

THE COSMIC CLOCK

The more deeply we study the nature of time, the better we understand that duration means invention, creation of forms, continuous elaboration of the absolutely new.

Henri Bergson (1907)

Change becomes possible only through a lapse of time. The existence of an objective lapse of time, however, means that reality consists of an infinity of layers of “now” which come into existence successively.

Kurt Gödel (1949)

If motion in space is feet per second, at what speed is the flow of time? Seconds per what?

Jack Smart (1967)

It is possible that some insightful person will one day devise a new way of looking at time and reveal a bona fide physical foundation for a time that flows.

Brian Greene (2004)

Time is central to our being in a way that space is not.

Michael Lockwood (2005)

The only true clock is the universe itself.

George Musser (2009)

His attitude has changed since he came back. It's like he has a new view of his own position. It's a thing I recognize. Once one tops Billy Goat Bluff one's gaze goes down. By the time I make it to the office it appears that he's away again today. As usual I try to figure why; as usual I fail. My latest theory is he leaves me time to digest his ideas and to catch up with him. I fail to do this too.

Instead I think about the time it takes his universe to Move. The natural assumption would be that separation between one Move and the next is what physicists say may be the shortest time. It's called the *Planck time* and it's about 5×10^{-44} seconds.

Of course this is too cumbersome. We need a word, he and I, for the Move time. A tick, I think, because I'm thinking of a clock. Unexpectedly his voice says: “Tock.”

I think he's being cute: Tick . . . Tock. But then it dawns on me that he is serious. Though why . . . ?

“Tick is taken. It's a Tock.”

I buy it. So a Tock's the basic unit of real time. By now there have been many Tocks. How many? Well, I may have flunked philosophy but even I know Gödel's famous for his views on time. However, on this count he's wrong: A finity, not an infinity, of layers have existed, as he says, successively. At least, that's time as built from the Beginning. From, that is, in both its senses; also by. This, I think, is time that Newton says is absolute and true and mathematical.

By contrast, Buddy, do you have the time? will get you, if you're lucky, Newton's relative, apparent, common time—the time of Buddy's watch and Einstein's clocks. *Our* time we may call it but we own it not. Pseudo-Tolkien talking. Another time, the saying goes but does not mean it truly. Other lives, of which the poet Auden wrote,

Just as if time were what they used to will
When it was gifted with possession still

Although we may not notice it, the world around us marches absolutely on, says the Beginning. How can we know this time? Or what can we know *of* it? Well, we can think through a thought experiment. As the universe is Tocking on let's think that we can stop it. Let's stop it for, let's say, one Tock. In effect, the universe must miss a Move. But what does that mean? His Beginning says it means nothing at all.

If it happens at the end of the last paragraph just as I hit Enter—sending Line Feed, Carriage Return to the CPU—let's say as its first electron starts to move: How do I know the Tock went missing? Well, it seems to me, I don't. Of course a Tock is so extremely small that neither Buddy's watch nor finest instruments could spot it. But even if, let's say, a trillion trillion trillion trillion Tocks—the best part of a day to Buddy—should go missing, no Buddy nor nobody would wise up to it.

Why so? Well, because everything would stop. Well, not exactly stop. Just would not go on until it went. Including everything we might think marks the Tocking or the stopping of the Cosmic Clock. In some non-existent way, Buddy's watch, birds, rivers, moons, thoughts, light and instruments would falter. His watch would not even *not tick*. The birds would neither fly nor fall. The rivers would not run but would not stand unrunning. Rather than wait the Moon would just pick up where it left off. Minds would not think nor have any reason to complain of lack of reason. Photons wouldn't zip a new light-speed. They wouldn't even wait, because waiting's what a photon can be made to do by QM magic but it waits *while* time goes on. The photon's stately progress at the speed of light would *not* progress. For how long? Well, for no time. And then it does; its wave unfazed but not unphased skips ne'er a beat.

When the Cosmic Clock resumes, everything picks up again where it left off.

Well, not quite so: It didn't *even* leave off. It's simply the next Tock. The stop would be (if we could give it meaning) so to speak, for the time being, but the time would *not* be being, also so to speak. *Inside* the universe there cannot be a stop. We may like to think, as Newton says, that time 'flows equably.' Notwithstanding ridicule from Reichenbach it seems he's right. Not because there's any way to prove it. Given that the Cosmic Clock exists, there is no way for its Tocks to *not* flow equably. Equably *is* what the CC says it is.

Its time is a succession of 3-D universes, with our 3-D selves embedded in each one, in what MacDonald calls the reiterant now. The more I think of it the less the Cosmic Clock seems like a clock. Checking further, it seems that this sense of sequence as distinct from time is primitive. Early humans likely knew it well. Tribes of chimpanzees use tools in sequence to accomplish certain ends. They must get the sequence right for it to work. They teach this sequence to their young.

At a much higher level of sophistication, Tumulka proposes how this sort of sequence might arise in time:

A radical explanation of nonlocality postulates the existence of a preferred slicing, or *foliation* (as mathematicians would say), of space-time into spacelike 3-surfaces. This foliation might naturally arise from the space-time geometry; for example, it might consist of the 3-surfaces of constant timelike distance from the big bang.

Radical schmactical. He attributes the idea to Bell but chimps may have a claim to prior use. Bell, it's true, is far ahead of Frank.

There is a difference between their concepts. Tumulka's is a man-made foliation that is not a built-in aspect of the universe; this is why he needs a reference point such as the time of the Big Bang—he's just generating a new kind of time. My guy's does not need a reference—not even Move 1. His every Move makes not what Tumulka calls a spacelike 3-surface but a real 3-space. His foliation *does* naturally arise. Not from geometry, but from the foliated constant reconstruction of the 3-D universe.

I'm glad I found Tumulka. What he is suggesting is: Maybe time proceeds in jerks. Maybe Moves are not so rad. I think of cruising in a car that's driven by what Anvil and, before him, I recall, another—was it Russell?—calls a gasolinen djinn. Passengers don't notice they are moved by multiple explosions though each is big enough to kill. There are about 10^2 per second. In 1860, *Scientific American's* first objection to this engine is 'the jerks of its action'. But with this many jerks per second cars just hum along. So no surprise that no one feels the cosmos jerk 10^{43} times.

All afternoon I read of foliation. I start with Wikipedia; it's a mistake. It has

no physics, only math I can't be bothered trying to digest. Next, dictionaries tell me it's a rock formation, numbered pages, or the circumstance of leafing. ArXiv has about a hundred papers, titles like 'Nice foliations of globally hyperbolic manifolds' and much more math. Nobody has anything as simple as his universe that Moves. But then nobody begins with his Beginning. The key to *his* foliation is the Cosmic Clock. Viewing it from the Beginning makes it easier to understand. It isn't like the strange synchronous spawning where a billion coral polyps spew their gametes by the light of the right moon. They spawn *in* time. The universe's synchrony is not *in* time. It is what we see *as* time.

One might think it's spooky action at a distance but it's not. It's wonderful how this is clear from the Beginning. He's given me no reason why the Moves occur in lockstep. No reason, that is, in the sense of explanation based on other things. The reason is that it's the Rule. As usual I'm left to look around. Quantum theorists give the universe a three-dimensional Wave Function. No time appears in its equation. Schrödinger is toast. The new toast is to Wheeler and DeWitt. The extra Rule that's introduced from the Beginning is the Move. In Wheeler-and-DeWitt terms, each Wave Function is 3-D and each, in turn, becomes another. Each Move the universe goes: Next. The never-ending nested nexts are what Tumulka terms a foliation.

What, I wonder, *drives* the universe's Moves? Drive is not the same as reason. He says mass must be the gas that makes the Flecks divide. Or does he really? Each time I press the point he ducks. Now, as I try to pin the concept down, he intervenes.

"All in good time." And then is gone again.

I'm tired and so I let it drop. Locking up the office, I keep thinking of the universe as a machine. Thought-habits deep-wired in my brain bring scenes of a computer with its own succession of clock-driven states. Following my trail toward the Metro station I cannot dismiss this vista.