Flash Fiction Fugue

In Four Dimensions

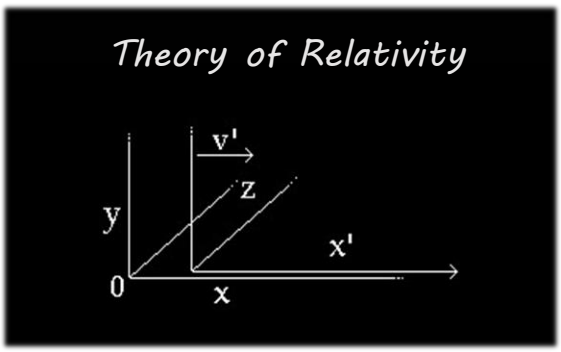
Tom Ransom

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 soccer-ball-size 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.

It wasn't helping that the previous night had been long, restless, and worrisome. And while such a prelude would likely precede any public performance, what's more, Tina, the prettiest girl in school, was 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 when his name finally was called, standing up at the back of the classroom, all eyes upon him, that he proceeded nervously down the narrowing isle between the desks, a gauntlet of expectant faces, to arrive long last at the front of the class stationed before the blackboard. His apprehensions now fully realized, he reached for the nearest nub of chalk, looked up, and wrote: Theory of Relativity. 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 at the speed of light they finally went "singular" and *vanished*. And because physical objects are extensions in space, their locations 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 why the mathematics of motion go singular at the speed of light: "It was Einstein who first found that because energy has mass, and to accelerate mass requires ever more energy, to then move ever more mass, an *infinite* amount of energy would be required for anything massive to attain it. That's why the velocity of light through empty space is 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 *then* is happening everywhere *now!*"

And with that it was mission completed, 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 *all* of this, the Big picture, 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 disappointment, 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 pearlescent 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 fashion an understanding of this internal world, and fathom its depths, but what was at the bottom of it all? What was the ultimate *source* of this warm radiance within?

So he began to imagine what was transpiring inside. He took a deep breath and followed the 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, sucked through surrounding cell walls into the intake ports of a myriad 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 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 mixing it up *millions* of times a second. He watched how rapidly the incoming oxygen was processed into fuel and followed the cascade of chemistry down to its source. There, at the bottom of it all, in orbital pursuit of their nuclei, was a radiant fury of electrons.

Now surely, if heat was the result of matter in motion, things couldn't get much faster, or hotter. For all that remained, insofar as he knew, as far within as the galaxies were far away, was a dark, sequestered, subatomic underworld. And yet, he also remembered reading that resident somewhere, at the theoretical threshold of reality, was a "harmonic oscillator". This was the genesis engine where 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, from deep within the depths of his imagination 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 listened in, but wait... this wasn't coming from the deep, this was from a source *outside*, the sound of a distant voice?

"Tom! Tom, are you okay?"

It was one of his classmates! Abruptly sitting up, the world still spinning, the sound of crickets and the chill in the evening air, he opened his eyes to see the remains of his baseball mitt 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!"

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 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 spaceship. 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... and apparently it's all expanding!"

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 mind-boggling *breadth* of it all.

So just how vast *is* 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 its apparent Origin, then how much the distance has likely expanded between the objects within. From this they figure that a fourteen billion-year-old, spherically expanding 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 singular 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 it's been—its past, or is it the size of its *present* surface?"

"Well, let's pause and consider 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 an instantaneous "Big Bang" 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 stars 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. He remembered reading that at the speed of light everything was happening everywhere at once. So then if every photon from the Sun, and from every other star, is refreshing everywhere *now*, from the omni-present 'view' of light, the breadth of the Universe would be *instantaneous*.

He stopped in midstep: But then what about time? If the entirety of the expanding Universe is everywhere now, and physicists believe *nothing* exists prior to it, then there's no 'place' for time! Does it even really exist? If simultaneity reigns supreme, upon 'what' are the notions of succession, expansion, and duration predicated? What do the ticks of a clock represent? Ah, the mystery of time, the perfect topic for a class presentation!

Wrapping his mind around the absence of time, however, would paradoxically 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 with his classmates and hit some fly balls.

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 he couldn't sleep, school was just a few hours away, and this was the day he was to stand before class and give a presentation.

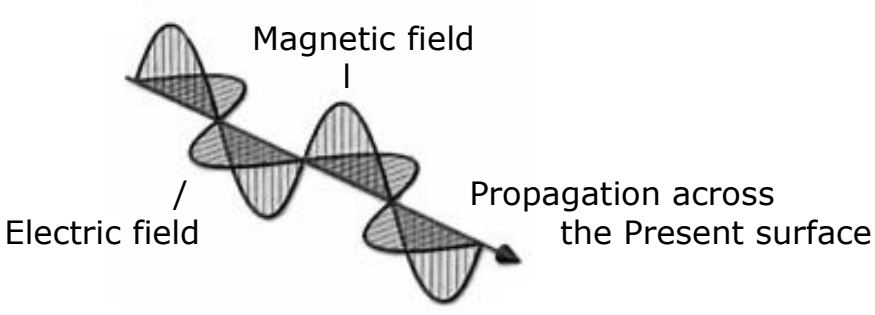
Glancing across the room to his desk, he got up and went over to revisit the notes he had prepared on his chosen subject. It was so cool! Most of it he had figured out; he would make a drawing on the blackboard to illustrate Einstein's theory. But still, the mystery of time remained so confounding. How 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. Scientists may be 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, they are at a loss.

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'? 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 advances "orthogonally" relative 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 impetus propelling the wave's advance. But if the propagation of an electric pulse is resident on the 3-D surface of the present, to 'where' 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 a 4th dimension, which was also the convention used by Albert Einstein to represent the *temporal* dimension in his "spacetime" gravitational field theory.

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 a 4th dimension of *time*, and its coordinate "t", we obtain motion, distance over time, velocity. With an omni-external dimension of time, we have the potential *vacancy*—the future 'space', necessary for events to advance.* Were it not for time there would be nowhere for the electromagnetic field *to* expand.

Which means—the belief that before the expanding Universe *nothing* exists, is both right *and* wrong, because this nothing is 'something' so nothing *exists!* Were you to reach out into this 4th dimension of time, forward in time-future or back in time-past, you would find absolutely... nothing!

Here and now, however, he was worried about his pending 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 accelerated clocks slow down, the greater the gravitational force, the slower clocks run. Theoretically, clocks falling into a "black hole" would accelerate to the speed of light and stop entirely. Not only were gravity and time curiously coupled, apparently, at the ultimate *center* of gravity, there was no time at all!

So just as clocks on satellites accelerated into Earth orbit actually run slower then those stationed on the ground,** clocks downstairs, closer to the center of the Earth, have greater G-force accelerations than those upstairs, and thus really do tick a tiny bit slower. But 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. Besides, English was his favorite hour of the day. His assigned seat was right behind the prettiest girl in school. Sweet dreams!

* Although the electromagnetic field transverses both time future *and* time past, the past waves 'converge' and cancel out, netting a *future* advance.

** 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.