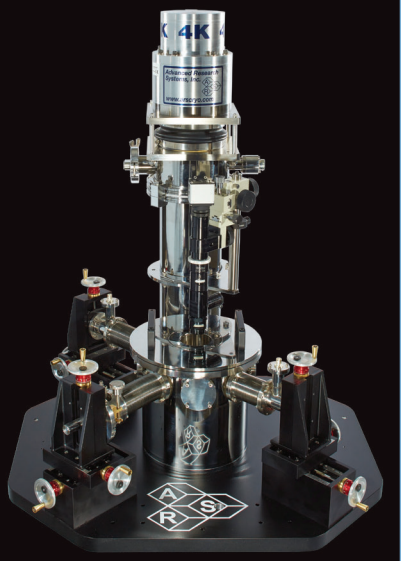
CRYOSTATS FOR THE QUANTUM ERA



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three-quarters of a century thought it important to reexamine the meaning of probability. For most physicists, probabilities are user-independent frequencies, but for most statisticians, they are guides to action by the person who made the probability assignment. If physicists in 1926 had held a personalist view of probability, it would have *required* them from the very beginning to hold a personalist ("epistemic") view of quantum states. There would have been no need for an "interpretation."

I have comments on several issues raised by Derry. Max Jammer and many others have indeed written for over half a century that quantum states are nothing more than formal devices for encapsulating probabilities of observation. But nobody before Carlton Caves, Christopher Fuchs, and Rüdiger Schack ever added that *if* probabilities are viewed as personal judgments of the person who assigns them, then that same view *must* be taken of quantum states.

Derry quotes Niels Bohr's statement that he does not "appeal to the observing subject." Later in that paragraph, Bohr adds that "all subjectivity is avoided by proper attention to the circumstances required for the well-defined use of elementary physical concepts."[1] That does contradict my reading of the two Bohr quotations that appear in my Quick Study. By "experience," Bohr must have meant collective rather than individual experience. I doubt that Bohr took a personalist view of probability. That Bohr, however, *was* a personalist is argued interestingly by Ulrich Mohrhoff.[2]

I quote Bruno de Finetti on "Fairies and Witches" only to give a poetic statement of the unfamiliar view of probability that I am inviting physicists to examine. My point is that *if* de Finetti is correct, then it would profoundly affect our understanding of quantum mechanics. For me, the illumination it sheds on the interpretation of quantum mechanics is all by itself a compelling reason for adopting a personalist view of probability.

The expansion of my argument that Derry looks forward to reading can be found in the article of mine[3] cited in my Quick Study along with the rather more technical article[4] by Fuchs and Schack that inspired mine.

References

1. N. Bohr, *Essays 1958–1962 on Atomic Physics and Human Knowledge*, Ox Bow Press (1987), p. 7.
2. U. Mohrhoff, https://arxiv.org/abs/1905.07118.
3. N. D. Mermin, *Rep. Prog. Phys.* **82**, 012002 (2019).
4. C. A. Fuchs, R. Schack, *Rev. Mod. Phys.* **85**, 1693 (2013).

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I appreciate David Mermin's letter. There is, of course, an ongoing debate in the philosophy of probability about whether probability is best thought of as objective or subjective. Experts continue to disagree, which suggests that we might want to acknowledge a "problem" in that wider-than-quantum context, even if we think we have the right answer.

Whatever our stance is toward probability, we can still wonder about reality (ontology). People disagree about that too, and there are respectable but mutually incompatible possibilities—which represents another problem.

In particular, one can be a subjectivist about probability (as I am myself!) within different approaches to the quantum measurement problem. Both Everettian and Bohmian quantum theories invoke subjective probabilities, concerning which branch of the wavefunction you are on (Everettian) or the values of the hidden variables (Bohmian), although they treat quantum measurements differently. Taking a subjective stance toward probability does not by itself resolve the measurement problem.

Objective-collapse models, by contrast, sit more comfortably in (as the name suggests) an objective picture of probability. To the extent that such models are empirically viable, it seems wrong to deny the existence of the quantum measurement problem, since, again, they address it very differently than other models.

I am optimistic that the quantum measurement problem is solvable and will be solved, but I am wary about prematurely declaring victory.

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