THE BIG FIZZ

Three-dimensionality would thus be recognized as a logical consequence of certain fundamental properties of matter, which in turn would have to be accepted as ultimate facts.

Hans Reichenbach (1927)

Each small piece of [Nature's] fabric reveals the organization of the entire tapestry.

Richard Feynman (1965)

The cover was blue with yellow type.

Stieg Larsson (2004)

The inflationary bang is best thought of as an event that the pre-existing universe experienced, but not necessarily the event that created the universe.

Brian Greene (2005)

Physicists have long speculated that the Planck length is the ultimate atom of space.

Leonard Susskind (2008)

Everybody thinks that depth is the great thing about 3-D. But in my book, volume is the great thing.

Wim Wenders (2011)

The investigation takes him to the very edge of space. Yet space has, it seems, no edge *in space* and now I can see why. It never does from the Beginning. But now he's leaving from its leading edge *in time* and heading for the here and now. Right away his trip gets down and dirty with an ancient question. The answer seems impenetrable. He'll never find it if he's looking for it, sing The Used.

"Go over it again."

I sit here with him in the empty office and I think it to myself for him once more with feeling. Kurnitz from the 1950s. It's a knock-down, drag-out battle that's about a simple issue: Is space real? That is, is it Something? Or only an idea? If it isn't real then it's just a way to organize what we perceive, a stage of our invention, an imaginary backdrop against which we see things like stars or we imagine rods and clocks. He's setting out to say that it is real.

"So the second Move makes *two* new Flecks."

Move 2, I call it. I was there already. So now right away I see where he is headed. It's curious both (blue) and (yellow) how one story gets divided. Once

begun the question is: How will it end? And when? Until something changes, Flecks must madly multiply like rabbits with no limits on the carrots. With each Move their number doubles. 1, 2, 4, 8, 16, 32 etcetera. That's the Rule. I know this game's name and reputation: It's called exponential growth. There is that story of the Persian king who's given an exquisite chessboard. He asks what he can offer in return. The reply is humble: just one grain of rice upon the first square, two on the next, then four and eight and so on to square sixty-four. He thinks this over-modest and is horrified to find that it consumes his empire's rice supply for something like a million years.

In other words, the Flecks are on a roll.

Why, I wonder, do they Move in lockstep? Then I think: It's all non-local now. So *when* does it become non-local? Even as I think it he is ready with an answer.

"Why not from the Beginning?"

But *how*? I think of Move 1. The two daughter Flecks must be entangled. If it is so for the first division then it must be so for all the rest. Entanglement must be a Rule. Or, seen another way, if quanta get entangled later, how *not* in the Beginning? I bet they do. What exactly *is* Entanglement? Too many questions tug at my attention. They must wait while he and I Move on.

After Move 2 there are four Flecks. All four are entangled with each other. It seems simple: Is this how and why we live in an entangled universe? Does this solve what Aczel calls the greatest mystery in physics? Are space quanta all entangled from the get-go? If so anything that's done to one is done to all. Like the musketeers, it's instant. Or, in cosmologic lingo, absolutely simultaneous. Is space, after all, a Special Frame? Which somehow leads to yet another question: What can one do to Flecks?

I'm struggling just to get my head around this. What I see for sure and must hang onto is his answer: Space is real. It is made of bits. Of Flecks. A Rule leaps out and grabs me: Flecks have volume. A fourth parameter, I think; the thought goes by, a leaf swept by the storm. They must have volume or the universe would have no space. Each Fleck a clone of every other so the volume of each one must be the same. I recall something I read; it's Barrow: 'Elementary particles come in populations of universally identical particles.'

Flecks, then, are like particles of space. Like, it seems convenient to think, a world of 3-D pixels. But *why* are they the same? Because—my thought, his thought, our thought runs on—the Rules need not, and simple Rules would not, add something so superfluous as several sorts of Flecks. A light goes on with cartoon light-bulb clarity. This would explain how that perplexing smoothness spreads through space. How does Smolin put it? I dig through my notes and reread that 'if space really has a discrete atomic structure, then it is extraordinarily

improbable that it would have the completely smooth and regular arrangement we observe it to have.' Far from improbable, it looks like smooth and regular are properties a simple space that starts with his Beginning maybe can't avoid. A Problem? Sure. A problem? Maybe not.

The next piece of the picture is the Flecks should stick. Why? Well, this is simpler than providing in the Rules for gaps. On second thought though, gaps would have no meaning. If there were gaps, what would they be made of? Space? Space *is* the Flecks. Could gaps be made of nothing? There's no nothing in his space. Topologists would say it is simply connected. It's like cheese that isn't Swiss.

"What about a Window?"

What shape, I think idly, would a Window have?

"It has two dimensions."

He says this much too quickly. Perhaps he isn't sure if it is right. But it sounds okay to me. The Flecks that I envision are like bubbles. Bubbles with a kind of Window where they meet, a common bubble-wall. I think he is thinking that the Windows must be in the Rules.

"How could they not?"

It's true. I hadn't thought of it that way but if the Flecks do stick together then they must have some kind of Windows.

With a laugh—he laughs!—"The quantum theorists will have a field day with the Windows."

I'm not sure why he says this. But I too have a feeling that the Windows may say much about the laws of physics. Just by being there I mean.

He seems to think he knows now how it must have been. He sounds cocky. Is his vision right? It's hard to grasp both its simplicity and its enormity. I begin to see that every detail of the way it all begins is fundamental to what happens on a larger scale. I may not be much good at this but I am *thinking* it. I try the first few Moves, freeze-framing, turning the whole universe, inspecting, thinking: Okay, what just happened here, and how? And in almost no time proto-space turns into real space. It is like a Zip file that has fantastic compression, unzipped by a CPU that has fantastic speed. Come to think of it, compression's Barrow's term for it—and he concludes maybe the universe is a computer.

"What does a Window do to the dimensions?"

Nothing comes to mind but if it's nothing then he wouldn't ask. He could be right about a Window having two dimensions if it's flat. But does flat have any meaning at this scale? A moment's thought convinces me it can't. But a Window wouldn't need to be flat to be 2-D, would it? Just thinking of this stuff could make me crazy.

I think on. If a Window does have two dimensions then it has no depth, no thickness. And the two are two of six that one Fleck has; there are no others. But which Fleck? It dawns on me that there's no difference. Things must be the same both sides. The two Flecks *share* the two dimensions! I think this at him as a challenge but he says no further word. While I wait my thinking's fevered, almost random. Inner vision keeps re-running movies of his almost instant bloom of space. What's happening? Well, one thing's clear—what isn't happening. Maybe the Big Bang's on the way but it can't be yet; it needs some space. And this is *not* Inflation. At least not as it's advertised. Inflation happens once the Big Bang's underway. Inflation happens *to* space, *in* time. If it happens.

Suddenly I see that his Beginning's not a prelude to Inflation. It is telling us Inflation *doesn't* happen. There's no need. Inflation is a band-aid, modern myth to paper over cosmologic cracks. It's a name for an unreal idea his space doesn't need. But there is no name for what it really gets. With images of bubbles there in my mind's eye, I think of it as fizz. The penny drops. Existing labels leave me little choice: The thing the cosmos does before the Big Bang is Big Fizz.

These musings drive me back to the Beginning. I have been thinking that he's looking for Time Zero. Now I see this doesn't make a lot of sense. The Manifold that launches the Beginning must be timeless. It *has* no time that could be zero. *After* the first Move the universe has proto-time because it has begun. It seems a long shot but I check it out at Simple English Wikipedia and strike semantic gold: 'Before counting starts, the result can be assumed to be zero; that is the number of items counted before you count the first item and counting the first item brings the result to one.'

When counting things the first count isn't number zero; it is number one. So Time One is the pot at the beginning of his rainbow. At Time One some kind of pseudo-time exists. It all follows from his simple statement about Flecks dividing. Once begun, time must move on Move by Move as the Big Fizz blooms into space.

With the next Move, Move 2, it becomes Time Two. I'm still grasping where this goes. It's not only that the Moves become the elemental metric of time, though it seems they do. They also tell the size of space. I set up a spreadsheet table:

Move	1	2	3	4	5	6	7	8	9	10 …
Flecks	2	4	8	16	32	64	128	256	512	1,024 …

Vaguely my brain gropes for what this means for math that must come with our universe, built-in as it were. Why does it matter? I let that thought go as I grasp another sliding by: There is no way to make a *distance* metric. The space

metric must be based on volume. It's a disturbing thought. Down at Fleck size, distance doesn't mean a thing.

Time seems comfortable, less elusive. How long does it take to make the universe? Well, at first it seems that that depends entirely on how big it is. After all, it's thought that now there may be more of it than we can see. But how much? What if the part we can see, vast though it may seem, is just a tiny fraction of the universe? Well, I could start by asking: How long does it take to make a universe the size we see? That is, ten million trillion trillion cubic light years, more or less. A quick conversion says that this is 10^{77} cubic meters. The idea is to make this volume using Flecks. The volume of each Fleck is 4×10^{-105} cubic meters. He needs a staggering proliferation, a vast host of Flecks. Some 10^{182}. This number is beyond my comprehension. I pursue the math. How many Moves to make a universe this size? I'm trying to imagine such a number when he says:

"About six hundred."

Obviously not. But then I see he must be about right. It takes just over three Moves to increase the number by a factor ten.

The arithmetic is easy. Each Move just multiply by two. But soon it's getting messy. I bring up a calculator app on my computer. It can handle 32 digits. It can do scientific notation but for some reason I want it to be exact.

"Try sixty."

I calculate 2^{60}. It shows me that by then the number is already big.

Move	60
Flecks	1,125,899,906,842,624

Next I check his answer for how many Moves. The calculator says he's right—about 600. I'm still struggling with these numbers. Like: How many Flecks are there after 600 Tocks? I dig up a website that does exact big-number math. Its answer is 3,273,390,607,896,141,870,013,189,696,827,599,152,216,642,046,043,064,789,483,291,368,096,133,796,404,674,554,883,270,092,325,904,157,150,886,684,127,560,071,009,217,256,545,885,393,053,328,527,589,376. How long does this take? Well, it takes less than 10^{-40} seconds. It's mind-boggling that he and I can figure out the number of submicroscopic bits of space some instant about forty nano-femto-attoseconds after the Beginning nearly 14 billion years ago. By that time the universe has grown as big as all the Hubble telescope can see!

Of course the universe may be *much* bigger. What difference does this make? Well, let's suppose it's a billion billion billion times bigger. I might call this Sagan-cosmic size. This would need an extra ninety Moves. That's right, ninety. In terms of our time, ninety Moves need almost no time. This far larger universe would *still* need less than 10^{-40} seconds to unfold. It doesn't matter if it grows to a

quintillion times the Sagan size. It *still* takes less than 10^{-40} seconds.

Trying to envision it, my mind's eye sees the first Moves make a momentary kind of proto-space. And then the Big Fizz blossoms into space with space-like properties. Mass-energy can move.

"Does it have time?"

I think he means that the Big Fizz is over before anything can move. Once there's space there's gravity. It spreads in space at light-speed. How far can it travel? It is hard to grasp such tiny numbers. While the Big Fizz fizzes, light moves less than the size of an atom. Much less? Well, at light-speed, light would move less than a billionth of a billionth of an atom's width as the whole cosmos comes into existence. The universe is sitting pretty before gravity moves anything around.

What I don't get yet is when Big Fizz becomes Big Bang. It must slow down or everything would still be fizzing. The Big Flash shows in a few hundred thousand years the fizz has long-since stopped and the Big Bang is doing its no-bang thing. What strikes me is the Big Bang seems so ponderously slow compared with the Big Fizz. By the time Big Fizz becomes Big Bang the universe is vast.

"Those big numbers may be fun but they're not right."

He flings this at me, severing my train of thinking. I am sure my numbers are *exactly* right.

"When does multiplying stop? When does fizzing end?"

Well, when he puts it this way it is hard to answer. I don't know why the Big Fizz stops. It seems he has calmed down.

"Does each Fleck split at every Move?"

Each time he utters 'split' it bothers me. It begets a messy picture in my head, a Manifold that is attempting suisect. It seems he doesn't like divide. We need a better word for what Flecks do and as I think the thought another image comes and goes: a nucleus that fissions into two. It's not a good analogy but it's less ugly as a picture. A moment passes, then, of course: The word I'm looking for is *Fizzion*. It's not a real word but give it time. It's summertime and Fizzion is the easy way the universe makes space.

And now that I think about it, having each Fleck Fizzion every Move is not the quantum way. And they can't; the need for Fizzion's over almost instantly. One way would be for the Rules to have the stopping programmed into them; it's ugly. Neater would be Flecks with odds of Fizzioning at any Move: Virtual certainty for Flecks with lots of matter, becoming less certain as there are more Flecks and so each has less. Soon there will be a Fleck that doesn't Fizzion, that skips one, so to speak. Is that what he had in mind when he picked on Move 60? It had a quadrillion Flecks. So each would average less matter. So, say one Fleck

skips Fizzion at Move 60. It could happen. It depends on how the odds depend upon the matter, and also on the Fizzion Rule—the way two daughter Flecks divide up Mom's estate.

"What *is* the Fizzion Rule?"

Good question but no way I'm going there. It's heavy lifting, best left for the physicists to do. All we need is that the odds on a Fleck Fizzioning must decrease as its mass goes down. Maybe we could even say that it's the pent-up mass that drives the Fizzion. That's about as far as I would want to go.

"But when one Fleck misses one Move all your numbers will no longer be exact."

Okay, he's got me. But thinking on I realize it doesn't matter. If Move 1 divvies up the mass 100-zip all of it goes to a single daughter. It seems unlikely, but it's worst-case. And all that happens is the Fleck with zero mass will not go on to create space and leave it massless; it will never get to Fizzion. The other Fleck continues Fizzioning as if it's the whole show. The result will be the same except the universe will have an extra Fleck and space unfolding is delayed a single Move. In principle he's right; it throws my calculation out of whack. But the difference could never be detected.

"So," he says, "you'd say that space is finite because the mass in the Manifold is finite."

I'm not sure he's right but he's convincing. He's assuming that each Fleck has its own mass or energy that debits the original mass-energy account. I think I see where he is heading. He is having shrewd detective thoughts. He's linking clues. He's thinking of Dark Energy. He's still excited, I can tell. His calm is just an oil slick on a surging sea.

The size of his space depends on Fleck size as well as number. He knows that Flecks must turn out to be very small. Like string physicists he needs this to explain why no one's ever seen them.

"It's the *Planck volume*."

That's no surprise. But how does he know?

"I can choose it."

Well, yes, I guess he can. I did say that. But he could wait. Why would he choose it now?

"It makes sense of everything."

I had hoped that things like size would come *from* his Beginning instead of being fed to it. But I shan't be picky. If his theory solves some problems using few parameters it will look good.

"There *is* no theory yet."

On this note I pack it in and we go home.