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Trajectory-Based Theory of Relativistic Quantum Particles

This presentation explores an alternate quantum framework in which the wavefunction ?(t, x) plays no role. Instead, quantum states are represented as ensembles of real-valued probabilistic trajectories, x(t, C), where C is a trajectory label. Quantum effects arise from the mutual interaction of different trajectories or “worlds,” manifesting as partial derivatives with respect to C. The quantum trajectory ensemble x(t, C) satisfies an action principle, leading to a dynamical partial differential equation (via the Euler-Lagrange procedure), as well as to conservation laws (via Noether’s theorem). An earlier, non-relativistic version of the trajectory-based theory turns out to be mathematically equivalent to the time-dependent Schroedinger equation [1–4], though it can be derived completely independently [3,4]. On the other hand, a more recent, relativistic generalization (for single, spin-zero, massive particles) [5] is not equivalent to the Klein-Gordon (KG) equation—and in fact, avoids certain well-known issues of the latter, such as negative (indefinite) probability density. The special case of the KG plane-wave solutions do in fact correlate to quantum trajectory ensemble solutions, but the superposition states do not. In fact, the x(t, C) do not obey any linear superposition principle, and otherwise lead to new physical predictions that could in principle be validated or refuted by experiment.

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