# Flash Fiction Fugue

## In Four Dimensions

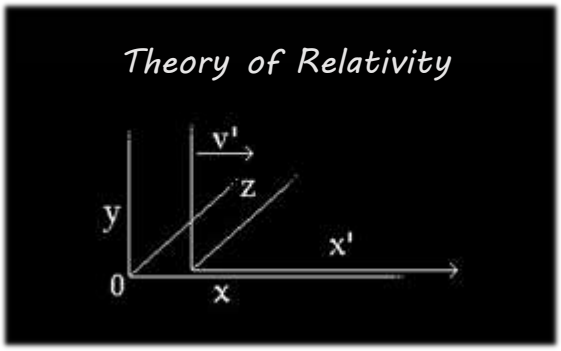
Tom Ransom 2017…

## Length

Well that's it, he thought, no way I can live up to that performance. This was the day in ninth grade English when each by turn was to go before class to present their "topic of choice" and Nolen had just delivered a comical demonstration cutting a golf ball open to reveal the 'mystery' at its core. This was back in the day when a hundred feet of sticky rubber band preceded the discovery, which ended up in a quivering pile on the teacher's desk. This was the same guy who was kicked out of concert band for sneaking a ball of twine from art class into practice, somehow getting the entire trombone section to roll it around their chair legs—unnoticed, such that when he walked out at sessions end, twine in tow, a colliding clash of folding chairs piled up in the doorway. Too funny. Legendary. Nolen had just done his thing, everyone was laughing, and sure enough, he was up next.

The night before had been long, restless, and worrisome. Such a prelude was likely to precede any public performance, but in addition, Tina, the prettiest girl in school, would be sitting in the front row of class. Would he even be able to gather his thoughts? And why in the world had he selected such a difficult topic anyway, one he could hardly understand, much less explain. And yet, then again, he knew full well why he wanted to present this subject—it was so unbelievably cool!

And so it was the following afternoon when his name was finally called, standing up at the back of the classroom, all eyes upon him, that he proceeded down the narrowing isle between the desks, a gauntlet of expectant faces, to find himself at last at the front of the class before the blackboard. His apprehensions the night before now fully realized, he nervously reached for the nearest nub of chalk, looked up, and wrote: Theory of Relativity. Directly below he drew two parallel lines, then two more extending up and out from each, and lettered them, just as he remembered from the encyclopedia at home.



"This drawing depicts two reference frames in what physicists call the Lorentz transformation," he began, "and Albert Einstein's interpretation revolutionized physics and forever changed our understanding of energy, space, and time." He went on to reveal how the Lorentz equations represented accelerations in 3-D space, how the lengths of the x, y and z coordinates contract with velocity until on final approach to the speed of light they went "singular" and *vanished*. And because all physical objects are extensions in space, they would contract with velocity and vanish as well. "Now *there's* a trick," he said in reference to Nolen's skit, "hit a golf ball the speed of light and watch it disappear!"

Clearly on a roll, his confidence on the upswing, he further explained that it was Einstein who first realized what it means when the mathematics of motion go singular at the speed of light: "Because energy and mass are equivalent, and it takes energy to accelerate an object, we find an *infinite* amount of energy would be required for anything to ever attain it. This makes the velocity of light through empty space an absolute limit and nothing can go faster. But why *is* that?", he teased, and then concluded with the grand reveal: "Because that's the speed of the expanding Universe so you can't out-run it. Besides, there's no place to go. At lightspeed the motion equations go singular meaning everything is happening everywhere *now!*"

And with that it was mission accomplished, he had turned his classmates onto the coolest *ideas* ever. He looked up from his notes assuredly, anticipating a sense of wonder on their faces, just as he had experienced. To be reminded how amazing and mysterious *reality* really is. But as he glanced across the faces of his peers he saw only bewilderment. He looked over at Ethan, the brainiest kid in class, slumped down in his seat fidgeting with a pencil. Nolen was sideways looking out the window. Tina, expressionless, was at least sitting upright. The teacher, witnessing his disillusionment, and then virtual dissolution, felt obliged to step in and direct him to his seat.

There he sat stunned and embarrassed. He could hear her reminding the class that tomorrow was the field trip to the planetarium, but he wasn't listening. He should have known better! He should have presented the conch shell placed on the fireplace mantel at home. He would have passed it around for everyone to see and touch. They could have listened to the ocean.

## Depth

Stars everywhere! In all his gazing up at the sky never had he seen stars as dazzling as these. This was a dizzying display. The entire stellar dome seemed to be spinning—counterclockwise, as if the planetarium program was rewinding. But then why was he laying here on his back, in the middle of a field, amid the stubbles of grass and widgeting crickets? The Sun was going down, a chill was in the air, why hadn't he worn a jacket?

And then... he was *gone*. No sooner had his eyes closed, as into a welcoming dream, he was free falling into a familiar warmth within. He fully appreciated how this inner heat was all that separated him from the big-chill outside. He had read enough biology and chemistry to fathom the depths of this internal world, and fashion an understanding, but what was at the bottom of it all? What was the ultimate *source* of this radiance within?

So he began to imagine what was transpiring inside. He took a deep breath and followed the infusion of fresh air as it rushed into his lungs, watching as the oxygen molecules were drawn out, captivated by the iron-laden red cells passing in his bloodstream. He was amused when a convulsive pulse suddenly flushed them away, through the heart's chambers, into branching arteries, then out every capillary. He was again surprised how quickly this oxygen was evacuated, channeled through surrounding cell walls into the intake ports of microscopic "mitochondria"—as if breathing was all about them!

And it is! They're *why* we breathe. These tiny organelles within every living cell are the metabolic furnaces that oxidize ingested carbohydrates to produce our cellular fuel. He had read that the heat from this combustion process gets absorbed into the bloodstream and circulated throughout, gathering in the central organs. So he knew that mitochondrial respiration was the proximate source of his immediate warmth, but he also knew that finding the ultimate source would require going deeper.

He further recalled that biological processes were really chemical in nature, and when you got down to it, chemistry was happening on the atomic scale. So he imagined the mitochondria from within. He was amazed how fast everything was moving, molecules bumping into one another *millions* of times a second. He watched as the incoming oxygen was absorbed in the "citric acid cycle", and followed the reaction down to observe what was at its source. At the bottom of it all was an energetic cloud of electrons in orbital pursuit. In fact, this kinetic affinity between the electrons and protons is the nexus of not just the biologic, but the entire material world. Surely, if heat was the result of matter in motion, things couldn't get much smaller, faster, or hotter.

All that remained, insofar as he knew, as far within as the galaxies were far away, was a dark, sequestered, subatomic underworld, and he was feeling more dizzy and disoriented than ever. And yet, he remembered reading that resident somewhere, at the theoretical threshold of reality, was a "harmonic oscillator". This was the genesis engine where pure energy potential first materialized into matter. For physicists, this "quantum wavefunction" was the bottom-most feature of the radiant Universe. If so, then it must be *very* close.

And sure enough, as his imagination and the moment merged, a certain distant "hum" was becoming ever clearer, closer..."om"? It sounded like the timeless mantra of the mystics! The Source? Holding his breath, he heard it again, ever closer... but wait, this wasn't coming from deep within, this was from an *outside* source, the sound of a distant voice.

"Tom!  Tom, are you okay?"

It was one of his classmates! Sitting up, the sound of crickets again and the chill in the evening air, he opened his eyes to see the remains of his baseball glove splayed on the ground before him, severed lacings dangling, the ball pocket entirely *missing*.

"Dude, look, that line-drive ripped right through the web of your mitt,
hit you in the head, and knocked you out cold."

"You were *gone*, for like... a minute!"

( Revised original from the 2013 *Quantum Shorts* essay competition.)

## Breadth

"No way!", the boy exclaimed. The planetarium director, taken by surprise, paused, turned toward the errant voice in the dark, and repeated again, with emphasis: "It's true, all the stars we see are located just *within* our galaxy. Even then, the nearest one, Proxima Centauri, is some four Earth years distant at the speed of light, which means it would take *thousands* of years for us to get there by spacecraft. The nearest neighboring galaxy similar to ours is Andromeda, two and a half *million* light years away. And as we look ever farther into space, countless more galaxies appear, with *billions* more light years of distance between them."

For the young students attending the show that morning, these astronomical magnitudes were amazing to behold, for sure, but for the astonished boy sitting in the dark, this was one of those defining 'before and after' moments. He had unexpectedly been awakened to the *enormity* of being.

So how great is the breadth of the known Universe?  Well, by way of the biggest standard measure they have—the speed of light, scientists estimate it would take a light beam more than a hundred thousand Earth years just to cross the spiral disk of our home galaxy. As for the entire cosmos, they consider how many light years have passed since the original "Big Bang", then how much the distance has likely expanded between the objects within. From this they figure that a spherically expanding fourteen billion-year-old Universe would have a radius of some forty-eight billion light years.

The planetarium director continued: "Now the radius of a sphere is the measure taken from a common point of origin to each point on its exterior. But is the measure of a sphere its interior radial volume, or its exterior surface area? Is the breadth of our expanding Universe the volume within, where its been —its past, or is it the size of its *present* surface?"

"Well, let's stop and expand on that for a moment", he said, stepping out from behind the master console and proceeding down an isle to the pedestal base of the towering primary projector, an impressive multiplex of appendages glittering in the dark. "Cosmologists believe the observable Universe began as a singular instantaneous pulse that's been omni-expanding at the speed of light ever since. So let's imagine the light source at the center of this projector is the origin of our radiant cosmic bubble. We look up and see a celestial dome. We see what appears to be the heavens above as if from within a sphere looking out, but this is an illusion. Sentient observers such as ourselves are necessarily *on* the surface of the cosmic expansion. We are residents of the present looking *across* the exterior of a continuous star studded "hypersphere". The distances between the stars and galaxies are vast geodesic arcs on the surface of our luminous expanding Universe."

Mind altering indeed, but it wasn't until he left the darkened dome of the planetarium and stepped into the bright midday Sun that the full significance of what he had just heard became apparent. In English class one of his classmates had presented the idea that at the speed of light everything was happening everywhere at once. So if every photon from the Sun, and from every other star, is refreshing everywhere *now*, then from the 'field-of-view' of light, the breadth of the Universe would appear to be *instantaneous*.

He stopped in midstep: But then what about time? If the entire, expanding, radiant Universe is omnipresent, and physicists believe *nothing* exists prior to it, then there's no 'place' for time. Does it even really exist? If simultaneity reigns supreme, then upon 'what' are the notions of succession, expansion, and duration predicated? What do clocks represent? The mystery of time... perhaps a worthy topic for his next class presentation!

Wrapping his mind around the apparent absence of time, however, ironically would have to wait, as the bus was now boarding for the ride back to school. The remainder of the afternoon should go quickly though, and then, if he hurried home, there still might be enough daylight remaining to run to the park and hit some fly balls before dark.

## Duration

Tossing the bedspread off to the side he abruptly sat up. A certain chill was present in the basement bedroom air, but no sound of crickets. He felt for a subsequent lump on his forehead—nothing? Getting knocked out by a baseball *was* all in a dream! A much welcomed relief, for what remained sorely real was that he was unable to sleep, school was just hours away, and this was the day he was to stand before class and give a presentation.

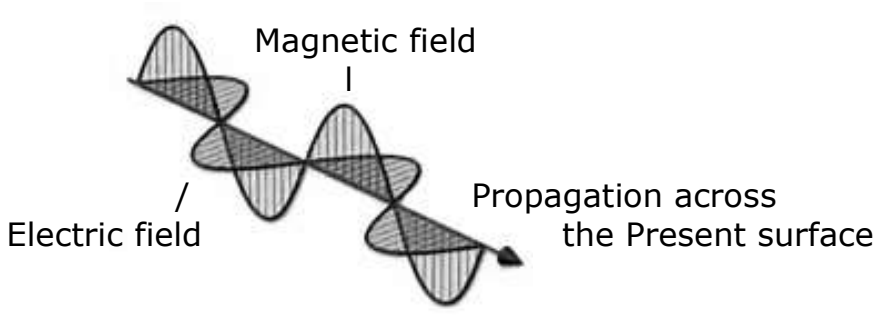
Glancing across the room to his desk, he got up and went over to revisit the notes he had prepared on his chosen subject. It was so cool! Most of it he had figured out; he would make a drawing on the blackboard to illustrate Einstein's theory. But still, the mystery of time remained so illusive. How was he to show his classmates that clocks upstairs actually run faster than those in the basement? Now there's an idea, maybe if he went upstairs to sleep it might shorten this interminable night!

Indeed, grasping the ethereal nature of time presents a profoundly curious challenge. Physicists are in final refinement regarding the particulars of matter and energy, but when it comes to apprehending time, ostensibly one of the fundamental features of the Universe, scientists and philosophers alike are all over the theoretical mindscape.

On the field trip to the planetarium the director talked about the light year distances between the stars, the geodesic arcs spanning the surface of our expanding cosmic hypersphere. But what does it mean to say the radiant Universe is "expanding"? Into what? What would we find were we to somehow reach out and 'expand' our hand into the future? Well, we can't, nor will we ever, because the speed limit of light prohibits us from ever advancing beyond the periphery of the expanding present. But surely a light wave must be advancing into the future—and does, with every oscillation.

Here's how: When an oscillating electron transmits a pulse of light across the electromagnetic field—across the present hypersurface of our cosmic sphere, it does so by "transverse" wave, meaning its magnetic component extends "orthogonally" to the surface propagation of its electrical component.

Transverse Electromagnetic Wave




Indeed, the reciprocating dynamic of an electric pulse and its magnetic "moment" is thought to generate the vector impetus propelling the photon's advance. But if the propagation of an electric pulse is resident on the surface of the present, to 'what' do we assign the orthogonal aspect of its wave? Of the mathematical formalisms depicting the electromagnetic field, perhaps the most illustrative are those assigning the magnetic phase of the transverse wave to the "imaginary" plane, which was also the convention used by Albert Einstein to represent the *temporal* dimension in his "spacetime" gravitational field theory.

The imaginary plane provides for a transformative rotation of the 3-D coordinate system *into* a 4th dimension. In the mathematics of motion the "x", "y" and "z" coordinates of space represent reference frames in a static state. In order for a motion sequence to occur requires the introduction of an additional domain of freedom permitting a hyper-expansion by way of "duration". With the addition of an imaginary 4th dimension of *time*, and its coordinate "t", we obtain motion, distance over time, velocity. With a *preexistent*, *external*, temporal dimension, we have the potential *vacancy* —the future 'space', necessary for events to advance. Were it not for time there would be no where *to* expand. Without time the Universe wouldn't know *when* to expand.

But there was a pending difficulty with his presentation. He got up from his desk and began pacing the bedroom. To show his classmates why clocks upstairs run faster than those in the basement would require he bring gravity into the mix. He would be left to explain that because gravity was an acceleration, and accelerating clocks slow down, the closer the greatest gravitational source, the slower clocks run. So intertwined was gravity with time that the case could be made they were really one in the same!

Just as clocks on satellites accelerated into Earth orbit run measurably slower then do their synchronized counterparts on the ground,* clocks downstairs have greater G-force accelerations and thus tick a tiny bit slower than those upstairs. Remember, clocks accelerated to the speed of light would stop entirely because then everything is happening everywhere *now*. At the speed of clocks on Earth, however, these variances were too small to see, the very idea too hard to believe—his classmates would think he was crazy!

Well, for all he knew, maybe all this thinking about time *was* making him crazy. Weary for sure. Perhaps now he might finally get some sleep. Anyway, enough worrying. Watching everyone give their presentations was sure to be entertaining. And besides, English was his favorite hour of the day. His assigned seat was directly behind the prettiest girl in school. Tomorrow, Tina would be again be sitting there in the front row of class.

* While clocks on satellites farther from the center of the Earth do tick a bit faster, this is more than offset by their time having slowed when accelerated to orbital velocity.