APR20-2020-001344

Abstract for an Invited Paper
for the APR20 Meeting of
the American Physical Society

If relativity is about space and time, what is quantum mechanics about?

JEFFREY BUB, University of Maryland, College Park

h $-abstract-$\pardThe theory of relativity is about the structure of space and time: we were wrong in thinking that events occur in a flat Euclidean 3+1-dimensional manifold. Similarly, quantum mechanics is fundamentally about probability: we were wrong in thinking that probability is just a measure of ignorance. The transition from classical to quantum mechanics involves going from a commutative to a non-commutative algebra of observables, equivalently from a Boolean to a non-Boolean algebra of 2-valued observables, which represent properties or propositions. The non-Boolean algebra of quantum mechanics is not embeddable into a Boolean algebra, which is to say there are no 'hidden variables' whose values would 'complete' the quantum state description to a consistent assignment of truth or falsity to all propositions (technically, a 2-valued homomorphism on the algebra). Non-Booleanity allows new sorts of nonlocal probabilistic correlations with no causal explanation, associated with 'entangled' quantum states, that are not possible in a Boolean or classical theory. I will expand on these ideas with reference to the Bohr-Einstein debate about the completeness of quantum mechanics and recent arguments applying quantum mechanics to complex systems that include agents who are themselves using quantum theory.\pard-/abstract-\