Yang, Jianhao M.

Relational formulation of quantum measurement. (English) [Zbl 1411.81056]


Summary: Quantum measurement and quantum operation theory is developed here by taking the relational properties among quantum systems, instead of the independent properties of a quantum system, as the most fundamental elements. By studying how the relational probability amplitude matrix is transformed and how mutual information is exchanged during measurement, we derive the formulation that is mathematically equivalent to the traditional quantum measurement theory. More importantly, the formulation results in significant conceptual consequences. We show that for a given quantum system, it is possible to describe its time evolution without explicitly calling out a reference system. However, description of a quantum measurement must be explicitly relative. Traditional quantum mechanics assumes a super observer who can instantaneously know the measurement results from any location. For a composite system consists space-like separated subsystems, the assumption of super observer must be abandoned and the relational formulation of quantum measurement becomes necessary. This is confirmed in the resolution of EPR paradox. Information exchange is relative to a local observer in quantum mechanics. Different local observers can achieve consistent descriptions of a quantum system if they are synchronized on the information regarding outcomes from any measurement performed on the system. It is suggested that the synchronization of measurement results from different observers is a necessary step when combining quantum mechanics with the Relativity Theory.

MSC:
81P15 Quantum measurement theory, state operations, state preparations
81P40 Quantum coherence, entanglement, quantum correlations

Keywords:
relational quantum mechanics; quantum measurement; entanglement; EPR

Full Text: DOI arXiv

References:
This reference list is based on information provided by the publisher or from digital mathematics libraries. Its items are heuristically matched to zbMATH identifiers and may contain data conversion errors. It attempts to reflect the references listed in the original paper as accurately as possible without claiming the completeness or perfect precision of the matching.