Kryukov, Alexey A.
Mathematics of the classical and the quantum. (English) Zbl 1454.81090

Summary: Newtonian and Schrödinger dynamics can be formulated in a physically meaningful way within the same Hilbert space framework. This fact was recently used to discover an unexpected relation between classical and quantum motions that goes beyond the results provided by the Ehrenfest theorem. The Newtonian dynamics was shown to be the Schrödinger dynamics of states constrained to a submanifold of the space of states, identified with the classical phase space of the system. Quantum observables are identified with vector fields on the space of states. The commutators of observables are expressed through the curvature of the space. The resulting embedding of the Newtonian and Schrödinger dynamics into a unified geometric framework is rigid in the sense that the Schrödinger dynamics is a unique extension of the Newtonian one. Under the embedding, the normal distribution of measurement results associated with a classical measurement implies the Born rule for the probability of transition of quantum states. The mathematics of the discovered relationship between the classical and the quantum is reviewed and investigated here in detail and applied to the process of measurement of spin and position observables.

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MSC:
81Q20 Semiclassical techniques, including WKB and Maslov methods applied to problems in quantum theory
81Q05 Closed and approximate solutions to the Schrödinger, Dirac, Klein-Gordon and other equations of quantum mechanics
70H05 Hamilton’s equations
81Q15 Perturbation theories for operators and differential equations in quantum theory
81S30 Phase-space methods including Wigner distributions, etc. applied to problems in quantum mechanics
81P15 Quantum measurement theory, state operations, state preparations

Full Text: DOI arXiv

References:

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