Entanglements in Poetry, Science, and the Arts
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July 2019

Quantum entanglement is a mechanical phenomenon in which the physical states of the subatomic particles that form matter, after having been joined and spatially separated, can become intertwined, interacting despite physical distance. Verified through scientific experiments and supported by quantum theory in physics, quantum entanglement challenges conventional assumptions about reality, locality, space, time, and matter. Much of my work as a poet explores poetry in relation to quantum theory and its radical departures from mainstream paradigms. In quantum entanglement, I have argued in *SciArt Magazine* and elsewhere, the time it takes for the joint states of entangled particles to interact is at a scale outside of normative language but within poetic language.

As the convener of the 2019 Reynolda Conference at Wake Forest University, *Entanglements: A Conference on the Intersections of Poetry, Science, and the Arts*, a gathering of transdisciplinary poets, scientists, artists, and scholars who move outside of and between established boundaries, I invoked quantum entanglement in the conference's name and central artwork to help forge our future mutual influence, our entangled joint states once we had separated. *Joint States* (2018), the name of the artwork by Matthew Baird that I used for the conference, is a collage made of books from multiple genres—indexes, dictionaries, glossaries, fiction, drama, and philosophical essays—selected by the artist for their physical shades and visual organization of text.

Going into this conference, we wondered: what might emerge in the scientific presentations, scholarly and creative talks, poetry readings, performances, and artworks, and then, beyond these days into the future?

Thinking ahead about these questions, we sought in anticipation to ask what could possibly follow and how we could engage with intention in this initial iteration of whatever *Entanglements* might become; for this purpose I collaborated with Elæ [Lynne DeSilva-Johnson], founder and creative director of The Operating System, as a documentation and open intelligence facilitator. For the conference, Elæ designed a custom work-book and guide for participants to use both as prompt and future archive, a space to engage with materials and central questions, as well as to document the emergent observations and inspirations that the days might hold.

To support our future joint states, several of us at the conference established *The Entanglements Network* to extend what we began. But what did we begin? And how might we share these origins with others, who might join us for what lies ahead?

What follows is my sense of this beginning.

Entanglements: Day One

At the opening panel, I provided an introduction to the tradition of those working across poetry, science, and the arts and those extending this tradition in the contemporary era. Due to the conference's organizational structure, I was empowered to convene individuals who I both know and did not yet know and some who have deeply influenced my work in quantum poetics, the critical theory and artistic practice across poetry, science, and the arts that I have been developing the past ten years.

Celebrated poet Will Alexander, a featured presenter at the conference, critiqued the traditional authority of science and its emphasis on conventional rationality by proposing that an inner technology is needed to move forward as a civilization, one created not by science's mechanical engineering but by poetic engineering. As a poet, Alexander populates language fields defiantly overgrown with lushly scientific vocabularies, surrealist resistances to realism, and gnostic investigations into mystery and what lies beyond both the immediate and the terrestrial. From a "quantum sailor" who encounters African communities while traveling on the Indian Ocean in "The Sri Lankan Loxodrome" to a self-defined narrator in "The Blood Penguin," two of his poems he read us, Alexander's transdisciplinary poetry is also radically trans-global, trans-temporal, trans-spatial, and transhuman, acutely embodying literary, artistic, and philosophical otherness that simultaneously critiques other forms of otherness forced by the status-quo.

Alexander played the piano in a live, improvised collaboration, *Entanglement and the Vortex*, with featured presenter and internationally distinguished poet Anne Waldman, who read from her poetry, and featured presenter and poet Andrew Joron, who played the theremin, an instrument that operates unconventionally without touch. Alexander's piano solo also can be heard as the soundtrack to a photo-film of the conference.

Featured presenter and Pulitzer Prize winning poet Rae Armantrout, whose recent work engages with physics, biology, ecology, and neuroscience in relation to themes of existence, consciousness, materiality, and immateriality, said her interest in science relates to her working at the edges and borders of meaning and form. Addressing the Copenhagen interpretation of quantum theory—which describes the wave functions of subatomic particles collapsing out of superposition, where they are in all possible states at once, and emerging into existence during measurement, where they are in one state or another—Armantrout asked a central question of her poetry: "What is observation?" Armantrout spoke about how poetic language, like science, can probe the nature of things, ask if things exist, and ask what we mean by things. Words have agency of their own and are open to environmental fluctuations, swerving at times like starlings in flight, she said. When she writes poems that challenge environmental problems such as fracking, she explained, she does so from a place of "complicit critique," signaling how individuals in the Anthropocene can be inevitably complicit in what they oppose.

In his talk, Joron, a founder of surrealist science-fiction poetry and author of some of the first contemporary science-informed essays on poetics I read, referenced Lucretius' *The Nature of Things*, Charles Olson's high-energy constructs, physicist Ernst Chladni's sound experiments with self-organizing vibration patterns, and more. Joron is known for his poetry's emphasis on sound and spoke about sound in relation to the theremin.

Joron said that he sees the theremin as an "Orphic lyre," invoking Orpheus, the musician, poet, and prophet of ancient Greek mythology who used the lyre, a small harp-like instrument, to enchant, move stones, and assist him on his travels to the underworld. Joron told us how after Orpheus' death, his lyre was placed among the stars by the Muses. For Joron, the theremin is a poetic device, the "lament of an electronic Orpheus" that creates a musical forcefield not unlike a poem, which is often composed of the lyric sounds of language. Joron argued that sound itself is more primary than light even in the universe, where acoustic waves shaped the early universe and large-scale structures. Joron argued that sound is more primary than light even in the physical universe, where acoustic waves shaped the early universe and large-scale structures. Echoing Ludwig Wittgenstein, Joron suggested that the mission of the poet is to say the unsayable. Referencing phase transitions in science, where a change occurs in a physical system, often through absorption or emission of energy from the system, Joron proposed that sound waves are phase transitions to the unsayable, making sound itself visible.

As Joron was speaking, I thought about renowned poet Nathaniel Mackey, who would be in attendance at the conference later that afternoon, and his Artist Statement in *Lyric Postmodernisms* (Counterpath Press) and later in *Blue Fasa* (New Directions) about the root of the word *lyric* being *lyre*, which Joron mentioned. For Mackey, whose *Song of the Adomboulou* and *"Mu"* poetry projects draw from West African cultural customs and radical African-American jazz, the lyric-lyre forges the vibrations of sound in poetry, including the extended vibrations in serialized poetry projects like his own.

In recent years, featured presenter and internationally celebrated poet Anne Waldman's epic poetry projects of feminist political resistance, alternative dimension, and heightened lived experience draw purposefully from new developments in science. In Waldman's poetry, we encounter scientific references to topics such as dark matter experiments, subatomic leptons, and quantum entanglement in both direct and associative proximity to the intensely performative collage of urgent questions, meditations, outrages, and laments she makes, from killer drones in Jordan to the urgent crises of white supremacy and climate change. A "committed antagonist against atrocity" who draws from Buddhist teachings about compassion and more (see, for example, her sutra, "Chenrezig Walks Among Us," for the Dali Lama, which she performed for us), Waldman invokes science in her poetry and poetics at not only the scales of novelty, beauty, and wonder—she showed us a page from a newspaper article she had been carrying with her on the recent first image of the black hole—but also as poethical critique, bringing attention to how science and technology can be used to contribute to the war culture and other social and political crises. The role of compassion in Waldman's poetics draws from and influences her lifelong work in building literary infrastructures and educational communities where poetry can flourish, including those at Naropa University's Jack Kerouac School of Disembodied Poetics, which she co-founded with poets Allen Ginsberg and Diane di Prima and where I used to teach.

In addition to her performances and musical collaboration with Alexander and Joron, Waldman screened *Crepuscular*, directed, edited, and filmed by experimental artist No Land, with sound by Ambrose Bye and Joanna Mattrey and assistant editing by Taylor Jerry and Gabriel Gall, drawing from her recent book, *Trickster Feminism* (Penguin).

Featured presenter Madhur Anand is both a poet and an accomplished scientist who works on human-ecological modeling, complex systems, conservation ecology, climate change, and sustainability science. Writing lyric found poems from her own scientific papers, as well as poems from her interests in natural materials like bird eggs and nests, Anand uniquely considers philosophically and intellectually rich subjects such as chaos theory, fluid dynamics, self-similarity, chance effects, emergence, the butterfly effect, the strange attractor, ambiguity, rationality, and error in both poetry and science. Anand told us that people often ask her how she, as a scientist, began writing poetry. She told us that she is unable to say why she wrote her first poem, but just before she did, she was at her computer, working on a scientific project, and looking out a window. As an established scientist who came to poetry later, Anand seems especially poised to theorize how poetry and science interact while also, as a practitioner, continuing to imaginatively and critically extend what is possible in and across each field.

Featured presenter and renowned poet Ed Roberson, who briefly studied science and once worked in a limnology lab and in the field, is a poet whose deep connection to nature, concerns for the environment, and challenges to racism come together through an intense focus on observation. Long after moving on to other kinds of work after his time at the limnology lab, he read to us in an essay he wrote for the conference, his poetry never "left that lab, which is really a school….an ancient school of thought." While Roberson's ecopoetics is mediated through what he calls "the scientific accuracy of seeing," he also examines the race and class dynamics of science as a cultural and anthropological institution. In his essay, Roberson related his experiences of being called the n-word as a racial slur and the social constraints of him using that word today in poems of his addressed to friends who are other African-American poets.

During his poetry reading, he told us about passing a glacier each day while doing field work in Alaska, one that could be observed from the highway in Anchorage. Later, he said, he learned the glacier was no longer visible from the highway due to climate change. In a panel on poetry and complexity theory in the Anthropocene in which he participated with Armantrout and Anand, Roberson conducted improvised interpretations of Anand's poetry, performing observation in the form of creative response as an act of complexity.

Drawing from *What Do Science, Technology, and Innovation Mean from Africa?* (MIT Press), edited by Clapperton Chakanetsa Mavhunga, a collection of essays exploring how science, technology, and innovation from Africa are not universalizable through British colonialist definitions, Roberson invoked the *Chimurenga*, now known as Shona, the people of the house of stone, who established the nation of Zimbabwe after winning independence from colonialism through guerilla fighting techniques based on cultural proverbs on how to survive that were

passed through the community. “Unlike the dzimbabwean,” Roberson said direly, “we are not likely to survive.”

Featured presenter Gustavo A. Schwartz, a scientist and writer, presented his theater play, *The Interview* (El Gallo de Oro Editions), co-authored with Luisa Etxenike, which addresses scientific discovery and the culture of science. A scene where two scientists take on the roles of physicists Niels Bohr and Werner Heisenberg is used to criticize an established scientist’s idealization of Bohr’s Institute for Theoretical Physics of the University of Copenhagen and to echo a breakdown of his relationship with a less established scientist. During WWII, Heisenberg worked for Germany’s weapons program, and a story of Heisenberg and his mentor Bohr meeting during the war is often presented as Bohr believing that Heisenberg has come back to obtain information about making the atomic bomb. Historians are not in agreement if this was the case or if Heisenberg was misunderstood, and it is also not clear if Heisenberg’s failure at producing an atomic weapon was intentional or not.

Schwartz emphasized that *The Interview*, which raises questions about the internal and external ethics of science, was collaboratively written by a scientist and a writer inside a scientific institution, the Donostia International Physics Center, where he conducts scientific research at the Material Physics Center and directs the Mestizajes Programme on the relationship of literature, science, and art. I gave a talk there once, having been introduced to Schwartz by physicist, poet, and novelist Juan José Gómez Cadenas, and contributed work to *#Nodes* (Next Door Publishers), an international anthology on literature, science, and art that Schwartz co-edited with literary scholar Víctor Bermúdez. Through the Mestizajes Programme, Schwartz has convened three international conferences at DIPC on literature, science, and art.

Featured presenter Mark C. Kruse, a physicist whose research is in high-energy particle physics with a focus on the analysis of data collected by the ATLAS detector at the Large Hadron Collider at CERN, and who was part of the team who discovered the Higgs boson, engages in interdisciplinary projects with the humanities, including co-advising and co-teaching across literature and science at Duke University. He presented on interpretations of quantum mechanics, wave-particle duality, space and time, the role of language in science, and more. Since quantum entanglement can only occur after particles have once been together, and since everything was connected at the Big Bang, is it possible, Kruse asked, that the universe itself is in a single entangled state? If so, he said, this would challenge the principle of locality, where an object is directly influenced only by its immediate surroundings. Providing a critique of how science is commonly explained to broad audiences, Kruse suggested that apparent paradoxes in quantum phenomena such as entanglement come from applying the language of the macroscopic level to the subatomic level. Since poets are aware of language’s incongruities, and since poetry works with ambiguity, poets might be particularly suited to helping interpret quantum theory, Kruse suggested. Drawing from these insights and his teaching experience, Kruse argued for the value in teaching literary devices such as ambiguity and metaphor in the field of science.

Featured presenter Ming-Qian Ma, a scholar of modernist and postmodernist poetry and poetics in relation to philosophy, science, and art, provided the keynote scholarly lecture, “Poetic Intimations of Everettian Multiverse: Toward a Quantum Phenomenology on/off the Page.” In

addition to exploring Hugh Everett's maverick scientific ideas in relation to consciousness, he provided a phenomenology of reading in quantum mechanics. His focus was on Everett's Many Worlds Interpretation (MWI) of quantum theory, which uses Erwin Schrödinger's wave mechanics—one of the two primary mathematics for quantum theory—to propose that a new branch of reality is created with every measurement. Ma argued that Everett is a quantum realist, taking literally the notion that whatever is probable is realized, and suggested that MWI's non-abstract account of quantum theory is aligned with my own work in quantum poetics and beyond. Rather than conventionally interpreting this literalness, Ma characterized it as radically imaginative. "The literal," Ma said in these cases, "becomes the threshold to the yet-to-be."

In MWI, Ma said, quantum superposition is resolved in a literal way: consciousness creates physical reality by collapsing the wave function of subatomic particles with each measurement. Is MWI proposing that consciousness is a quantum system itself? Ma asked. Applying the double-split experiment in physics, which demonstrates wave-particle duality by showing how subatomic particles can be both waves and particles, to an animated text that contained representations of Newtonian, quantum, and entangled tiers, Ma argued that reading, in the Copenhagen interpretation of quantum theory, is non-reading, whereas in MWI, we become what we read by splitting into multiple versions of ourselves. The book's spine could be a hinge, Ma further speculated, for coupling and decoupling these textual tiers. Ma suggested two kinds of consciousness might emerge, "consciousness of" and "consciousness with," in this phenomenology of non-reading.

Entanglements: Day Two

The second day of the conference began with a Wake Forest University roundtable featuring transmedia artist Lynn Book, collage artist Paul Bright, American and European art scholar John Curley, neurobiologist Wayne Silver, and British literary scholar Elizabeth A. Way.

Book's presentation critiqued structures of power, including scientific power. She invoked the chimera as a hybrid scientific-imaginative creature, the human microbiome, "unreading for future bodies," performing moxy, feminist critiques of escape, and resisting closure. She showed excerpts from her video installations, including *Derangements: A Monster Study*, and asked what power is being confirmed in constructing even radical books of poetry and art.

Bright discussed his de-collages, collage across mediums, the Lettrists and Situationists, post-Darwinian science, conceptual dimensions of the informal, the synthetic, and the hybrid. He invoked Jaques Villeglé's socio-political alphabet, Emily Dickinson's writing on scraps, Dadaist Kurt Schwitters, and more. He spoke of collage as "a forced simultaneity beyond linear spacetime" and a "rough gene splicing of new forms."

Curley spoke about global art and cybernetics in the Cold War, showing Pablo Picasso's *Massacre in Korea* (1951), where the killers look like robots, and depictions of cybernetics in capitalism and communism. Among other topics, he told us how Jean Tinguely's film, *Homage to New York* (1960), showing a sculpture being destroyed before an audience, was coded as an experiment rather than art, which was acceptable to communist social realism.

Silver discussed Santiago Ramon y Cajal, the founder of modern neuroscience, and his intricate drawings of the human anatomy he studied. Cajal sketched bones as a child and later drew cadavers before making detailed drawings of human cells. Creating suggestive motifs, Cajal drew nerve cells in the human brain, cells in the retina, and microglia in the central nervous system in part to support his cell theory of the nervous system.

Way presented on Erasmus Darwin, Constance Naden, and others. She argued that Mary Wollstonecraft Shelley's *Frankenstein; or, The Modern Prometheus* intervened in masculine territory by exploring what happens when the imagination goes dark. She also examined poetry that embodies structure, reason, and the 19th century science it tries to describe in contrast to the spontaneous overflow of the Romantic literary movement.

My conversation with transmedia artist Eduardo Kac, internationally recognized for his transgenic art and biopoetry, started with a discussion of his artwork, *Genesis* (2001), which contains an "artist's gene," a synthetic gene created by Kac, who translated a sentence from the biblical book of Genesis into Morse Code and then converted the Morse Code into DNA base pairs according to a conversion principle developed by Kac for this work. We discussed his statements from 2002 in *Biopoetry* (AcquAviva Editions) about poetry moving away from the printed page since the 1980s through video, programming, the web, and holography and his advocacy for the use of biotechnology and living organisms in poetry. After Kac responded to a question of mine about the ethics of using animals in his work, I asked him about *Inner Telescope*, his recent work with French astronaut Thomas Pesquet that involves an object on the International Space Station. I invited Kac to discuss the work's language system, which uses assembled papers that spell "moi," in relation to his manifesto on space poetry and his philosophy of language. Kac discussed writing poems for zero gravity, the poetics of the "gravitropic," and the ways in which space poetry requires a kinesthetic reader. Responding to a question by Waldman, Kac addressed the socio-political dimensions of his work and discussed poetry that goes beyond the page in relation to printed books.

Special guests of the conference included poet Lee Ann Brown; multimodal creative practitioner and performer, cultural scholar, and educator Elæ (Lynne DeSilva-Johnson); poet Adam Dickinson; astrophysicist and Odissi dancer Satya Gontcho A Gontcho; poet Stephanie Strickland; and poet Edwin Torres.

Brown, who read recent poems influenced by cosmology, opened with a spontaneous poem invoking the Hindu sacred syllable, "Om," since Silver said that he initially saw Kac's "moi" as "Om." Elæ [Lynne DeSilva-Johnson] read work from various projects related to their multimodal practice, including excerpts from the para-academic prose work on evolution and precarity, *In Memories of Feasible Grace,* and questioned the possibility of legibility "here, at the fall of Rome"; as mentioned earlier Elæ also collaborated with me on the conference as a documentation and open intelligence facilitator, designing the innovative work-book for participants and now presenting ongoing and archival materials related to the conference at The Operating System, serving as a nodal network point for future projects and iterations. Dickinson read poems, discussed his metabolic poetics project, where he has had his microbiome

scientifically tested for pollutants, and introduced new experiments involving innovative erasure and cockroaches being placed on Franz Kafka's *The Metamorphosis*. Strickland read complex poems exploring scientific, technological, and poetic discourses and later spoke about Alexander and Joron's "para-scientific poetry" and Roberson's anthropological approaches to science and poetry. Torres blended performative and sonic experimentation in his poetry reading and curated a collaborative Exquisite Corpse poem throughout the conference.

In addition to the special guests, Wake Forest alumna, poet, and conference coordinator Maddie Baxter read a poem where black holes collided; poet and visiting attendee Kelly Krumrie read poems referencing mathematician Emmy Noether; and poet and conference collaborator EJ Shu read poems drawing from a scientific paper.

Satya Gontcho A Gontcho, a practitioner of Odissi, a classical Indian dance, choreographed a dance to an excerpt of a book-length poem I wrote for the Dark Energy Survey, *At the Edge of the Abyss*, after my recent trip to the Chilean Andes, where I visited the Cerro Tololo Inter-American Observatory with astrophysicists from the Dark Energy Survey. As a scientist, she was at the observatory for a different scientific collaboration that used the same telescope.

At the conference's opening panel, I briefly discussed my Dark Energy Survey project as well as other recent poetry of mine that engages with science. *World Lines*, my quantum supercomputer poem that uses a theoretical model for a quantum supercomputer as its architecture, and which I developed while in residence at the Simons Center for Physics and Geometry, draws from the non-binary properties of poetic language, acting as a quantum system. *Wavicles*, my digital poem on wave-particle duality, was created using "digital couplets" I developed in a software program called 3D Poetry Editor. "The Positron Passport," my essay-poem that invokes quantum entanglement, nonlocality, dark matter, the Majorana fermion, and the poethics of science, draws from my site visits to CERN and a neutrino and dark matter experiment in Spain.

The Reynolda Conferences at Wake Forest University

The institutional support for this gathering was set in motion, according to scholar Dean Franco, my colleague in the English Department and director of the Humanities Institute at Wake Forest, by his predecessor, scholar Mary Foskett, along with Wake Forest's Dean of the College Michele Gillespie and Reynolda House Museum of American Art Executive Director Allison Perkins. They had a vision of re-centering the Reynolda House, the former home of Katharine Smith Reynolds and R.J. Reynolds next to Wake Forest and the site of the conference, as a place for crossing boundaries between our campus and the wider community. The grant for the Reynolda Conferences that I was awarded came from the Andrew W. Mellon Foundation with additional support from the National Endowment for the Humanities. Additional funding for this conference came from the Wake Forest Humanities Institute, the Creative Writing minor in the English Department, and Interdisciplinary Performance and the Liberal Arts Center (IPLACe).

During her opening remarks, Perkins explained that the Reynolda House's collection of American art includes Jim Dine's 1972 print, *The World (for Anne Waldman)*, a tribute to Waldman. The print is a series of colorful hearts, Perkins described, arranged across the surface

like locations on a map, each one labeled to identify personal associations for Dine. It was Waldman who, when I hosted her during a visit to Wake Forest in 2016, enthusiastically suggested I convene a conference on poetry and science.

In her opening remarks, Gillespie, a historian, shared material from her book, *Katharine and R.J. Reynolds: Partners of Fortune in the Making of the New South* (University of Georgia Press), telling us the story of sitting in the Presbyterian Church's southern archives near Asheville, going through the papers of D. Clay Lilly, a prominent southern minister in the early twentieth century. He had been a great friend of Smith Reynolds, who, for her time and place, and for her race and class as a wealthy white woman, was relatively progressive, Gillespie said. Lilly was progressive, too, advocating for women's leadership in the church, asking hard questions about racism and Jim Crow, and championing religious education that embraced the intellectual, Gillespie told us. Smith Reynolds had persuaded Lilly to lead her small church, and she sweetened the ask, Gillespie said, by partnering with him to create the Reynolda Conferences.

It was Smith Reynolds and Lilly's vision to turn the church into a great conference center for a powerful annual meeting of the minds, Gillespie said, inviting religious leaders to think and learn outside their traditional boundaries through conversations with other religious leaders, academic scholars, and a public eager to think more broadly and imaginatively about themselves and their society. For such a parochial place and time, Gillespie told us, the Reynolda Conferences were rather remarkable. The first conference, held 95 years ago this month on Smith Reynolds' living room, was on evolution and the church, a year before The Scopes Trial, when science teacher John Scopes was prosecuted for teaching evolution in a Tennessee public school after a recent bill had made it illegal. The Reynolda Conference supported the science of evolution, and the participants and the national press alike heralded the discussions that took place, Gillespie said, even as others protested what they considered the radicalism of these debates.

Gillespie said that we were taking up the most important aspects of Smith Reynolds and Lilly's vision by embracing the value, the power, and the illumination that comes with rigorous intellectual engagement explored in collaboration with art and imagination, testing and thinking beyond the boundaries of field and discipline to explore in exciting new ways the kinds of intersections that can come out of interrogating science, art, and poetry across seemingly impenetrable boundaries.