Retrocausality Is Not Symmetric in Time

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https://youtu.be/WugRN6xe9XQ&lc=UgzmyJwisQ0gZhJ_jzN4AaABAg

A Comment on the Dr Ben Miles YouTube post:
Why Physicists Think The Future Changes the Past - Retrocausality Explained (Mar 26, 2023)
https://youtu.be/WugRN6xe9XQ?t=8m9s

8:09 *"According to retrocausality [a] measurement [on one photon goes] back through time to [when the] two photons were created … allowing … both [to] agree on … spin direction [in the] future.* [10:21] *"Retrocausality [requires] time-symmetry, [meaning] the laws of the universe … work the same way … backward [and] forward in time. [However,] the second law of thermodynamics [says] this isn't true. Entropy — disorder — always increases and prevents things from moving backward in time."*

The specific version of retrocausality you mention at 8:09 is the one I proposed in early 2006 [1] in the context of quantum security. I did not realize it was an original idea at the time, so it got me some unexpected press [2]. The term "retrocausality" as a description of the idea popped up several years later, but I have no idea who coined it.

The earliest well-defined backward-in-time quantum mechanics theory I'm aware of is the delightfully strange Wheeler-Feynman absorber theory of 1945 [3], in which photons travel *both* forward and backward in time. John Wheeler and Richard Feynman surprised themselves that such a whacky-sounding idea gave predictions that did not violate causality. Yet, mathematically, it worked. Feynman based his QED work (Feynman diagrams) on absorber theory and eventually won a Nobel Prize. You can see the backward-in-time element of QED diagrams in how electrons and photons can go in *either* direction in time. Electrons traveling backward in time become positrons (antimatter), while photons traveling backward in time become "advanced" photons. The term for ordinary forward-in-time photons is, no kidding, "retarded" photons.

With that background, I must, alas, take exception to your assertion that retrocausality *must* invoke time symmetry. I defined the idea, and I did *not* define it that way. The critical constraint that keeps getting lost is that retrocausality works *only* if the wave function leaves *no* historical trace of the event before detecting the photon or particle pair. Such "ahistorical" wave functions safely lock out any knowledge of their eventual outcome because they *contain* no traces of that outcome. That was the essence of my security argument for why quantum encryption is so hard to break.

Now think about that: If an expanding wave function leaves no historical trace of where its particles and particle properties may land, then locking down two remote spins, even spins at opposite ends of the universe, becomes not a violation of history but a *delayed instantiation* of history. Delayed instantiation complicates history but, by definition, cannot *change* history. Instead, you get a ragged-edged version of time flow that is fully entropic and thus asymmetric in time. Ragged-edged time unfolds at different rates for different regions of space and combinations of particles.

The most amusing portrayal I've seen of the concept of ragged-edged entropic time is not from any physics video but from Stephen King's movie *The Langoliers.* Granted, King's wave function collapses are decidedly toothier and scarier than poking electrons with photons. However, his concept of time being fractured in both directions, sometimes catching up to itself only reluctantly, is delightfully apt.

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[1] T. Bollinger, *On the Impossibility of Keeping Out Eavesdroppers Using Only Classical Physics,* TAO Physics **2006,** 0123 (2021). DOI: https://doi.org/10.48034/20060123, Web: https://tarxiv.org/tao.2006-01-23.pdf

[2] B. Bulyubash, *Encrypted by Noise,* Around the World (Journal of the Russian Geographical Society) 2008-10-01 (2008). https://www.vokrugsveta.ru/telegraph/theory/754/

[3] J. A. Wheeler and R. Feynman, *Interaction with the Absorber as the Mechanism of Radiation,* Reviews of Modern Physics **17,** 157 (1945). https://authors.library.caltech.edu/11095/1/WHErmp45.pdf