A Froth of Bubbles and the Missing Middle: Two Thought Experiments on Time

The first section of this essay ("a froth of bubbles") is based on a waking "dream" I had on a walk in Boyce Park in Pittsburgh in 2018. I happened to be thinking about temporality at the moment it arose, a lifelong preoccupation of mine. So its apparent impertinence had a context. And I proffer it here, in at least its third iteration (this is a revised excerpt from my book *Harvest,* in which it appeared as a revised excerpt from my book *First, Summer,* in which it appeared as a revised version of a briefer record of the event that I put up on my website, without much context, immediately after it all happened, the italic section in the piece) with the same confidence and good will that I received it.

The second ("the missing middle") section of the essay, based on a nighttime dream I had a few days ago (June 2023), explores the implications of an experiment designed to determine whether time is continuous or incremental and, if the latter, whether there might be micro-betweens during which neither time nor space are "there.

Part One: Their arrow vs. my froth of bubbles

Time only has some reality (even if, as some scientists suggest, it is ultimately illusory in the larger picture) if there is some irreversible change that takes place. And, in our universe, it appears that such change is in only one direction, "past" to "future," indicated at the macro level by entropy, which always increases in a closed system; and at the micro level by the collapse of the wave-function, the change of state that measurement precipitates, even requires, which cannot be played back into some state of probabilities. So, time is change. Or at least irreversible change. There are many possible tropes we might use to indicate the directionality of this change. The one I want to start with here is "the arrow of time," a commonplace in

scientific discourse, certainly in Newtonian mechanics, but even more powerfully and problematically in post-Einsteinian theory.

But why, I wonder, use an arrow for this? It is such an aggressive metaphor, one of the implications of which is that there is always a forward-oriented thrust from a "something-already," a past, toward a "nothing-yet," a future. That is the stereotypical way we have for imagining the passage of time in our lives, in history, in everything: the past is fixed, done, like what a book is when it's published. The future is empty, open, like the rest of this page waiting for me to fill it with typing. The arrow of time is the vector that drives the now extant past forward into that blank-space-awaiting. The image of the arrow itself—the long shaft extending far back into the past, fully realized, the tiny point marking the moment of the present almost invisible, the future beyond that point entirely vacant—conveys this ideology visually. That seems so extreme, clumsy to me. Even the most trivial kinds of things we do pre-construct the future before it happens. That sentence, for example, or this essay, from the very first word: an expanding bubble of potential "realities" is created, a "field" of possibilities, which we then traverse along a single emergent path along the way, until it closes, becoming fixed, a past, when we're "done." There are all kinds of metaphors we could use to characterize this fuzziness of the intervening time it takes to get from there to here. But, to me at least, an arrow is one of the worst, presuming there is no intervening time which has been pre-cast by the first gesture and must be traversed, sometimes for a considerable way, to get to "here." It would be like thinking "born" and "die" are the only states of a life. Yes, the former necessitates the latter, but it doesn't account for anything that comes between.

I could probably come up with a half dozen better metaphors for that liminal space between past and future, which we call the present, but the one I like most is a "froth of bubbles." Here's what I wrote after that walk in Boyce Park in 2018, to give a sense of what happens if you shift metaphors:

> *I have always been skeptical about the "infinite alternate universe" aspect of the multiverse model, at least the way it is rendered in Discovery Channel shows, my primary contact with*

contemporary physics. In its simplest form, as I understand it, at each juncture in one's life (and the temporal frequency of such junctures seems never to be clearly specified), by either choice or accident or necessity, my lifeline goes off on one path while multiple alternate versions of me proceed on multiple (again, the exact number is never clearly specified) alternate paths, like particles flying off after a collision in the Large Hadron Collider. And on and on, all of this times billions of other lives and trillions of other junctures. This model seems to be exceedingly complex, random, clunky, and, honestly, nonsensical. [There are two other widely recognized IAU theories, the "puff pastry" version, with universes stacked in layers in immediate proximity to one another, every possible permutation of you and me inevitably made possible by the infinite number of them; and the single-universe with infinite numbers of separate sections, each operating according to a different set of laws. I have similar reservations about each of these, too, for different reasons in each case.] I (prefer to) think that the universe is more elegant than this. Still, there is so much theoretical framing for something of this sort (inflation, gravitational waves, quantum duality, string theory, etc.), it is equally unlikely that the old standard model (one life, one path, that's it) is adequately explanatory.

So I was walking in the woods one morning trying to fathom exactly what was wrong with the stereotypical infinite alternate universe model, and this thought came to me: It depends on a unilinear conception of time, the past always and only pressing into the future, the arrowhead of the vector of time locked in at the present moment, past receding behind, now fully formed (in infinite iterations), the future essentially empty, a blank slate waiting to be occupied by all those scattering particles. This way of thinking about time has seemed naive to me ever since I was a kid, frankly, and more and more so as I think and read more about time.

Time I believe is a fully extended, fluid field, the future already extant as something analogous to potential energy, and it approaches us, actually comes toward us, in a generally amicable way, as we stride into it, come to occupy it. In other words, the future is just as real as the past,

though it remains immaterialized until we inhabit it. The image that came to me to capture this, at least as it pertains to infinite alternatives, was a wave tipped with a froth of bubbles, an infinite number of such bubbles, as it slips toward "shore." All of the bubbles, as a whole, are relatively undifferentiated, like a froth is, rather than singular, like the ones we might blow in the backyard. Each individual bubble pre-constitutes a futural space with the potential for life, but it remains indeterminate, "empty," until we interact with it, filling it with life, realizing it in time. As we cross into that froth, we encounter only a small number of those bubbles, of course, and these are activated. As a consequence, a certain number of other bubbles on that wave and successive incoming waves become viable for life, waiting for us, full of potential, and a huge number of others become untenable, unlivable, dead, and these pop, done, gone. Only one life goes on, though it still has infinite alternatives available to it in the future that approaches it. Time in this model is more like a series of interacting tides, future approaching, past moving forward, back and forth, the present the scene of their interaction.

About a month later, on another walk, it struck me that this could also account for one of the other conundrums that has long afflicted my thinking: What part of our lifeline is a matter of choice, free will, responsive to our desires, controllable, and what part is a matter of "fate" or, my preferred word, "destiny," essentially out of our control, even if not entirely pre-determined. I do believe that choice is foundational to the human experience, organizes our ways of being in the world. But I also believe, based on my experiences, that certain paths, events, whatever, are pre-cast, obligatory, insist on happening or not happening no matter how hard I might try, (have tried!), to avoid or achieve them.

The frothy wave accounts for this in this way: Many, maybe most, of the waves we walk into and through are relatively mild, yielding to our intentions, letting us choose, more or less, the "bubbles" we prefer to interact with and enliven. Others, come at odd angles, surprise us, are beyond our control, like the sort of extrinsic historical or cultural or physical forces that are

non-negotiable, belong to the time period and the body we are, for whatever reason, compelled to inhabit. These enliven what I'll call "accidental" bubble chains. Then there are other waves that come head on, but strong, forcing us to "live" in certain bubble chains whether we like it or not. Many of the major events/changes in my own life seem to have been inescapable in this way. They just had to happen, for whatever reason. This is what I call destiny. All three of these can be accounted for, interactively, in the froth.

Finally, I think this can also account for that common human experience of seeing one's life "flash before our eyes" when we think we're about to die. There is no way one could "see" all the junctures and variations in the standard model of IAU theory in a flash. But one could see in an instant the string of interconnected bubbles that, in the end, account for our "life." We might even be able to see them as one bubble, all of them collapsing into that single, integrated whole. When we actually die, of course, all of the infinite number of remaining bubbles on the waves incoming probably pop or evaporate. But who knows? Maybe we go to another level where we can see, simultaneously, not only the whole, "time"- less bubble of our lived life, but even all the other unrealized lives in the infinite number of bubbles that popped or remain. Maybe we can even see all of that in a flash, too. That would be cool.

Note: The bubbles in my metaphor have nothing to do with the "bubble universes" that inflation seems to make at least theoretically possible. Mine are bubbles in time first, then space, not vice-versa. (Harvest, 96-103)

Okay, I know that's a long path to have walked just to get to a new metaphor. But I think there are considerable advantages to this one for the boundary between past and future we call the present, compared for example to the arrow, which doesn't seem to leave any room for the present at all, just a vector thrusting "forward" from past to future, the present almost by definition non-existent. It is, of course, easy to argue that the past and future don't "exist," are illusory. Augustine does as much by using negatives for each: not

now and not yet. Contemporary physicists have a variety of more exotic, sometimes esoteric (to me at least) ways of arguing essentially the same thing. So what is left of the "present"? Is it really "nothing," too?

Actually, I'm more than willing to accede to the relative nothingness of the present. It's like Zeno's paradox: No matter how small you imagine it, you can always cut it by half. But what about the past and future? If they, too, are nothing, then temporality is nothing. Maybe that's so, the "frozen river" of time business [the figure that came to represent Einstein's claim that the "distinction between past, present and future is only a stubbornly persistent illusion"]; but my froth of bubbles at least leaves open the possibility that time, like space, is a something, in that what we call the present is the active interface between a past moving ahead that remains momentarily real as it reifies its long trail behind, and a future approaching that becomes momentarily real, as it reveals its emerging trail ahead.

The realest dimension of all, from this point of view, is the future, which is always coming with force, an array of potentials, much like the ones I describe for linguistic and mathematical constructions. Is it fully fixed, determined? Who knows? But at least with my metaphor, possibilities remain open. What we think of as the present, then, is more like a vague interim where determinacy (what Anderthal Kord calls "free will," though I don't like either of those words for it, because it's never "free" and it's rarely "willed" in any simplistic sense) get negotiated, along with whatever other invisible forces, beyond our ken, might apply there. And what happens in the froth is what we can know of time, which is quite a lot compared to the "arrow" model. In fact, if there is any vector at all (and I know that term has almost all the same problems as the arrow, so I prefer to avoid it) it is coming "toward" the present from the future, not vice-versa. All of that becomes eligible for consideration simply by shifting metaphors. A scientist may well argue that "a froth of bubbles" is just too poetic a figure. I would counter-argue that so is "the arrow," except you can more easily pretend it's not.

Part Two: Searching for a Missing Middle

In last night's dream my mother, a famous physicist, some sort of "queen," set up an experiment to find some answers concerning what she called spacetime's potential "missing middle."

The experiment was designed to measure whether temporality was governed by the same quantum features that now demonstrably organize space, specifically the transfer of energy via quantum packets. For example, when an electron moves to a new orbit in an atom, it does so suddenly and completely, an instant jump, not a gradual descent or ascent. She wondered how that leap was effected, among these options: 1) a change of place/state of a single electron so instant it was not even limited by the speed of light; 2) a version of quantum entanglement whereby the "second" electron appeared in the alternate orbit and received all the qualities of the "first" electron instantly, a process not limited by the speed of light, the first electron disappearing precisely as its partner appeared; or 3) either of the above, but at the speed of light, in which case there would be a miniscule period of time between in which neither was "there," thus the "missing middle." [If an electron is construed as the "wave" aspect of its particle/wave duality, this conundrum disappears: It transits from one allowable "level" to another in a smooth way.]

My mother's concern was not with conservation of matter/energy problem (i.e., what that "between" state implied for the integrity of space) but with how to think about the movement of time: Is it a continuous flow, the way a second hand on a watch moves, accounting for every instant of it from one minute to the next, no missing middle, i.e. Or is it incremental, discontinuous, the way the clock in my schoolroom moved, jumping suddenly to the next minute without visibly accounting for the time it took to get there, a missing middle, i.e. To find out she gave me a super-giant magnifying glass and asked me to keep viewing intently a scene in the village we lived in. My task was to pay close attention and report if there were the slightest glitches that might suggest whether temporality moves stutteringly rather than smoothly; i.e.,

whether the scene I was viewing essentially disappeared and then reappeared in some regular (quantum) pattern over a specific interval of "time."

I think you can see the implications of this. If time is quantic in nature, then this village scene I was monitoring must operate temporally in one of three ways I list above in relation to time, a super-fast sequence of appearances and disappearances that 1) either take no time at all, therefore no missing middle; or 2) take some miniscule increment of time, therefore a missing middle. If it's the latter there would by micro-tiny instants in which time didn't exist, was suspended, and space would disappear as it exited time and then reappear as time reengaged. The interval between these two states of spacetime—the before and the after—was what my mother called "a missing middle." On the largest scale, it would raise questions about what sort of "nothingness" or "absence" characterized these spatiotemporal voids.

Obviously, and unfortunately, my dream ended before I "solved" this conundrum.