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Wavefunction Collapse via a Nonlocal Relativistic Variational Principle ALAN HARRISON, Los Alamos National Laboratory — We propose a relativistically covariant variational principle (VP) capable of describing wavefunction collapse. This produces a nonlinear, nonlocal, time-reversal-invariant theory; the hidden variable is the phase of the wavefunction. The VP is $\delta(A_1 + A_2) = 0$, in which A_1 and A_2 are positive definite integrals over all spacetime of functions of $\psi(t, \vec{x})$. A_1 is quadratic in deviations of the wavefunction from compliance with the standard quantum mechanical (SQM) wave equation. A_2 takes a minimum value when the wavefunction is a state of minimal uncertainty, penalizing certain kinds of superpositions and thus driving collapse. A multiplier sets the relative size of the terms so that (1) A_1 dominates in isolated microscopic systems, so they evolve according to the SQM wave equation; and (2) macroscopic superpositions cause A_2 to dominate, driving the system to collapse. Since any macroscopic measurement apparatus is entangled with the system being measured, process (2) explains the empirical observation that measurement collapses the wavefunction. We show that A_2 enforces the Born rule, under suitable assumptions and approximations. As an example, the theory predicts the results of the two-slit experiment, including the delayed-choice variant.

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