The Power of Future Superposition in Quantum Mechanics

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https://youtu.be/s5yON4Gs3D0&lc=Ugx5RD8APWZsPJoeBmJ4AaABAg

A Comment on the Arvin Ash (YouTube) post:
Boy, Was I Wrong! How the Delayed Choice Quantum Eraser Really works (Sep 16, 2023)
https://youtu.be/s5yON4Gs3D0?t=14m23s

14:23 *"Here is the clincher. If you combine all the patterns from D2, D3, D4, and D5 [in the future], you get precisely the same pattern you have at D1 [in the past]. This idea should make sense because every entangled pair that ends at D1 has a corresponding pair that ends up [later] at one of the other four detectors. So, you are not changing the past. What you are doing is, in the future, you are choosing a subsample of the data you made in the past."* Arvin Ash, thank you! Your video provides an accurate, well-explained, and nicely pointed explanation of why quantum erasure does *not* change the past. Sabine Hossenfelder also observed in her earlier YouTube video that *the past is the past* and never varies. It's odd how this simple point ends up lost in the shuffle!

If I may, your observations suggest a level of prediction that goes beyond randomly choosing a subsample: By leaving components of her experiment in an unobserved quantum state, the D1 experimenter creates a superposition not of particles but of *permissible futures* [1] for how the experiment later can reach completion. Your D1=D(2,3,4,5) formula is an example of one such future superposition. It permits multiple futures to unfold yet limits that superposition to futures in which the sum of the expressed patterns always equals D1.

One notable difference between particle and future superpositions is that different futures may have radically different explanations of how D1 arose. As you noted in your video, these diverse explanations of the already-fixed past must still always match D1 results.

But doesn't the idea of superposing *futures* run the bizarre risk that, at least in some cases, it may *never* be possible to arrive at a single, well-defined history of particle paths?

Sure. It's called the double-slit experiment.

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[1] Sidenote: Why would one want to superpose futures instead of particles? Wouldn't that entail a massive and unnecessary change in the maths?

While particle-and-wave superposition maths work great for medium-energy quantum mechanics problems, they also wholly depend on Bohr's fixation on breaking quantum mechanics down into two then-familiar classical extrema: Infinitely precise particle states and infinitely smooth wave states. He then insisted on using these classical extrema as the "fundamental" building blocks of all quantum mechanical superpositions.

That's a problem. Using energy-indifferent extrema states as superposition building blocks is akin to attempting to define a dog as a superposition of a mouse and an elephant and then adding more maths to renormalize the result to better match the mass of real-world dogs. In particle physics, the experimental creation of just one of Bohr's classically point-like particle states would require more energy and momentum than exists in the universe, while the creation of one of his perfect plane-wave states would require infinite time and space. Bohr's overuse of classical analogies is why particle-and-wave superposition maths blow up so easily and produce, for example, infinite-mass vacuums. In contrast, superposing *futures* dispenses with all infinite-energy states from the start and focuses instead on superposition as a tool for predicting how future *information* (history) on the interaction and evolution of those entities proceeds.