MUCH ABOUT NOTHING

Atoms and Void (alone) exist in reality.

Democritus (ca. 400 BCE)

Pedro. Lady, will you walke about with your friend?

Hero. So you walke softly, and looke sweetly, and say nothing, I am yours for the walke, and especially when I walke away.

William Shakespeare (ca. 1598)

[Sir Kay:] They say the pagan has invented a number which is nothing—nought—written like an O, a hole, an oblivion.

John Steinbeck (1976)

Atreyu: What *is* the Nothing?!

Wolfgang Petersen (1984)

Everything may thus be a quantum fluctuation out of nothing. But if this is so, I am still confronted with the enigma of what encoded the quantum possibility into the Void.

Frank Close (2009)

How sweet the siren song of nothing whatsoever. I've seen and maybe he has how it lures the minds of thinkers through the years. Its empty nothingness is what attracts. How now is the mighty vacuum fallen! He shows why it isn't. Nothing is a thing with which this universe is not endowed. Did I say ideas are perilous? What could better make my case than the long tyranny of nothing?

Its latest iteration comes from Hawking in *The Grand Design*. As an answer to the origin of everything it seems a little skinny. He says that our universe is only one of many but don't bother looking for the others as they're out of sight. He says that they all arise from nothing. Physics does it. Thus, he says, God is not needed. It's the worst of fates, I think as I recall the aether, to be thought unnecessary. If you will, have faith, he seems to say, but don't imagine you have reason. Yet he has his own faith: He believes in nothing. Larry King asks Mlodinow, who's Hawking's physicist co-author, 'Where does the nothing come from?' Unkind cut, much closer to the bone than Close's similar enigma. Mlodinow decides to duck. Nothing on the origin of nothing. Quite a serious omission if there is no nothing. Once more, YouTube lets me see the show.

Back to space, which now is Something. Can the Something explain everything? Too bad she won't get to see. Momentarily I think she'd like it. Then I think: Forget her quest; it doesn't matter anymore. I hum Buddy Holly; I think

Frank. His Fleck-filled space is all that matters. Rap my knuckles! Flecks don't fill space; they just *are* space. Fleck-filled is a mental habit that I need to change.

Finding space is quantized changes everything and I can hardly start to think about the physics that will flow. But it's also like that saying *en français*, the one that translates as: The more things change the more they stay the same. The quanta are so small that with a little distance or a wider view space seems continuous, the way most physicists pretend it is. But they can reap a harvest from the shape of space close up and its behavior as the universe unfolds, and see how QM and GR or something like them emerge from emergent space and time. A whole new physics. It may take a lot of work. Just what the doctor ordered. Lots of doctors. Faculties of physics full and institutes besides.

A long day and long sleepless night are my reward for taking up his task. What *does* his new Beginning do? It's deeper than his absolute space dooming relativity—the which I wot it won't. The question is: How can the relative relationship survive in space that's so ephemeral? Why would he insist upon *my* solving this? Two hours on the beach awaiting moonrise soothe my soul but don't disclose an answer. Early morning in the shower comprehension dawns.

The tip-off is the way that Einstein finds a path to his GR equations. He says they have no geometry like Euclid's; rather they must work with *any* system of coordinates. Coordinates are like map references and dates; they pin down where places are and when things happen. Einstein says that in a world mapped with a funhouse mirror, physics is the same. His space has no structure of its own. Thus Fleck structure may unhorse some sacred cows. For example, that a sideways shift leaves everything the same, leads to a Law—Conservation of Momentum—without which the game of pool would never trouble River City. But in Frank's universe a sideways shift would *not* leave things the same! His space is so far from being nothing it is idiosyncratic. The same goes for time. The fact that a shift ahead or back in time does not change physics leads Amalie Noether to a Law—Conservation of Energy. But in Frank's universe the physics is all chance and *anything* may change from one Move to another. There's no system of coordinates, no funhouse mirror. Up close relativity's not even wrong. No surprise to physicists; they are expecting it. Though few say they see it coming from Time One.

GR convinces Einstein space is Something and, consigning aether to chopped-liver status, he calls it a field. It seems that physics can be like that; theories may shape the minds of physicists as much as the reverse. In physics, field's a word for not knowing what Something is while having math to prove it. Or so it seems to me. Einstein says space is the field of gravity. He says gravity's the curvature of space. My Frank says this space-field is a substance. So does Einstein. Well . . . of late. So, on this, his—my Frank's—and Einstein's later take

on relativity agree. But Einstein doesn't build the *structure* of this substance into GR. Why not? Well, in part because he has some sort of hang-up about how it all begins, in part because he cannot figure out its math.

What, then, does this growing stuff look like? It's tempting to think of it as a shape, like a balloon of foam expanding out of sight in an insanely instant instant. But this can't be right. This would put a boundary, an edge, like the balloon's, between the inside and all else. There *is* no else, no edge. There's only inside. I'm fumbling for a way to think of this and he's no help.

I push on hoping that this is the right track. If his Fizz were happening 'in space' it might look like a sphere. But it isn't *in* space. It is *making* space. It starts without a boundary where something else—or even nothing else—begins. Yes, this is the way to get a handle on it. As it grows it never *makes* a boundary. It still has no boundary. I need to keep reminding myself it is all there is. As space grows large its three dimensions grow large with it but they don't get to infinity. They're closed from the Beginning and they stay closed. That is, they loop back on themselves as the two dimensions of Earth's surface do. Thus the universe is finite but there is no end to it. This is exactly as, in 1917, Einstein concludes it has to be—more Frank-Einstein agreement!

What intrigues me is Frank starts out with what space is made of and he follows what it does. Einstein starts out by insisting that the field in each small piece of space, wherever it is and no matter how one tracks it, must fit seamlessly with those of every other piece. He calls this *General Covariance*. He looks for math to make it so. Then, having found it, he spoils it all by adding in that antigravity. What *it* does is: It lets his space behave like Frank's.

So one difference is the tiny structure of Frank's Flecks. String theories have tiny structure. They too see their space as Something. Are their string space and his space the same? Well, his and theirs (or some of them) both have nine space dimensions. His and theirs both say that three of them are big. His and theirs both say six are curled up and very small. But his and theirs are deeply different. His curled-up dimensions are *not* some six unlucky out of nine that inexplicably compactify all over town. Rather his six stay the same from the Beginning. They do their rabbits-with-no-limits-on-the-carrots, two-four-eight, proliferating thing. Amanda Bonner might call this a little difference. But as the French would say of Bonner's difference this difference is also big!

Next question from my push-down stack is: Why *does* space have three dimensions? It's a consequential question as, with any *other* number such as two or four, nothing in the universe would work. But I know that's not an answer and I can't imagine what the answer is.

"It's in the rules."

Did I do that? Did something I thought bring him back? Perhaps he thought I was about to get anthropic. Actually *I* was on the brink of thinking it is in the Rules. Because he made it so. The Rules say a Fleck has a certain volume quantum. All those volumes must add up. And of course! Three-Dee is what wholesale volume would look like to us.

I read how Einstein finds his General Covariance in *Ricci Curvature*, which is how far space curves off from Euclid-straight. What if he had looked, instead, at volume? Volume is, by happenstance, the only other generally-covariant object in the universe. Of course Ricci-Curbestrato's book sales might have suffered. But maybe Einstein would have found his way to volume-quantized relativity—the ToE! Who knows?

Which leads me to a better question: Is space the new aether? The more I think of the Beginning the more it seems to me the aether just came roaring back.

"It doesn't interact with matter."

Does he mean it is Lorentz's version of the aether? How could he know anything about Lorentz? It all goes back to one of several harbingers of stormy science as the 19th century comes to a close. Michelson and Morley measure light-speed as the same regardless of the way their apparatus moves. Very hard to figure—if it moves through aether. Einstein says the aether is not needed thanks to relativity and not because of M and M. Physics puts the two together and it drops the hot potato; only Lorentz keeps the faith. Moving matter doesn't stir Lorentz's aether. If that's what Frank means then maybe he is right.

But now he wants to take on SR at Planck scale. Searching I soon find this too is nothing new. Giovanni Amelino-Camelia asks: If space has some kind of Planck-scale structure shouldn't all observers see the size of these Planck pieces as the same? Of course he thinks of size in terms of Planck length. Frank knows Planck size is really volume. For him Amelino-Camelia's idea works just fine. All observers should 'see' Flecks (they can't see Flecks) the way he thinks they are and not—if they should hop a rocket—squashed. A-C says that this can be arranged. Einstein weds the principle of relativity to *c*, the cosmic speed limit. A-C bigamously brings Planck's small-size limit to the bed. He checks out this new *ménage* and says that Planck size stays the same no matter how fast an observer's moving. He calls it doubly special relativity. The clapping from offstage is Planck and Frank. In my mind's ear *sotto voce* Frank tells Planck that flattened Manifolds have no meaning.

Planck is dead so this leaves Frank and Amelino-Camelia tilting at the SR windmill. Is this prudent? Smolin tells a telling tale of how his early work 'in loop quantum gravity appeared to contradict Einstein's special theory. … That possibility was too scary to contemplate, and after struggling with this, I dropped the

whole line of research.'

Unintimidated, Frank is bursting to articulate his story. I know because I have this feeling and it isn't mine. He has in mind—my mind—some kind of show and tell. More like show *off* and tell, I think; it's understandable but he's not ready, *we're* not ready. I haven't thought through half the implications of his thinking but it's clear that they are huge.

"Like what?"

Well, for example, *general* relativity. What can he say, what does he even *think* of that? He himself was asking this not long ago. He hasn't thought about what all this does to the solutions of GR for the whole universe. Friedmann's or Lemaître's or de Sitter's. Einstein's. Anyone's. Where does he stand on that? Surely he'll be asked.

"How are they relevant?"

Relevant? GR is the gold standard in cosmology for more than ninety years. Some may tinker; everybody uses.

"What is that to do with the beginning?"

Well . . . okay. That's not so easily explained. I mean we're on a different planet here from relativity. He's looking at a space that is *itself* way more than half of all reality. GR sees space more as a mathematical abstraction.

"So what's the difference?"

Of course there are a lot of them but I am groping round to find them in my mind. Or even one of them . . . The knife edge! Einstein—or his equations—have space balanced on a knife edge. Will it expand endlessly or will it reverse? Or will it balance—as it seems to have for nearly 14 billion years—on the knife edge between them?

It seems to me Frank's universe has none of this. It's not expanding through some tricky math—it is expanding Fleck by Fleck. It can't reverse. It doesn't *have* reverse. It can't unmake its Flecks. He's right again—I think, more to placate him than from any sense we are secure. Even as I try to feel more sure of this conclusion there's a niggling worry that I'm trying to ignore but can't dispel. Why *does* the universe continue to expand?

I feel that he is holding something back. Something that he's working on. Something that he doesn't want to show me, not just yet.

Anyway it should be no surprise that GR doesn't work at first. It needs a theory of its own—*the* quantum theory—as most everyone expects. Most everyone, that is, who's following cosmology. Most every one of *them* expects soon after the Beginning the new theory will translate into GR and QM. All this will need work that I'm sure he can't do. He wants to tell his tale. I reckon I should go along. Lead on, I think, unsure of who is leading.