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Interaction Free Measurement of Quantum Systems ONOFRIO RUSSO, Department of Physics, New Jersey Institute of Technology, LIANG JIANG, Institute for Quantum Information, Caltech — A measurement of the state of a physical system always causes some degree of disturbance in the system. When the scaling consists of nano or smaller quantities, measurements can cause severe changes in the information contained in the system. Noteworthy are the quantum computing elements, or qubits, used operationally and as memory. The main and foremost concern for the quantum computing elements is decoherence which is exacerbated by the measuring process. We propose to overcome these obstacles using an intriguing quantum mechanical interaction free measurement (IFM) method. High-efficiency IFM has been demonstrated by combining quantum interference and the quantum Zeno effect [P. G. Kwiat, et al., Phys. Rev. Lett. 83, 4725 (1999)]. In addition, IFM can be useful for quantum information processing, because it eliminates photon absorbing/scattering processes, which often are responsible for undesired information loss and decoherence in neighboring atoms. This is manifested in optical lattices, dephasing of proximal nuclear spins of nitrogen-vacancy centers in diamond, etc. We further propose and investigate using IFM to replace conventional optical readouts for specific quantum systems with the advantage of elimination of undesired decoherence.

Liang Jiang
Institute for Quantum Information, Caltech

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