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Science and Math in Everyday Life

At One Point

At summer camp after sixth grade, I wrote a paper—in longhand, on three-hole-punched, blue-lined sheets—outlining various theories of the origin of the universe. I was trying to get back to the beginning of things. Maybe I would see my own orbit in a clearer light. Maybe I'd get a glimpse of the cradle of the cosmos and the hands that rocked it. That there were no real facts at all, only theories, I found comforting. The big, echoey college library—the camp took place on the campus of a small college—was a model of the universe, books and ideas rotating round each other. You got dizzy if you thought about it all, all the words, all the contradictions, all the dark stacks and odd corners.

Many years later I would read, love, and teach Italo Calvino's "All at One Point," in which the universe is born. The story, told like the others in the volume by an ageless narrator named Qfwfq, begins with its very brief epigraph about the universe's matter being "concentrated in a single point, before it began to expand in space," and then: "Naturally, we were all there—*old Qfwfq said*,—where else could we have been? Nobody knew then that there could be space. Or time either: what use did we have for time, packed in there like sardines?" The marvelous, miraculous thing is that it is Mrs. Ph(I)Nk₀ whose generous wish, prompting the imagining of its fulfillment, leads to the expansion of the point into the universe: "Oh, if I only had some room, how I'd like to make some noodles for you boys!" And suddenly, the imagining of the space to make noodles creates worlds and worlds.

Such an incandescent, expansive view.

Testing, Testing

The camp was designed for "gifted" children; an IQ test, that zenith or nadir or, simply, misconception of a quantitative measurement of the qualitative, was required for acceptance. I did not question the number assigned to me, one point below the usual gifted cutoff. I was not supposed to know that number; the letter my mother received stated explicitly that she should let me know I was accepted but should not tell me my actual test results, so she duly showed me the letter, which stated that although I was just under the bar ("That's too

bad, isn't it?" my mother said), I was welcomed as a camper anyway. One point below, but not to fret. What mattered to me at the time: my two best friends were going, and now I was, too.

We studied astronomy in the mornings; in the afternoon, we had "activities," none of which I recall except swimming in the college pool. We campers could pretend we were college students, going to classes, living in dorms, even, to my great chagrin, attending sock hops and dances. Perhaps the camp was trying to teach us about the maintenance of the universe, the foundational male-female theory. Attendance at the sock hops in the dorm lounge and at dances on the stone terrace was mandatory, as if to say, Your adolescent lives begin at this point, from which they would theoretically expand. I heard "Going to the Chapel" for the first time and watched as paired-off ten- and eleven-year-olds clung to each other with gingerly abandon, shifting weight from one leaden foot to the other. I watched my friend Debbie of the lush long eyelashes with her heartthrob, her head resting lightly on his shoulder, her eyes closed in a prim schoolgirl half-swoon. The boy was smiling foolishly, his face beneath the freckles flushed pink, his right arm manfully clasping her waist, his left hand entwined in hers. Perhaps their stars were briefly aligned.

Not Long at the Fair

In the spring preceding camp, I participated in the science fair, that bane or boon of students, gifted and otherwise, across the world. I produced a project on—the beaver. God knows why. True, I loved animals; later, I would love imagining those creatures who could scoot smoothly and sleekly through water, though I never again focused on beavers.

My science-fair display included a report on beaver habits and life cycle, with the animals' unique attributes, buck teeth to tail; a piece of wood possibly chewed by a beaver; photographs of beavers (not taken by me—I'd never seen a beaver in the wild and still haven't); and the pièce de résistance, a model beaver dam, consisting of a baking tray painted a vivid blue and a row of artfully placed twigs and leaves—artfully, to imitate a careful jumble—crossing the tray in the middle, with a slightly higher mound to represent the lodge. My mother had helped me construct the model.

Stargazing

My stargazing soon migrated from the skies to stage and screen, my new heavens. I increasingly trained my sights and dreams on the great classical actors and actresses, mostly British, and on

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musical-comedy leading ladies. I perused every page of *Theatre Arts* and *Plays and Players* magazines. I studied my father's collection of *Playbills*, so that productions I'd never seen became adopted memories. I longed to know Laurence Olivier, Ralph Richardson, John Gielgud, Paul Scofield, Peggy Ashcroft, and on and on. I listened over and over again to my recording of *The Sound of Music*, the movie version, because I was totally enamored of Julie Andrews. Before I got into bed, I bade her picture good-night. I saw *Mame*, and I wanted Angela Lansbury for my own Auntie Mame.

It was my father's career as an actor that allowed me to peer into the theatrical firmament, as if he were a well-known astronomer and I as his child was invited into his observatory to look through the giant telescope.

One of my father's friends, a director, gave me a book which he inscribed with these words: "Love actors, adore actresses, but marry a good man."

What I Learned about Physics

The theater was one of the few sources of my limited physics education: in 1969 my father played the physicist J. Robert Oppenheimer at the Vivian Beaumont Theater in New York City's Lincoln Center. The play, based on Oppenheimer's 1954 security-clearance hearings, primarily gave me a sense of historical context and some notion of the fraught connection between politics and science—not actual physics. Still.

My memory of my father's performance as physicist, his fictional/factional Oppenheimer, became an indelible part of my own history of science.

What Else I Know about Physics

I have understood string theory through my cats—string! It's moving, chase it, grab it, drag it.

The image of Brownian motion first appealed to me when I was living in New York City: I saw all of us, on the streets, in the subways, on the buses, tucked away in apartments, as particles with no determined paths. Although, in fact, many of us had overly determined paths, as we desperately attempted to reach the office or the train or the best broccoli at Fairway or smoked fish on Fridays at Zabar's. But in the midst of it all, I felt a defined and determined randomness. I felt myself to be a random particle, never sure of which direction I was being carried in.

Isn't "chaos theory" a beautiful oxymoron? I think

immediately of bodies moving in a dance called “Connoisseurs of Chaos,” choreographed by a dear friend. And I can apply chaos theory to my own physical existence: in my immediate surroundings, books and papers and oddments multiply and spread on every possible surface. I am, I suppose, a connoisseur of chaos myself, trying to fill the void, staving off the vortex of the black hole, that vacuum of seemingly empty, cruelly burgeoning space.

Negative Numbers

I learned that you can take more from less: I learned about negative numbers, which give us the means of counting nothings, quantifying the volume of increasingly less than nothing. I can remember playing school with my cousins in the dim basement of our grandmother’s semidetached house, insisting on taking the role of the teacher, and writing a subtraction problem on a blackboard easel: a larger number subtracted from a smaller number. I felt glorified in revealing the answer was, yes, a negative number, which made one of my cousins quit the game.

When I told my mother about negative numbers, she refused to accept their existence. She shook her head in disbelief.

Later, when I married, I tried again to take more from less.

New Math

I was one of the hapless victims of New Math in the sixties. As far as I could tell, New Math was meant to prepare us for understanding the mathematics of creatures from outer space, in case we ever had to deal with aliens who had four or eight fingers, odd numbers of toes, perhaps no physical symmetry, perhaps no limbs or digits at all.

New Math taught us to question what normal meant. The very numbers we counted with were suspect.

Then New Math became outdated. It was disappeared. It became a set of negated numbers. Hoary, wizened, and wise, Old Math took back its reign.

The X Actors

In seventh grade, I was entranced by the x ’s and y ’s of algebra. They were doing something I could understand: they were actors, playing roles, as required.

I learned the basic laws: the commutative ($a + b = b + a$) and the distributive ($a(b + c) = ab + ac$). In other words, no matter where

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a and *b* are, whatever role they're taking on, their relation remains basically the same. Isn't that comforting?

I appreciated equations. I liked their complete symmetry, one side balancing the other. Ideal. I tried to apply that symmetry to life. If I were *x*, what is on the other side of the equal sign? I sought balance.

Weighing Time

If time were less substantial, had no mass, did not, as they say, weigh on our hands, or our shoulders, or any other part of our bodies, the years could bounce off the surface of our lives just as we would bounce off the moon's surface gravity. Actual light years.

My choreographer friend and I worked on a piece dealing with time, which we called "Unfurled"—movement interwoven with text. We considered including, in voiceover, this statement from physicist Brian Greene:

[E]vents, regardless of when they happen from any particular perspective, just are. They all exist. They eternally occupy their particular point in spacetime. There is no flow.

. . . The flowing sensation from one moment to the next arises from our conscious recognition of change in our thoughts, feelings, and perceptions. And the sequence of change seems to have a continuous motion; it seems to unfold into a coherent story.

Which makes sense in current neuroscientific conceptions of memory: memory is the creation of narrative, the linking of moments in a comprehensible trajectory. In this sense, we create time; or, rather, if we move and time does not, we *are* time.

In the first scene of Chekhov's *Uncle Vanya* (one of my touchstones), Dr. Astrov tells the old nurse that in two or three hundred years, their descendants will not remember them or their suffering, and the nurse responds, "Man will not remember, but God will remember." Astrov both acknowledges and dismisses her viewpoint: "Thank you for that. That's a nice saying."

Now, a new telescope will, it is hoped, see back and back in time, perhaps to when the first stars formed.

My friend and I never completed "Unfurled." It stayed furled, for us. In spacetime, however, it continues to exist, still, stable, rippling, and I remember our work fondly.

Graphing Coordinates

Geometry, to which I was introduced in ninth grade, wore the

face of the tangible—ruler, protractor, graph paper with its neat blue squares. The notion of coordinates was itself soothing: you can plot the relation between any two points; the points don't seem to move—no Brownian motion, no random particles, no chaos. I craved such steadiness, such logic.

But just because in two dimensions the coordinates were graphable and getting from point *A* to point *B* presented little difficulty, what happens in three dimensions? on the curved surface of the earth? through the madly circulating molecules of air? The third dimension, beyond the lines on the graph, proved a ghostlike presence. (When our sixth-grade teacher read us *A Wrinkle in Time*, I'd tried hard to move beyond the dimension of that harsh but nebulous dimension of time and grasp the fifth dimension, but my literal mind had some trouble with the tesseract.) The shortest distance between point *A* and point *B* had to be a straight line, but a straight line was hard to come by in the course of any given day, month, year, except—as I learned—in retrospect.

Higher Math

Of Algebra II, I have, appropriately enough, only two memories: my friend Cindy composing movie titles with algebraic terms, my favorite of which was *Beach Blanket Binomial*; and our teacher, Mr. Shropshire, emphatically pointing out to us, “A circle *ain't* a function.”

I was never required to take calculus or trigonometry. When I came to the GREs and the math section presented questions dealing with logarithms, chains, slopes, sines, cosines, tangents, and secants, I had no idea what these terms meant (I've had to look up lists of relevant terms), and I left the problems blank. These were *x*'s and *y*'s too far.

Now, of course, I cannot escape knowing that all relations with the web, all online lives, meaning so many lives, are algorithmic. I read recently that for Lacan, a deep layer of the human psyche is algorithmic. This must be the layer that Amazon and Facebook and millions of advertisements on the web seek to reach and manipulate. Remember the protagonist of that paranoid television show *The Prisoner*, a former spy relegated to the panoptical prisonlike Village? In every episode, he declares, “I'm not a number, I'm a free man!”

Further Math

Before the advent of the internet and instantly accessible information, a dear friend asked her father, a mathematician, to explain cybernetics. “Ah,” her father said in his distracted way, “Cybernetics.

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Yes, cybernetics.” That’s as far as the explanation went.

Marine Life

Once, I longed to swim with the dolphins, like the dolphins. And the whales, and the sea turtles, their wings spread, and jellyfish, their cometlike tentacles trailing.

In my junior high years, I thought I might become a marine biologist or an oceanographer. That I did not fully distinguish between the two careers was a giveaway. How serious could I be, if I thought of these in terms of either/or? Mostly, I just liked the idea of moving through water along with the living things of the ocean.

I was entranced when I read Rachel Carson’s *The Sea Around Us*. The very cover of my hardback copy was inviting. The mottled-green design made me think of algae floating near the sea’s surface, rippling like dancers. The water seemed to beckon me. And there was Jacques Cousteau’s undersea world, as featured in my *National Geographics*. Dazzling photographs of him and his team gliding through an intense blue; dim photographs in the darker depths, as the bathysphere settled on the ocean floor, down, down, down. I felt a strange urgency to descend to this world. I would meet Davy Jones, I would find the hole in the bottom of the sea, and the log in the hole, and the frog on the log. I’d return to the surface—slowly, avoiding the bends—tired, changed, renewed. I’d emerge into bright sun, and the crystalline water would slap me lightly and lovingly.

I dreamt of slipping through water like a sea creature, a paragon of motion and suspension.

I’ve wanted, as an adult, to go on whale-watching trips. But the few times such an excursion has even been a possibility, I haven’t seized the chance. Years ago, I wrote a story in which the narrator, my fictional surrogate, takes one of these trips and spots several of the big dark spouting breaching creatures and is awed. She buys a tape of whale song and then has nightmares about the wrong mammals underwater—cats, dogs, horses, all with enlarged, frightened eyes. Some of these nightmares were actually mine.

At times these days, I think of my long-ago undersea ambitions, and I want once again to lower myself down from the surface of the days into darker, colder depths, where straight lines bend and blur, water caresses all bodies, and space and time curve toward each other in a perfect marriage.

Once, in a seaside garden in California, I saw dolphins in the distance arcing through air and water, echoing the curves of spacetime. I remember this sighting, and I am moved.

Nova

In college, a distant period of my life from which I've never fully recovered, I did not visit the placement office, because I was afraid—quite logically—that a counselor would ask me what I wanted to do with my life.

I knew I could not answer the question, except in this way: I wanted what rubbed and made sparks and caused possible burns, things with a definite shape, things that gave off heat. But I'd nearly failed chemistry—actually, our arts high school teacher gave up on the class partway through—so such reactions and near-conflagrations seemed impossible to achieve.

For a few years after my college graduation, I drifted, weightless, invisible, off the star charts. Then I met the man who would become my first husband. This young musician, stars in his eyes, was bound to rescue me. I saw in him a soul that burned, visibly, phoenixlike. I admired that flame, one I believed I could not kindle alone.

Mr. Science

A comedy troupe out of San Francisco called The Duck's Breath Mystery Theatre had a regular sketch spot on my public radio station: "Ask Mr. Science." The tag line, after the expert had inexpertly answered a scientific query, was "Mr. Science. He has a master's degree. In *Science*." Mr. Science went on to receive his Ph.D., and Mr. Science became Dr. Science.

I still have questions.

Space Travel

My first husband once asked me, "If a spaceship landed right here in front of the building, and they asked us to come on board, would you go?"

"Would you?" I asked.

"I asked first."

"Not me," I said. "Never ever." He'd known perfectly well what my answer would be.

"I would," he said immediately. "I'd go in a second." I knew this, too. After a moment, he added, "You'd really let me go off into space on my own?" He looked hurt. "You wouldn't come?"

We did, however, practice our own form of space travel. Our apartment itself became a spaceship, and we two were astronauts, careening through space in our little capsule. There was faint radio

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communication with Ground Control, but not much other contact.

The particles within the spaceship were highly charged. Every molecule shimmered with meaning. In their minute, ceaseless dance, protons, neutrons, electrons whizzed through our minds and bodies and the objects around us. It made us dizzy. We both feared that something would go wrong with the mission. We threatened to collapse into our own singularity, beyond implosion.

Me:Universe

I struggled with problems of ratios and proportions. I asked myself again and again, What is the proportion of happy to unhappy hours? fictionalized moments to realistic ones?

If you try hard enough, almost anything can be seen in relation to almost anything else. Mixing apples and oranges is, on some level, valid enough. A marriage, for instance, is just such a mixture. It all depends on your level of inquiry.

I tried to understand the ratio of me to him. He tried to comprehend the proportion of musical notes to the moments of the day (there were many more notes than available minutes). I tried to reset the ratio of time awake (too much) to time asleep (not enough). The numbers never came out right for either of us.

Was less really more? My psychiatrist at the time used to say, inexplicably, “The more, the more, the least, the least.” Actually, in her native French accent, this came out: “Da more, da more, da leez, da leez.”

I tried to plot the x and y coordinates of my life, of our lives. To trace the learning curves. Learn the curves of the road ahead. Render proofs, graph projections. See into the future, around the time curving away from me. I tried to be open to new variables, new equations. I tried to be open, but I heard doors behind me closing. Shutting out, shutting in.

The man I'd married opened a door and walked out, trying to shut the door behind him as softly as he could. I was subtracted. I became the variable. My tentative tether to gravity was broken again, and I had no orbit. A circle ain't a function.

My universe shrank. Or, my universe expanded. Or, entropy and its disorder proved the end of the marriage irreversible. Whichever law or theory works best.

Do the Work

“Do the math” has been widely bruited (can one bruit on social media? Perhaps that's all one *can* do) these days, shorthand

in every sort of circumstance for “Figure it out” (although it’s not much shorter). Often, the implication is that if you can’t do the math, you’re probably an idiot, which I would prefer not to be. But the actual mathematics involved in serious questions is beyond me and beyond plenty of intelligent people. At the same time, we have learned, certainly, that we cannot automatically trust statistics, so easily manipulated are they and so nefariously used.

“Do the research” has also been popular in our sound-byte universe, particularly in terms of the Covid pandemic and the vaccination debate. We are, of course, bombarded with research results—most of us are not actually doing the research—and we must pick our way carefully through the thicket of what might or might not be reliable information, or creditable hypotheses and projections. I find myself wishing for breadcrumbs.

Today, I saw a bumper sticker that read, “Stand Up for Science.” A call to arms of some kind. Vote “Science” for president, or senator, or governor. Don’t take it sitting down.

Zeroes and Ones Dancing Together

And we are, most of us, caught up in that dance. We are wandering—randomly or deliberately, we may think—through the arcades and alleys we hold in our hands. The archetypal flaneur of our time must be the person scrolling through an iPhone, manipulating zeroes and ones that are probably manipulating the scroller. Scrolling as strolling. Countering our tendency to “let our fingers do the walking,” as the old *Yellow Pages* ads entreated us to do, are the numbers of books about—yes, walking, in countryside or city, putting me in mind of that 18th-century walker and dreamer, Jean-Jacques Rousseau, and by association reminding me of the little abridged version of *Les Rêveries du Promeneur Solitaire* I read in a college French class.

I see I’ve just given in to a perhaps real but possibly too-neat dichotomy: the inside/outside; we are either glued to our devices, or our eyes, ears, all our senses are tuned into the natural world. Technology versus nature. But since we, as well as other animals who devise tools, invented it, technology (such a broad term) can be considered just as natural as my sea creatures, my cats (domesticated), the “wild” places, all of us. The very concept of nature itself could be considered a human invention.

Oh, dear. The rabbit that is science has disappeared down its rabbit hole, and I, like Alice, have followed, to find myself in a mazy world. The one that I think I am has plunged into the central vortex of a zero and is looking for a way out.

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Permeable

Long after meeting and memorizing the term in an introductory biology class, a terrible form of osmosis became clear to me. My skin became, not semipermeable, but too-permeable, hardly a boundary at all. “Thin-skinned” did not begin to describe this anxious state of being; I felt as if I had no skin. Any slight wind blew through me, everything—noises, voices, events large and minuscule, demands and responsibilities—bombarded me. I was diffused, dispersed into the air, as if my very self were leaking out.

Gathering myself back in meant some years of trembling.

Uncertainty Principle

Once, I misunderstood the Uncertainty Principle: I took it to mean knowing neither where I was nor how quickly I was hurtling toward a destination that was also, of course, unknown. Later, I thought that it was a question not of both or neither but of either/or, two unequivalent binaries. Later still, I realized that it is a question of relations, between position and momentum: as the *Stanford Encyclopedia of Philosophy* tells me, we cannot determine “exact simultaneous values to the position and momentum of a physical system.” And now, I see again that we can know only up to, well, what we call a certain point, a point whose position or movement we may not be able to fully ascertain, either.

Retrospect

When I look back, as I do here, I ask, What has been added? What subtracted? Multiplied, divided, fractioned, x'd? What can be measured? What is best left unmeasured? What uncertainty is at work? What heat has been lost?

How far back in time can the light stretch, as it recedes from us and we from it?

“I am glad for the luck / Of light,” writes May Swenson in her poem “October”:

Light that hatched life
out of the cold egg of earth.

Once and again, I see the curving blue-gray backs of dolphins, splash-stitching air and water. A gleaming.

Analogy

I picture my neurons—your neurons, too—reaching, stretching out toward surrounding neurons, not quite touching but in fervent, feverish electrochemical communication, the synapses not a void to fall into but a conduit, a weird disconnected connectivity. Constantly associating this impulse with that, the impulses connecting somehow to build sounds, images, tastes, stories. Functioning by analogy, this to that. You to me.

I have wanted to link my own stories with the perhaps cleaner, purer worlds of science and mathematics. I've wanted to map those worlds, like an overlay of graph paper, onto the narratives I've contrived in order to make sense of the phases of my life. Phases that may be arbitrarily drawn. A mapping akin to the futile application of classical physics to the actions of atomic and subatomic particles, which shatter cause-effect relations essential to most stories—but that's another analogy. Perhaps I have tried too assiduously to find analogues and metaphors. Too much synthesizing, perhaps. Too many possible connections. Too much osmosis.

I hear the objections: oversynthesizings, boundary crossings, boundary blurrings—these erase the singular. And I know that analogies can mislead us. God as clockmaker. Nature as a book. Survival of the fittest as manifest destiny. Human memory as computer. But I think the singular, the boundaried, and the deeply connected, the entwined, can exist in the same spacetime. Analogies can provide us with a means of not only knowing but also admitting we cannot know. Somehow my analogies soothe me.

A friend sent me the following passage from Gérard de Nerval's *Aurélia*:

All is alive, all is in motion, all is connected; my radiant energy, along with that of others, passes unobstructed through the infinite chain of all created things; it is a transparent network drawn over the world whose fine filaments are ever extending to the planets and the stars.¹

These words, analogized from the French, also soothe.

New Proofs

For all that I don't and will probably never know, I am learning, I think, to understand some things. For instance, the

1 Translation by Nicole Wong and the author.

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conservation of energy. I can see now that the energy once seemingly lost to me—energy limited to begin with—has reorganized and become at least somewhat available. It has consolidated itself, without turning in on itself, within the little house where I live with someone I dearly love. There is gravity, there is light and lightness. The days both multiply and dwindle. Pleasure and delight need not be overcharged; sadness and ease can curve toward each other like time and space. Our lives loop inward and outward, a theorem always in the proving.

