On the measurement problem for a two-level quantum system

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Abstract

A geometric approach to quantum mechanics with unitary evolution and non-unitary collapse processes is developed. In this approach the Schroedinger evolution of a quantum system is a geodesic motion on the space of states of the system furnished with an appropriate Riemannian metric. The measuring device is modeled by a perturbation of the metric. The process of measurement is identified with a geodesic motion of state of the system in the perturbed metric. Under the assumption of random fluctuations of the perturbed metric, the Born rule for probabilities of collapse is derived. The approach is applied to a two-level quantum system to obtain a simple geometric interpretation of quantum commutators, the uncertainty principle and Planck's constant. In light of this, a lucid analysis of the double-slit experiment with collapse and an experiment on a pair of entangled particles is presented.

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