioelectric pattern is crucial to proper development or just an interesting by-product, the researchers disrupted the biochemical pump that generates electric potential. This affected specific critical genes, which resulted in abnormal tadpole facial development. Apparently, the genes are activated by the bioelectricity."[52] That is, what we may be witnessing are electric traces of a bioelectric epigenetic switch that regulates genes expression or the pattern of where genes are expressed.[53]

"Our research shows that the electrical state of a cell is fundamental to development. Bioelectrical signaling appears to regulate a sequence of events, not

just one," explains Laura Vandenberg, a postdoctoral associate who works with Adams.[54] "Developmental biologists are used to thinking of sequences in which a gene produces a protein product that in turn ultimately leads to development of an eye or a mouth. But our work suggests that something else—a bioelectrical signal—is required before that can happen." Adams does not hold back on touting the possible implications of this finding: "If it holds that these bioelectrical signals are controlling gene expression, or the patterns of where genes are expressed, we have a whole new approach to correcting birth defects, or preventing them, or spotting them before they happen."

Wedding bioelectricity to molecular genetics, and charged cultural imaginaries from the past with future hopes for regenerative medicine, Levin, the lab's director, delights in playing the errant genius in search of one of life's most profound and promising secrets. As one Tufts University reporter puts it: "In the world where Michael Levin's vision has come to life, people who lose a limb in an accident are able to re-grow it. Birth defects can be repaired in the womb. Cancer cells are detected and rendered harmless before they become tumors. Any number of other diseases are conquered as cells are altered and adjusted."[55] "Grow Your Own," the article's headline, makes an apt motto for the lab, even if this autopoietic framing belies the enormous labors, the patchwork of entangled practices that will be necessary to move toward anything like this futuristic goal. But this futuristic imaginary is no doubt currently sparking the interest of a host of potential funders.

## Quantum Phenomena: Entanglements of Disparate Parts

This article is a patchwork. Made of disparate parts. Or so it may seem. But why should we understand parts as individually constructed building blocks or disconnected pieces of one or another forms of original wholeness? After all, to be a part is not to be absolutely apart but to be constituted and threaded through with the entanglements of part-ing. That is, if "parts," by definition, arise from divisions or cuts, it does not necessarily follow that cuts sever or break things off, either spatially or temporally, producing absolute differences of this and that, here and there, now and then. *Intra-actions* enact cuts that cut (things) together-apart (one move). So a patchwork would not be a sewing together of individual bits and pieces but a phenomenon that always already holds together, whose pattern of differentiating-entangling may not be recognized but is indeed re-membered. Memory is not the recording of events held by a mind but marked historialities ingrained in the world's becoming. Memory is a field of enfolded patterns of differentiating-entangling. Remembering is not a process of recollection, of the reproduction of what was, of assembling and ordering events like puzzle pieces fit together by fixing where each

has its place. Rather, it is a matter of re-membering, of tracing entanglements, responding to yearnings for connection, materialized into fields of longing/belonging, of regenerating what never was but might yet have been. This article is dedicated to re-memberings, to reconfiguring anew seemingly disparate parts.

The task now is to attempt to stitch together, if only imperfectly, the pieces of this monstrous article by tracing a few of the uncountable and generative entanglements in their ongoing reconfiguring. What do we have so far? Lightning, primordial ooze, electrifying origins, frogs, galvanism, Frankenstein, trans rage, queer self-birthing/regeneration, fecund void, quantum vacuum, virtual particles, indeterminate wanderings, lightning's errant pathways, queer touching, bioelectricity, Franken-frogs, monstrous re/generations, the promise of monsters, future cures, and radical im/possibilities.

Let us begin by learning just a bit more about the striking phenomena of lightning and bioelectricity. To see lightning from above the earth's atmosphere (again I encourage the reader to stop reading and have a look at this impressive phenomenon) is to see something visually akin to the flashings of the electric (pre) face of the embryonic tadpole.[56] Both the becoming of lightning and the becoming of face exhibit flashes that mark out the traces of (what might yet) be-coming. Preceding the flash of a lightning bolt, and preceding gene involvement in cell differentiation, electrons and photons play at making virtual diagrams, flashes of light painting possibilities across the sky and across an embryo, hinting at things-to-come. What I am suggesting is that as instances of the virtual play of electron-photon intra-actions that QFT tells us are the elemental happenings of electromagnetic phenomena (all such phenomena, including the ones presently under consideration), these electromagnetic phenomena in their (ongoing) be-coming illuminate an intrinsic feature of materiality: *matter's ongoing experimenting with itself—the queer dance of being-time indeterminacy, the imaginative play of presence/absence, here/there, now/then,* that holds the disparate parts together-apart.

### *Embryonic Lightning*

At the US Air Force Atmospheric Research Center in Colorado Springs, Geoff McHarg, an atmospheric physicist, is trying to capture the elusive birth of a lightning bolt. McHarg is using a new generation super-slow-motion camera that can record thousands of images per second—visually resolving temporality on unprecedented scales that allow the human eye for the first time to see how very much happens in the "flash of an eye."

What does embryonic lightning look like? The Discovery Channel program shows McHarg at his computer terminal replaying the video of his lucky first-ever catch of the "birth of a lightning bolt," although, as we soon learn, what we are wit-

nessing is arguably not its birth but the display of its embryonic electrical stirrings before any part of a lightning bolt begins to manifest.

The video playback shows "a flash of light dart out of a cloud and zigzag downward in roughly 50 yard segments."[57] (Once again I encourage the reader to watch this remarkable video now.) What the Discovery program narrator does not mention, but the viewer is witnessing in the video, is a stunning feature of the not-yet-lightning flashes: the flashes of light do not just head downward for fifty yards and then change direction and head out again (much like a child's drawing of lightning). Rather, one sees erratic, disjointed sets of flashes tentatively testing out different pathways. The trace of each trial gesture vanishing as quickly as it appears. The narrator's voice continues, "This first stage of lightning is called a stepped leader." Then the scientist's voice: "You can see the stepped leader coming down here looking for a ground, going back and forth. You can see the tortuous channel it is taking as it divides back and forth." Look closely, and you can see that the so-called back and forth motion is a discontinuous pattern of flashing (it flashes here and then over there, some distance away), and that some of the gestures are upward rather than downward. That is, what McHarg's film seems to have captured is a stepped leader gesturing toward the earth, variously expressing its yearnings. It is important to keep in mind that this is not a lightning bolt yet or even the birth of one. Stepped leaders are the barely luminous first gestures of a lightning bolt-to-come. What we are witnessing is the potential face of lightning yet to be born—*a discontinuous exploration of different possible pathways*—before a lightning stroke explodes and shatters the darkness.

Uman points to the fractal-like nature of the stepped leader's musings and attributes this wondering/wandering to a kind of electrical confusion:

> There are zigs and zags 100 yards long and, within these, other zigs and zags 10 yards long, and within these yet smaller zigs and zags. . . . Why is the lightning channel so tortuous? The answer is not known, but some reasonable guesses may be made. The larger-scale tortuosity in the channel (representing, say, tens of yards or more) is due to the fact that the stepped leader makes such an errant trip to ground. Why does it do this? Possibly various airborne regions of charge (space charge) divert the leader on its trip. *More likely, the leader just doesn't know exactly where it wants to go*, except that ultimately it wants to move downward. (my emphasis)[58]

It is as if the electrons are trying out different paths, feeling out this desiring field, exploring entanglements of yearning, before any discharge to the ground takes place. Remember that the buildup of negative charges (electrons) in the lower

portion of the cloud does not resolve itself by a direct channel of electrons making their way to the earth by a stepped leader moving to the ground. Instead, *the ground* responds next with an upward signal of its own. These gestures are material imaginings, electrical flirtations signaling connections-to-come. Lightning is born of discontinuous spooky-action-at-a-distance signaling in a decidedly queer communication between earth and sky as they exchange gestures toward the other before either exists, signals of the desiring field that animates their intra-active becoming.[59] If this is reminiscent of the indeterminate exploration of the multiple errant pathways of a quantum phenomenon, it may not be that surprising. Lightning is, after all, the luminous activity of strong electromagnetic fields where photons and electrons engage in a quantum exploration of multiple temporalities and polymorphous/polyamorous couplings—the dance of indeterminacy.

### *Lightning Face of an Embryo*

The "electric face" phenomenon that Adams caught on video is a blend of the fantastic and the scientific, utterly mesmerizing. We catch the glimpse of a face that does/not (yet) exist, but before we can fully discern its indeterminate features, it is gone, in a flash. As Adams describes it:

> The result is so remarkable it almost doesn't seem real. As cells divide within the ball of the embryo, lines and shapes glow and disappear. A slash where the mouth will form shimmers into view, only to quickly fade away. A dot, signifying an eye, appears briefly on the left side of the embryo; a moment later, a matching dot flashes on the right. Vertiginous time-lapse photography is a staple of nature documentaries, but this is different. *These features—the mouth, the eyes—didn't actually exist.* In fact, many of the genes that are linked to their development hadn't even been turned on. *It's only after the patterns fade, the ghost of features yet to come, that all the necessary proteins are activated.* (my emphasis)

The electric traces of a face flash across the cells of the undifferentiated tadpole embryo and disappear. Much like the faint traces of embryonic lightning that tease with the promise of an electrifying connection, the flashes of light that paint out the face of the tadpole offer tantalizing glimpses of what does not (yet) exist. What we witness are traces of differentiating materializations-to-come, virtual explorations of making face. Internally generated lightning flashes are coursing through the embryonic body exploring different possibilities of what might yet be/have been. What I am suggesting by drawing on quantum field theoretic imagery to describe this event is that what Adams captured is in fact a *quantum* feature of the

biophysical epigenetic phenomenon she and her colleagues have been studying: the material play of indeterminacy, the teasing gestures of what might yet be/have been.[60] If my conjecture is correct, it places the Levin-Adams regeneration investigations within the emerging field of quantum biology. The stunning nature of this example is that what it shows is not merely (nonrelativistic single particle) *quantum mechanical* effects (e.g., quantum entanglement) that scientists now believe account for photosynthesis, bird navigation, and olfactory function, but *quantum field theoretical* effects, like virtual explorations of what might yet materialize (or what might yet have been) as an integral part of ongoing processes of materialization in the dynamical play of indeterminacies in being and time.[61] The sky and the embryo, like the quantum field theory void, are having brain flashes, imagining all matter of becomings. They are trying on different faces, electrical patterns of differencing/différancing, diffraction patterns of differential mattering. *Experiments in virtuality—explorations of possible trans*formations—are integral to each and every (ongoing) be(com)ing.*

## Virtual TransMatterRealities and Queer Political Imaginaries

> I find no shame . . . in acknowledging my egalitarian relationship with non-human material Being; everything emerges from the same matrix of possibilities.
> —Stryker, "My Words to Victor Frankenstein above the Village of Chamounix"

The promise of monsters is a regenerative politics, an invitation to explore new ways of being in touch, new forms of becoming, new possibilities for kinship, alliance, and change.[62] Regeneration understood as a quantum phenomenon brings indeterminacy's radical potential to the fore. *The indeterminacy of being-time/time-being means that matter/materiality is a matter of material wanderings/wonderings, a virtual exploration of what might yet be/have been, dispersed across spacetimebeing and condensed into each material bit-here-now, every morsel (each "dressed point") of spacetimemattering.*

The virtual is not a set of individual possibilities, one of which might yet be realized or actualized.[63] Virtual possibilities are not what is absent relative to the real's presence. They are not the roads not taken or some yet unrealized potential future, the other to actual lived reality. The virtual is a superposition of im/possibilities, energetic throbs of the nothingness, material forces of creativity and generativity. Virtual possibilities are material explorations that are integral to what matter

is. Matter is not the given, the unchangeable, the bare facts of nature. It is not inanimate, lifeless, eternal. Matter is an imaginative material exploration of non/being, creatively regenerative, an ongoing trans*/formation. Matter is a condensation of dispersed and multiple beings-times, where the future and past are diffracted into now, into each moment. Matter is caught up in its own and others' desiring fields. It cannot help but touch itself in an infinite exploration of its (im/possible) be(com)ing(s). And in touching it/self, it partners promiscuously and perversely with otherness in a radical ongoing deconstruction and (re)configuring of itself. Matter is a wild exploration of trans* animacy, self-experimentations/self-re-creations, not in an autopoietic mode, but on the contrary, in a radical undoing of "self," of individualism. Ever lively, never identical with itself, it is uncountably multiple, mutable. Matter is not mere being, but its ongoing un/doing. Nature is agential trans*materiality/ trans-matter-reality in its ongoing re(con)figuring, where trans is not a matter of changing *in* time, from this to that, but an undoing of "this" and "that," an ongoing reconfiguring *of* spacetimemattering in an iterative reworking of past, present, future integral to the play of the indeterminacy of being-time.[64]

The electric body—*at all scales*, atmospheric, subatomic, molecular, organismic—is a quantum phenomenon generating new imaginaries, new lines of research, new possibilities.[65] The (re)generative possibilities are endless. Fodder for potent trans* imaginaries for reconfiguring future/past lived realities, for regenerating what never was but might yet have been. Can we cultivate bioelectrical science's radical potential, subverting Dr. Frankenstein's grab for power over life itself, aligning (neo)galvanism with trans* desires, not in order to have control over life but to empower and galvanize the disenfranchised and breathe life into new forms of queer agency and embodiment? Can we (re)generate what was missing in fleshiness but materially present in virtuality? Can we (re)generate what our bodies sense but cannot yet touch? Can we find ways to adjust the appropriate ion potential to activate and generate new fields of re-membering? Can we learn to reconfigure our fleshliness bit by bit by slowly changing the flow of ions? Can dis-membering as well as re-membering be facilitated through such charged reconfigurings of molecular flows? Can we trans/form, regenerate, dismember, and re-member anew fleshly bodies in their materiality? And if these fleshy hopes feel cruel to us sometimes, especially perhaps when reality seems impossibly hard and fixed and our own naturalcultural bodies and desires feel immobilized, if there are times when we have to face the knife, tear ourselves open, draw blood, might a regenerative politics with all its monstrously queer possibilities still serve to recharge our imaginations and our electric body-spirits, helping us transition from momentary political and spiritual rigor mortis to living raging animacy?

Surely these imaginings of the queer potential of regenerative science (and quantum theory more generally) should not be (mis)understood as an uncritical embrace of science's utopian promise. No meditation on Frankenstein could entertain for a moment such a straight alliance with the scripted equation "science = progress," indeed, as the very incarnation of this promise. There is no illusion of queer regeneration being a bloodless affair.

The promise of regenerative medicine is surely not inherently innocent, progressive, or liberatory. It does not constitute an innocent mode of engagement with science, divorced from any heteronormative reproductive impulses. Indeed, its own quite explicit commitment to normative ideas of embodiment, able-bodiedness, and naturalness belie any such suggestion. On the contrary, its goals are to renormalize and eliminate bodily irregularities in a quest to honor Nature and her intentions, if only by doing her one better. The current bioelectric studies of regeneration are already aligning themselves with promises of curing cancer, birth defects, and disabilities because of lost body parts.[66] Levin's initial motivation was to create robots that could heal themselves. Projects in the service of the military-industrial complex, capitalism, racism, and colonialism cannot be disentangled from the practices of modern science. Nonetheless, even as "science seeks to contain and colonize the radical threat posed by a particular transgender strategy of resistance to the coerciveness of gender," and even if "its cultural politics are aligned with a deeply conservative attempt to stabilize gendered identity in service of the naturalized heterosexual order," this is not reason to believe that trans* desires can be corralled into cooperation.[67] In alliance with this crucial point, this article engages with science in a mode that invites us to imagine not only the possibilities of subverting science's conservative agendas from the outside, as it were, but also those of opening up science from the inside and serving as midwife to its always already deconstructive nature.

Significantly, according to QFT nature is an ongoing questioning of itself—of what constitutes naturalness. Indeed, nature's indeterminacy entails its ongoing un/doing. In other words, nature itself *is* an ongoing deconstructing of naturalness. As I have shown in this brief encounter with quantum field theory, the void is "the scene of wild activities," perverse and promiscuous couplings, queer goings-on that make pre-AIDS bathhouses look tame. The void is a virtual exploration of all manner of possible trans*/formations. Nature is perverse at its core; nature is unnatural. For trans*, queer, and other marginalized people, "The collective assumptions of the naturalized order [can] overwhelm [us]. Nature exerts such a hegemonic oppression."[68] The stakes in denaturalizing nature are not insignificant. Demonstrating nature's queerness, its trans*-embodiment, expos-

ing the monstrous face of nature itself in the undoing of naturalness holds significant political potential. The point is that the monstrously large space of agency unleashed in the indeterminate play of virtuality in all its un/doings may constitute a trans-subjective material field of im/possibilities worth exploring. And the political potential does not stop with regeneration, for there are other wild dimensions within and without that rage with possibilities. *For all its entangled history with capitalism, colonialism, and the military-industrial complex, QFT not only contains its own undoing—in a performative exploration/materialization of a subversive materialism—but in an important sense makes that very undoing its im/proper object of study.*[69]

The point is not to make trans or queer into universal features and dilute their subversive potentials. The point is to make plain the undoing of universality, the importance of the radical specificity of materiality as iterative materialization. Nor is this to set trans as an abstraction, to deny it its fleshly lived reality, sacrificing its embodiment in an appropriative embrace of the latest theory trends. What is needed is not a universalization of trans or queer experience stripped of all its specificities (as inflected through race, nationality, ethnicity, class, and other normalizing apparatuses of power), setting these terms up as concepts that float above the materiality of particular embodied experiences, but to make alliances with, to build on an already existing radical tradition (a genealogy going back at least to Marx) that troubles nature and its naturalness "all the way down." In doing so, it would be a mistake to neglect the spaces of political agency *within* science—its own deconstructive forces produce radical openings that may help us imagine not only new possibilities, new matter/realities, but also new understandings of the nature of change and its possibilities.

Queer kinship is a potent political formation, crucial to Stryker's forceful analysis. Imagine how the possibilities for alliance with nature's ongoing radical deconstruction of naturalness might enable the (re)making of queer kinship with nature. What would it mean to reclaim our trans* natures as natural? Not to align ourselves with essence, or the history of the mobilization of "nature" on behalf of oppression, but to recognize ourselves as part of nature's doings in its very undoing of what is natural?

Stryker's queer topological musings, both in "My Words to Victor Frankenstein," where she is giving birth to her rage that births her, and also in more recent works, reverberate with the trans* generative mode being explored here:

> From my forward-facing perspective I look back on my body as a psychically bounded space or container that becomes energetically open through

> the break of its surface—a rupture experienced as interior movement, a movement that becomes generative as it encloses and invests in a new space, through a perpetually reiterative process of growing new boundaries and shedding abandoned materialities: a mobile, membranous, temporally fleeting and provisional sense of enfolding and enclosure. This is the utopian space of my ongoing poesis.[70]

This topological dynamic reverberates with QFT processes, much like the one that perverse kinds of self-touching/self-re-creating electrons enact. An electron touching itself, rebirthing/regenerating itself (there is no singular birth moment, no origin, only rebirthings/regenerating), in a process of intra-active becoming, of reconfiguring and trans-forming oneself in the self's multiple and dispersive sense of it-self where the self is intrinsically a nonself.

In her "Frankenstein" piece, Stryker writes poetically of her transgender (re)birthing in a manner that echoes the literal passage of birthed body from the liquid darkness of the womb. Her voice solicits me to diffractively intercut her words there (italicized in the text below) with those (nonitalicized below) of an electron I imagine to be speaking contrapunctually of its own perpetual (re) birthing.[71]

> I am an electron. I am inseparable from the darkness, the void. *It is dark. I see a shimmering light above me.* I am one with the void I was allegedly immersed in, but from which there is no possibility of extrication. There is no myself that is separable from it. *Inside and out I am surrounded by it. Why am I not dead* ***if*** *there is no difference between me and what I am in?* While I struggle to come into being I am virtually annihilated and re(sub)merge into the nothingness, over and over again. Time has no meaning, no directionality. My being no more than an im/possible indeterminate yearning. Bubbling up from the nothingness, I fall back into the void that fills me and surrounds me. I return to the void and reemerge once more only to fall back again. *This [void] annihilates me. I cannot be, and yet—an excruciating impossibility—I am. I will do [everything] not to be here. . . .*
>
> I will try out every im/possibility, every virtual intra-action with all beings, all times.
>
> *I will die for eternity.*
> *I will learn to breathe the [void].*
> *I will become the [void].*
> *If I cannot change my situation I will change myself.*

I am transforming in intra-action with the light above me, below me, and within me, and with all manner of other beings. I am not myself. I am becoming multiple, a dispersion of disparate kinds.

*In this act of magical transformation*
*I recognize myself again.*
*I am groundless and boundless movement.*
*I am a furious flow.*
*I am one with the darkness . . .*
*And I am enraged.*

*Here at last is the chaos I held at bay.*
*Here at last is my strength.*
*I am not the [void] —*
*I am [a] wave [a raging amplitude, a desiring field surging, being born],*
*and rage*
*is the force that moves me.*
*Rage*
*gives me back my body*
*as its own fluid medium.*

*Rage*
*punches a hole in [void]*
*around which I coalesce*
*to allow the flow to come through me.*

*Rage*
*constitutes me in my primal form.*
*It throws my head back*
*pulls my lips back over my*
*opens my throat*
*and rears me up to howl:*
*: and no sound*
*dilutes*
*the pure quality of my rage.*
*form.*
*teeth*
*No sound*
*exists*
*in this place without language*
*my rage is a silent raving.*

I am one with the speaking silence of the void, the cries of im/possibility move through me, until there erupts a raging scream without sound, without language, without comprehensibility or articulation.

*Rage*
*throws me back at last*
*into this mundane reality*
*in this transfigured flesh*
*that aligns me with the power of my Being.*
*In birthing my rage,*
*my rage has rebirthed me.*

Let us align ourselves with the raging nothingness, the silent howling of the void, as it trans*figures fleshy possibilities. Wandering off the straight and narrow path, wonderings alight. Trans* desires surge forth electrifying the field of dreams and transmaterialities-to-come.

## Notes

I am grateful to Mel Chen and Dana Luciano for their patience and enthusiasm and for wonderful suggestions for reeling in an article that had grown to monstrous proportions. I would like to thank Susan Stryker for graciously accepting my proposal to have some of her poetics diffractively read through mine and, especially, her willingness to have her powerful poetry interrupted by the murmurings of the void (in particular, the musings of a virtual electron that is inseparable from the void). As ever, I am grateful to Fern Feldman for her feedback and ongoing support.

1. TransMaterialities is a term that arose in the planning of UCSC's 2009 "TransMaterialities: Relating across Difference" Science Studies Cluster graduate student conference, co-organized by Harlan Weaver and Martha Kenney, with faculty sponsors Donna Haraway and Karen Barad. The first time I saw the playful term *matterealities* was at a conference run by Monika Buscher at Lancaster University in 2007.
2. Inspired by QFT's understanding of each moment as a condensation of other beings, places, and times, this ontological-political project resonates with Marco Cuevas-Hewitt's call for a "futurology of the present": "The futurology of the present does not prescribe a single monolithic future, but tries instead to articulate the many alternative futures continually emerging in the perpetual present. The goal of such an endeavor is to make visible the living, breathing alternatives all around us" ("Futurology of the Present: Notes on Writing, Movement, and Time," *Journal of Aesthetics and Protest* 8 [Winter 2011–12], joaap.org/issue8/futurology.htm).

3. For more on lightning's queer quantum nature, see below, and also Karen Barad, "Nature's Queer Performativity (the authorized version)," *Kvinder, Køn & Forskning/ Women, Gender, and Research* 1–2 (2012): 25–53; and Vicki Kirby, *Quantum Anthropologies: Life at Large* (Durham, NC: Duke University Press, 2011).
4. Charles Darwin seems to have suggested as much. See, for example, Helen Fields, "The Origins of Life," *Smithsonian Magazine*, October 2010, www.smithsonianmag.com/science-nature/The-Origins-of-Life.html.
5. Douglas Fox, "Primordial Soup's On: Scientists Repeat Evolution's Most Famous Experiment," *Scientific American*, May 28, 2007, www.scientificamerican.com/article.cfm?id=primordial-soup-urey-miller-evolution-experiment-repeated.
6. Nick Lane, quoted in Cynthia Graber, *Electric Shock: How Electricity Could Be the Key to Human Regeneration* (2012), readmatter.com.
7. Douglas Fox, "Primordial Soup's On."
8. Mary Shelley, *Frankenstein, or The Modern Prometheus* (n.p., 1818), 15.
9. Jessica P. Johnson, "Animal Electricity, circa 1781," *Scientist*, September 28, 2011, www.the-scientist.com/?articles.view/articleNo/31078/title/Animal-Electricity—circa-1781/.
10. Aldini quoted in Anne K. Mellor, "Frankenstein: A Feminist Critique of Science," in *One Culture: Essays in Science and Literature*, 287–312, eds. George Lewis Levine and Alan Rauch (Madison: University of Wisconsin Press, 1987), 304.
11. Graber, *Electric Shock*.
12. J. D. Roger, "1816 Textbook Suggests Use of Electric Shock in Treatment of Cardiac Arrest," *Canadian Journal of Cardiology* 20, no. 14 (2004): 1486.
13. Susan Stryker, "My Words to Victor Frankenstein above the Village of Chamounix," *GLQ* 1 (1994): 237–54.
14. Stryker, "My Words," 238.
15. Stryker, "My Words," 240–41.
16. For one thing, as Judith Butler points out, "Not only is the gathering of attributes under the category of sex suspect . . . indeed, the 'unity' imposed upon the body by the category of sex is a 'disunity,' a fragmentation" (quoted in *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* [Durham, NC: Duke University Press, 2007], 60). But there is much more to this point. For more details on an agential realist reworking of the nature of nature, matter/ing, and the cutting together-apart of disparate parts, see Barad, *Meeting the Universe Halfway*.
17. Stryker, "My Words," 251. I am left wondering why Stryker talks about the womb as a place of "blackness" rather than say "darkness," or even, as I suggest, "nothingness" (the void). Part of my political investment in enlarging the scope of my project to include quantum field theory (QFT) is its ability to trouble the underlying metaphysics of colonialist claims such as *terrae nullius*—the alleged void that the white settler claims to encounter in "discovering undeveloped lands," that is, lands allegedly devoid of the marks of "civilization"—a logic that associates the beginning of space

and time, of place and history, with the arrival of the white man. In contrast to this doctrine, according to QFT the void is full and fecund, rich and productive, actively creative and alive. Which, of course, is not the only way to contest the racist and colonialist impulses at work but is to try to further unearth and unsettle how space and time are themselves racialized.

18. Parts of this section are borrowed from Karen Barad, *What Is the Measure of Nothingness? Infinity, Virtuality, Justice / Was ist das Maß des Nichts? Unendlichkeit, Virtualität, Gerechtigkeit*, dOCUMENTA (13): 100 Notes—100 Thoughts / 100 Notizen—100 Gedanken | Book Nº099, English and German edition (2012).
19. A. Zee, *Quantum Field Theory in a Nutshell*, 2nd ed. (Princeton: Princeton University Press, 2010), 4.
20. Quantum field theory does not negate the findings of quantum mechanics but builds on them. Similarly, these explorations help further articulate agential realism. As I argue below: QFT entails a radical deconstruction of identity and of the equation of matter with essence in ways that transcend even the profound un/doings of (nonrelativistic) quantum mechanics.
21. The more general term *electromagnetic field*, rather than *electric field*, is sometimes used. The interchangeability is due to the fact that electricity and magnetism were unified into a single electromagnetic force in the mid-nineteenth century.
22. While the idea of a field may seem like a convenient fiction, and was in fact originally introduced as an imaginary construct to facilitate calculations, physicists in the nineteenth century began to embrace the idea that fields are real. This shift was a result of the finding that light is an electromagnetic wave made of (nothing but) changing electric and magnetic fields.
23. This is a subtle point that I develop further elsewhere (Barad, "On Touching: The Inhuman That Therefore I Am," *differences* 22, no. 3 [2012]: 206–23): namely, the difference between the play of indeterminacy and a rapid appearance and disappearance of particles as the hallmark of virtuality. I would argue that "flashes" of potential are traces of virtuality synchronized to clock time, but this very particular manifestation is far from the only set of possibilities in the play of virtuality. I address these issues further in a forthcoming publication.
24. Parts of this section are borrowed from Barad, "On Touching."
25. Parts of this section are borrowed from Barad, "Nature's Queer Performativity."
26. All quotations in this paragraph are from the Discovery Channel television program "Discovery Wonders of Weather: Lightning Phenomena," September 2007, www.discovery.com/video-topics/other/lightning-phenomena.htm.
27. Martin Uman, *All about Lightning* (Mineola, NY: Dover, 1986), 49–50.
28. I am indebted to Vicki Kirby's writings on lightning, and in particular her attention to the untimely nature of lightning's connective engagement. See Vicki Kirby, *Quantum Anthropologies: Life at Large* (Duke, NC: Duke University Press, 2011).

29. I have repeatedly made the point that quantum phenomena are not restricted to some alleged "micro" domain. Perhaps a(nother) large scale example like this one will help to defeat that misconception.
30. Parts of this section are borrowed from Barad, "On Touching." See also Barad, "On Touching—The Inhuman That Therefore I Am (v1.1)," in *Power of Material/ Politics of Materiality*, eds. Susanne Witzgall and Kerstn Stakemeier (Zurich-Berlin: Diaphanes, 2015).
31. The virtual photon can also be absorbed by another particle, and that would constitute an electromagnetic interaction between them, but that is not my focus here, which is how to understand an "individual" particle.
32. *Trans** is a term that employs the wildcard symbol (*) for internet searches. It is at once a term meant to be broadly inclusive (e.g., transgender, transsexual, trans woman, trans man, trans person, and also genderqueer, Two Spirit, genderfuck, gender fluid, masculine of center) of an array of subversive gender identities, and also self-consciously tuned into practices of exclusion. As "Anony Mouse" notes in a response to a posting on the Q-Center of Portland web page: "When you see a [starred] word or sentence while reading [a] book or articles, you automatically look [to] the margin to see if it has any more meaning to it." See, for example, www.pdxqcenter.org/bridging-the-gap-trans-what-does-the-asterisk-mean-and-why-is-it-used/ (written by Addie Jones, "Bridging the Gap — Trans*: What Does the Asterisk Mean and Why Is It Used?," posted August 8, 2013).
33. Richard Feynman, *QED: The Strange Theory of Light and Matter* (Princeton: Princeton University Press, 1995), 115–16.
34. Renormalization is a sign of physics' ongoing (auto)deconstruction. Physics continually finds ways to open itself up to new possibilities, to iterative re(con)figurings.
35. Electrons are not an arbitrary choice for this article. Electrons are not only the source of our body electric, the genesis of our own inter- and intracellular lightning flashes; in an important sense, "electrons R us": we are made of electrons and their wanderings. Note: to suggest that electrons are trans/material configurations/reconfigurings is not to naturalize trans (or queer for that matter), but rather to acknowledge the radically transgressive potential of nature itself in its own undoing/deconstruction of naturalness (sufficiently subversive, in this case, to instill "horror" in those who would propose to know it fully).
36. This material was presented during my talk, "Multispecies Intra-actions: Queerness and Virtuality," Distinguished Lecturer for Environmental Humanities, University of New South Wales, Sydney, Australia, July 11, 2013. I am grateful for the lively discussion it generated.
37. Research into bioelectricity and regeneration has a history going back to the nineteenth century. Although some articles covering the research activities of Tufts University Center for Regenerative and Developmental Biology position Michael Levin,

the center's director, as the direct descendent of Galvani and a scientific maverick in the sole pursuit of bioelectricity and regeneration in contemporary times, this is an ongoing field of research that has multiple devotees. For a history of bioelectricity and regeneration, see, for example, Joseph W. Vanable Jr., "Bioelectricity and Regeneration Research," in *A History of Regeneration Research: Milestones in the Evolution of a Science*, ed. Charles E. Dinsmore (Cambridge: Cambridge University Press, 1991), 151–78. What is important and cutting-edge about Levin et al.'s approach is the study of bioelectricity using the techniques of molecular biology.

38. "This animal is widely used because of its powerful combination of experimental tractability and close evolutionary relationship with humans, at least compared to many model organisms" (Wikipedia, "Xenopus," en.wikipedia.org/wiki/Xenopus [accessed October 28, 2013]).
39. "During the 1940's, female *X. laevis* were injected with the urine of a woman. If the human was pregnant, then the injected frog would start to produce eggs. *Xenopus laevis* was the first vertebrate cloned in the laboratory." Both quotes from the entry for "Xenopus laevis," Animal Diversity Web, University of Michigan, animaldiversity.ummz.umich.edu/accounts/Xenopus_laevis/ (accessed October 28, 2013).
40. Wikipedia, "Xenopus."
41. Brittle stars are organisms that combine the two: reproduction and regeneration. Some species of brittle stars asexually reproduce via regeneration, for example, via the fissioning of the central disk (Wikipedia, "Brittle Star," en.wikipedia.org/wiki/Brittle_star [accessed October 28, 2013]). For more remarkable features of this creative creature, see Barad, *Meeting the Universe Halfway*, chap. 8.
42. Ai-Sun Tseng et al., "Induction of Vertebrate Regeneration by a Transient Sodium Current," *Journal of Neuroscience* 30, no. 39 (2010): 13192–200.
43. Dany S. Adams, Alessio Masi, and Michael Levin, "H+ pump-dependent changes in membrane voltage are an early mechanism necessary and sufficient to induce Xenopus tail regeneration," in *Development* 134 (2007): 1323-35.
44. Misia Landau, "Regenerative Biology: The Body Electric," *Focus: News from Harvard Medical, Dental, and Public Health Schools*, March 9, 2007, archives.focus.hms.harvard.edu/2007/030907/regenerative_biology.shtml.
45. Helen Ragovin, "Grow Your Own," *Tufts Journal,* January 14, 2009, tuftsjournal.tufts.edu/2009/01_1/features/01/.
46. "Unlocking the Biological Code," *What A Year! Introducing Medical Discoveries to Biology Students*, www.whatayear.org/06_13.php.
47. "Researchers Discover That Changes in Bioelectric Signals Trigger Formation of New Organs," *Tufts Now*, December 8, 2011, now.tufts.edu/news-releases/researchers-discover-changes-bioelectric-sign.
48. "Researchers Discover."
49. "When new tissue is introduced, Levin explains, it sends out axons to make connections with host tissue. In these tadpoles, the eyes' axons almost universally connected

with either the spinal cord or the gut (Levin, quoted in Michael Price, "'Franken-Tadpoles' See with Eyes on Their Backs," February 27, 2013, news.sciencemag.org/plants-animals/2013/02/franken-tadpoles-see-eyes-their-backs). The ones that connected to the spinal cord were able to see.

50. The video is available on the Tufts University website: "The Face of a Frog: Time-lapse Video Reveals Never-Before-Seen Bioelectric Pattern, now.tufts.edu/news-releases/face-frog-time-lapse-video-reveals-never-seen#sthash.DgsjzC7y.dpuf. If any of the videos mentioned in this article aren't current, see people.ucsc.edu/~kbarad.
51. "The flashes are caused by a process called ion flux, which causes groups of cells to form patterns marked by different membrane voltage and pH levels. When stained with dye, the negatively charged areas shine brightly, while the other areas appear darker. The result? 'Electric face.'" Jennifer Viegas, "Electrical Patterns Found on Frog Face," July 20, 2011, news.discovery.com/animals/electrical-patterns-frog-110720.htm.
52. Brian Thomas, "Tadpole Faces Form by Bioelectric Patterning," July 27, 2011, www.icr.org/article/tadpole-faces-form-by-bioelectric-patterning/.
53. Daisy Yuhas, "It's Electric: Biologists Seek to Crack Cell's Bioelectric Code," *Scientific American*, May 27, 2013. www.scientificamerican.com/article/bioelectric-code/?mobileFormat=false.
54. See now.tufts.edu/news-releases/face-frog-time-lapse-video-reveals-never-seen#sthash.DgsjzC7y.dpuf.
55. Ragovin, "Grow Your Own."
56. See www.discovery.com/video-topics/other/lightning-phenomena.htm.
57. "Lightning in Super Slow Motion," a segment from the Discovery Channel video on lightning (2007), www.youtube.com/watch?v=RLWIBrweSU8.
58. Uman, *All about Lightning*, 83, 90.
59. "Spooky-action-at-a-distance" is the notion that Albert Einstein introduced in his objection to the nonlocality of quantum phenomenon. Today, this nonlocality is understood to be a feature of quantum entanglements. See Barad, *Meeting the Universe Halfway*, chap. 7; and Karen Barad, "Quantum Entanglements and Hauntological Relations of Inheritance: Dis/continuities, SpaceTime Enfoldings, and Justice-to-Come," *Derrida Today* 3, no. 2 (2010): 240–68, special issue, "Deconstruction and Science," edited by H. Peter Steeves and Nicole Anderson.
60. Indeed, this is further evidence that quantum effects, falsely believed to exist only at micro scales, are being detected at larger and larger spatial scales. Here we may be witnessing yet another inherently quantum effect at the molecular level, at the level of biology, orders of magnitude larger than the atomic scale (of the so-called microworld).
61. Note that untimeliness and temporal indeterminacy are intrinsic to the nature of virtuality.
62. This is an invocation of Donna Haraway, "The Promises of Monsters: A Regenerative Politics for Inappropriate/d Others," in *Cultural Studies*, eds. Lawrence Grossberg,

Cary Nelson, and Paula A. Treichler (New York: Routledge, 1992), 295-337. I have in mind here also brittle stars among other creatures who display an array of nonheteronormative modes of reproduction, including asexual reproduction through regeneration. See the discussion of the brittle star in Barad, *Meeting the Universe Halfway*, chap. 8.

63. Although a common story of measurement in quantum theory is that the "wavefunction," which represents a superposition of possibilities, is collapsed on measurement and one of the possibilities is realized, I argue that there is no collapse, that measurement intra-actions reconfigure possibilities. For more details on an agential realist solution to the measurement problem, see Barad, *Meeting the Universe Halfway*, chap. 7. The notion of the *virtual* discussed here is based on my interpretation of quantum field theory. It is not the same as Gilles Deleuze's notion of the *virtual*, although there are some interesting resonances. I discuss this further in a future publication.
64. Thinking the temporalities of transitioning outside linear and external conceptions of time seems important, and this ontology gives us new understandings of being and time that may be useful. For example, what is at issue, then, is not necessarily a matter of discovering a past that was already there or remaking a past through the lens of the present but a reconfiguring, a cutting together-apart of past-present-future in the wild play of dis/identities and untimely temporalities.
65. I have tried to make the point over and over again that quantum phenomena are *not* restricted to the so-called micro scale. Scale does not precede phenomena; scale is only materialized/defined within particular phenomena.
66. This is not to suggest that curing cancer and addressing birth defects and disabilities are not worthy goals, on the contrary. But the question of what constitutes a "defect" and a "disability" needs to be thought through in conversation with disability scholars and activists, among others.
67. Stryker. "My Words," 242.
68. Stryker, "My Words," 248. The notion of a natural order is certainly important to scientific racism as well. On the historical links between scientific racism and scientific discourses on sexuality, see, for example, Siobhan Somerville, "Scientific Racism and the Emergence of the Homosexual Body," *Journal of the History of Sexuality* 5, no. 2 (1994): 243–266.
69. I take up this issue in depth in Barad, *Infinity, Nothingness, and Justice-to-Come* (book manuscript).
70. Susan Stryker, "Dungeon Intimacies: The Poetics of Transsexual Sadomasochism," *Parallax* 14, no. 1 (2008): 36–47.
71. With apologies to Susan Stryker for disrupting her powerful poem, and with gratitude to her for her generosity and willingness to be open to this experiment in entangled poetics.