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$4x10^{-8}$ cm (normal)

Before I put on my virtual reality goggles, subtitle script on my iPhone tells me that in this space I am going to enter, there are aliens invading my home and I am one of two adorable bunnies responsible for saving the planet. This is fine by me. And yet, when the scene opens, I am staring at the Earth, a long way off. I look around me, a 360° view of the Earth in the distance, and the stars in the distance, as I imagine it really appears from some far-off angle in space. A light flashes from the planet ahead, the planet I know, blue and bright. A spaceship zooms toward me. Up until this moment, I am alone in a space that looks in every way like real space. This spaceship, however, looks a bit less *Planet Earth* and a bit more *Wall-E*. It comes up close and from within, some comically unfrightening extraterrestrial stares at me, matching

me curiosity for computer-generated curiosity. Then it flies away

$2x10^{-8}$ cm (compressed x 2)

In the book *Black Holes and Time Warps,* astrophysicist and 2017 Nobel laureate Kip Thorne describes how scientists in the 1990s thought it might look and feel to fall into a black hole. On Thorne's graph depicting the Harrison-Wheeler equation, plotted against density (grams per cubic centimeter), is matter's resistance to compression. In other words: how a body of matter changes under immense pressure. In this case, a body of iron. A lump, cold and dead. At first, as iron is compressed, the electrons gather tightly around their nuclei—a sort of congregation of claustrophobic motion—like flies increasingly frantic around a bite of meat in the sun. Then, as compression increases, the electrons begin to ignore the nuclei altogether. They make what is known as degeneracy motion, likewise producing degeneracy pressure. An erratic, wave-like protestation of space. Thus, Kip Thorne writes, *the matter has now become the kind of stuff of which white dwarfs are made.*

I don't know who I am in a virtual space, other than a spectator. If I am a bunny, why am I so far out? If I have yet to become one, when will it happen, and how much will it hurt?

$1x10^{-9}$ cm (oblivious to the nuclei)

The third-proudest moment of my life was the day I won a drawing contest in my Black Holes class. It was my first semester of college, and I enrolled in Professor Andrew Hamilton's course at the University of Colorado at Boulder. The class marketed itself to non-science majors, which meant that in addition to solving basic problems of speed and light refraction, in addition to leveling-up our physics understanding from a high school algebra foundation to a rudimentary (and still, like, way-hard) calculus base, we got to watch sci-fi movies with black holes in them and debate their accuracy.

The contest was to assess who could best draw what one might see while traveling close to the speed of light. Though this possibility is undoubtedly more complex than I understood it then (even more so than I understand it now), I drew my scene based on the following principles: moving at this speed, my visual world consolidates into a circular window in front of me. At the center of this image, all that I am moving toward appears blue—light waves shortened. All from which I am moving away, everything around the outer edge of my circle-vision, appears red-shifted—light waves elongated. At this speed, everything becomes distorted, bending toward the center.

In a powerful (though possibly low-budget) 3-minute and 56-second

film,[*] Carl Sagan describes all of this, as well as the unsettling issue of relative time. As one travels near the speed of light, time slows down. So, Sagan explains, one might leave on her space-time journey, travel for only a few minutes, then come home to find that all her family and friends have died. In the film, a boy leaves his Italian home on a super-speed Italian motorcycle, then returns to find his parents dead, only his brother alive, waiting for him on a park bench, an old man in a sweater and a hat.

$1x10^{-10}$ cm (behaving all relativistic)

I started seriously thinking about black holes at the same time that I started writing poetry. This synchronicity is poetic, perhaps, but also, perhaps it's not. This was also the time that I started drinking coffee, and cooking my own dinners, and working at a bakery that sold cookies until 3 a.m. This was the first time I went on a date with a boy in college, who I met in Black Holes class. And the first time I met a different boy, who I would later marry, who also took the Black Holes class, but with a different professor. All of us eating dorm cereal and drinking unlimited chocolate milk and riding our bikes thinking about the same thing: what is a black hole and what would happen if you fell into one?

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[1] https://www.youtube.com/watch?v=-CIs3jOnfiM

How it would feel to fall into one is speculative, since 1) presumably, no one ever has and 2) anyone who has or does would/will be unable to communicate their experience to us, should they survive at all. How it would *look* to fall into a black hole depends, like most things, on perspective. It depends on who you ask.

It's like this: You, the one falling into the hole, stretch into a long, slim thing. Assuming, of course, your continued ability to see despite the speed and the pressure and the terror of it. Around you, a sort of turning of space like time looping back to itself. A snake eating its tail. You see and feel your body stretch and if you survive this immense and elongating pain, you see a tumbling settle into a singular bright light.

But it's also like this: You, the one watching a person fall into the hole, see only a blink of light as the person falling crosses over the event horizon, the boundary of a black hole beyond which there is no coming back. Bodies go in and do not come out. Yet, because, in our universe, matter is neither created nor destroyed, the information of a body can't simply disappear. There has to be evidence that the body is gone. Thus, as you watch a person fall into the hole, you see a flash of light: a body exploding on the boundary of the unknown.

A body crossing over a boundary feels no particular jolt, but rather, an immense and excruciating stretch. And yet that same body is seen to

explode in an instant, to explode upon crossing some line, some clearly defined point. The body is seen to be gone.

$1x10^{-11}$ cm (converting protons to neutrons)

I am not a great artist when it comes to colored pencil on paper. Really, I won the contest because out of the 300-some students that were assigned the homework, I completed it and somehow managed to find four or five different colored pencils to use, which I somehow managed to keep within the lines of my simple drawing. Of all the scenes I could have imagined, the one I chose was a street scene, a New York City street scene, maybe, with tall, rectangular buildings of different primary colors warping easily, uniformly toward the center. I drew windows on the buildings, glass that bent, and flowers and grass on the ground. For this, I won the contest. I collected my extra credit—a few percent added to my overall grade—and marveled at what I now, as a teacher, understand to be not an unusual lack of general effort toward homework.

In addition to judging drawing contests, Professor Andrew Hamilton is the creator of the Black Hole Flight Simulator, a computer-generated visualization of what one might see when traveling through black holes of various qualities. Visit the simulator's website and you will find a small video clip of, in Hamilton's words, "a general relativistic

visualization of a supercomputed magneto-hydrodynamic simulation of a disk and jet around a black hole."[*] It looks a bit like the visualizer function of iTunes, the thing my friends and I marveled at when we got our first laptops and they started smoking weed and I kept busy coloring in the lines of warped space-time cityscapes. Color streaks across the screen, circling a field of supposed black space. Various shades of browns and whites, like steam streaming off a boiling pot of broth. That is to say, it's much brighter than I imagined it might look.

My efforts to verbally describe black hole flight simulations tend to induce a similar reaction in loved ones as describing dreams or complaining about grading papers (kindhearted patience belying disinterest). When I show my husband this video, he tells me that I should reconsider bringing it into my graduate poetry workshop because people will think I do a lot of drugs.

A bit more investigating of Hamilton's online presence might lead to his compiled list of media involving black holes.[**] Apparently, he continues to offer up to two percent extra credit for students who refer movies and books to him though, he reminds us, they have to be about black holes specifically. They can't just be about time travel like *Back to the Future*. When I took the course, we watched the 1997 film, *Contact*.

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[2] http://jila.colorado.edu/~ajsh/insidebh/intro.html

[3] http://casa.colorado.edu/~ajsh/astr2030_09/bhmovies.html

Based on the book by Carl Sagan, *Contact* follows Dr. Ellie Arroway, played by Jodie Foster, as she searches for evidence of alien life. Arroway discovers a sequence of prime numbers apparently sent from the Vega star system, twenty-six light-years away. She also has a relationship with a Christian philosopher, played by Matthew McConaughey. According to Hamilton, director Robert Zemeckis consulted Kip Thorne on the science of the worm hole, but couldn't wait long enough for a scientific rendering, and instead went for something "artistic and dramatic." The film does, Professor Hamilton concedes, offer a "momentary glimpse of an exquisite galaxy."

$6x10^{-13}$ cm (paired neutrons and degeneracy pressure)

The VR goggles came in the mail and they don't work very well. The cardboard frame itches my face. The part that touches my forehead gets noticeably greasier each time I use them, and they came with a magnet that looks like a washer, and I don't know what it's for. But when I hold them to my face, I can see things like I'm there.

I tell people that I am interested in the poetics of black holes. Or the poetics of space-time relativity. Maybe this sounds smart, like I can talk about poetry but also about math. Or maybe this sounds like pseudo-science, some dangerous elision of aesthetics and astronomy with little regard for fact.

My fascination is nothing new. In a series of correspondences,[*] writers Amy Catanzano and Andrew Joron debate connections between contemporary poetry and physics—specifically poetry and quantum mechanics/string theory. Joron names the feeling I get both from physics and from poetry "wonder." He writes, "wonder is the one, primary affect that conjoins science and art." Joron and Catanzano agree that poetry, like quantum mechanics, has the capacity to, as Joron explains, "destroy—or do what amounts to the same thing: radically renovate—the universe." According to the theory of quantum mechanics, the world at the micro level does not look anything like the world at the macro level, but rather functions on uncertainty. Amy Catanzano describes quantum mechanics as the "physical expression of alienation," a move within science from an explanatory (and therefore, she argues, "less alienating") description of the natural world to a disrupted, uncertain understanding of physical phenomena. This, she argues, is like poetry's capacity to "say the unsayable."

Physics offers me another way to think about the limits and extensions of the poem. I am interested in the degeneracy motion of language, it's incapacity to hold some solid state. The inevitability of pressure buildup, the inevitability of breakage. How long can language hold itself under pressure, and what happens when it breaks?

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[4] Published online, as "Magical Correspondences" in six parts, by *Jacket 2*.

$3x10^{-13}$ cm (a repulsive nuclear force enhances the pressure)

Using crappy VR goggles is not very similar to falling into a black hole and writing a poem is also not very similar to falling into a black hole. As far as I know, my body is at no greater risk of falling into a black hole than any other body, but I want to—feel compelled to—think of my body's place in time and space. How do I move from a body creating a replica (artist), to a body observing a replica (virtual body—inert), to a bunny fighting for the Earth from space (virtual body—active), to a self? What is the time/color shift? When do I enter a new space entirely? In what way have I become not the least virtual of two bunnies, but some actual, non-virtual thing?

And what about the gone body? The body that explodes, a bright flash in the distance. The event horizon is that barrier of spacetime beyond which there is no possible escape—not of matter, not of sound, not of light. At which point, if we are watching this happen, the body leaves a mark in its wake. A flash on the horizon. Evidence of its own goneness.

I don't want to watch from the distance. I want to stay with the gone body. The body that is also, at this instant, an intimate self, a self disappearing, red shifted, but looking forward onto its own.