THE ULTIMATE UNCERTAINTY

The incomplete knowledge of a system must be an essential part of every formulation in quantum theory.

Werner Heisenberg (1958)

Heisenberg *may* have slept here.

Bumper sticker (1990s)

The ultimate theory would provide an unshakable pillar of coherence forever assuring us that the universe is a comprehensible place.

Brian Greene (1999)

As bizarre as it may sound, recycling discarded ideas of the 19th century might provide a way forward!

Naiyesh Afshordi (2010)

The worst thing in writing is to not know who you're writing for. For whom, I mean. At first of course it was for her, and maybe for myself between the lines. And then for Frank. Poor hopeless hireling Frank, erstwhile consumer of my words. Then for a while I think it was for me, for my own self alone but then also somehow for him, my other Frank, although it seems that he can't read unless I read it for him. Now I have come to realize it's for my book. I'm writing for some hoped-for readership to be. For people really—people I don't know.

It's harder now, I find. I found it easier to write for her. She seemed to understand the physics. I hope others—other than the physicists that is—will come to understand it too. The thing I'm sweating now is what to do with imprecision. It's a synonym for Heisenberg's uncertainty that I prefer. His principle is based, I'd say to Frank, on measurements of things that don't exist, like the position of a particle. My bumper sticker might say: Heisenberg was never anywhere. There isn't, at the quantum level, any *where* his particles can be.

The real uncertainty of Heisenberg's uncertainty is not the problem. It may be a problem but it isn't mine. My problem is that I think imprecision must be *real*. Well, even that is not my problem. My problem is I'm gun-shy yet I'm torn. Gun-shy since each time I stick my neck out, I get my foot into something else—pure Patsy Cline. Torn because this may be one way I can lure him from his lair.

So here I go, like Charlie Brown I kick the ball again. No doubt he'll scoop it off my foot. Or so I hope. A thought: Does Good Old Charlie *want* to miss the ball? What would his mental-health advisor say? The thing is this: My over-simple mind, my overheated brain, keeps picturing the universe of Flecks and

jerks, frames of some manic movie, nothing changing much yet *everything* a-changing every Move and, foolishly I know, I want to track a Fleck. I'm sure he'd say to me, if he would say at all, a Fleck has no identity. He would be right. They're all identical. Identity of course consists in *not* being identical. There is no way to stick a label on a Fleck's lapel.

And so I think: Slow down the frames. Now freeze. I know it can't be done. But the not-doing is the essence of a thought experiment. Let's pick a Fleck. Now step one frame. The Fleck cannot move far.

He'd say, "What's *move*? What's *far*?" He wouldn't even bother taking shots at *freeze* and *pick*.

But still I have this picture in my mind. At any given Tock, a twist that is a part of some sub-sub-atomic particle has, he says, location of a kind. Let's say the Link between my Fleck and an adjacent Fleck, to be precise. Its twist is there, but it's the *there* that isn't. It would have a Fleck address if Flecks themselves possessed addresses. Flecks don't lack location; the location that they have cannot be tracked! It's worse than *banchi* blocks in Fujisawa City since, every Move, the block guide board is up for grabs. And so maybe he's right.

But then another way to look at it is this: If my twist moves to the next Fleck it hasn't moved at all. Why not? Because one Fleck is like the next; maybe it wasn't twist, it was the Fleck that moved. Not by a length but by a volume. What I think I want to say is imprecision must exist in terms of volume and of sequence. It seems to me that these are the right variables, right because they're *real*. And there is no need to measure them; just count—which is exactly what a quantum theory is about.

This tells me that the imprecision of his universe, the way it works, must be a Fleck of space over a Tock of time. In units that the universe is using, 1×1 is 1. In physics units it's some endless multi-digit number times 10^{-148} m^3s. This is why, in *physics* units, those small numbers are so small. It all *is* small compared to our emergent scale. The Problem of Small Numbers hits the deck! Another check.

His answer has been under physics' nose for years. Physicists get tired of tracking messy units. These are either way too small—the culprit is Planck's constant—or way too large, for which the culprit is the speed of light. Their lazy way to fix this is: Pretend there is no problem. They make equations simpler and more beautiful with units that adjust the culprits to exactly one. But here's where physics is so near but yet so far: It makes them equal 1.0! To complete the revolution, take a small step (but a giant leap) to 1. One flecktock of his spacetime.

Surely this must provoke him: I picture an equation, delta vee times delta tee is at least one, no decimal. I wait for a response but there is only stony silence and my picture wavers and then vanishes, evicted by a black despair. I think: Move on.

It comes to me, unwilling, that this imprecision's not to do with measuring; it is to do with meaning. Does his saying nothing mean I've got it right?

His question would be: What does imprecision say about causality? For him, like Bohr, causality's a big concern. Still fishing for reaction, I recollect that Bohr says, when forced to choose between causality and imprecision, it is better just to let causation go. Einstein says that we can have both QM and causation. QM, he says, is incomplete. The fix, he thinks, when found, will breathe life back into causation. Bell shows that there is no fix; the universe is not the place that Einstein had in mind. Frank's imprecision backs both Bohr and Bell. It's built right into space and time.

Bereft of his direction, I explore the physics Web. I come across a paper Markopoulou wrote some years ago. After reading it I have no clue. Second and third readings too. It has heavy text like: 'We can, however do better than this and assign truth-values at *p*, not only to "*r* precedes *p*," but to *when r will happen*.'

Four reads and I'm still adrift. But her subtitle, 'What the universe looks like from inside', keeps me coming back for more. I mean, he is the only one who ever looked at it from outside so from inside's an important point of view. She says: 'In general, an entire spacetime … can only be seen by an observer either in the infinite future or outside the universe. This is unphysical, so… .'

Unphysical, she calls him, adding to my pain. Slowly, though, some thoughts take root and, slower yet, make sense. Her paper's about *Causal Sets*. A Causal Set, she says, 'is simply a very large collection of causal relations.'

I think she would call his universe a Causal Set. As I try to learn her language some of it seems tantalizingly like his, though different. I find all kinds of intersections. His Beginning she would call an infimum, his Tocks, time stages. His universe she'd call the universe. She's developing its math. She tries to prove 'causality persists at the planck scale.' She says Causal Sets work with black holes. A few years later she moves to P.I. There she is B-T's mentor. It all is indeed connected. Still no word.