Distillation of Quantum States through Zeno-like Measurements

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It has been realized that quantum features such as the superposition principle and the nonlocality in quantum mechanics afford us with new ideas to go beyond classical ones, and the so-called quantum information is now one of the hottest topics in quantum physics. Recent astonishing advances in nanotechnology are driving experimental physicists to various attempts to run the ideas into reality, but still more ideas are needed. For example, such an elementary and fundamental problem as how to prepare a desired quantum state is one of the significant issues to be tackled, since typical quantum states necessary for quantum information, like entangled states with high quantum coherence, are fragile against environmental perturbation and are not naturally found in laboratory.

In this presentation, we discuss a novel method for preparing a quantum state with high coherence, i.e., *distillation through Zeno-like measurements* [1,2]. "Distillation" is a notion of extracting a desired state from an arbitrary (naturally given) state. We have realized recently that one can distill a pure state of a quantum system by repeatedly applying measurements (Zeno-like measurements) on another quantum system in interaction with the former. The framework is simple and general, and possesses various potential applications, among which we discuss the following examples:

(i) One of the important applications is **distillation of entanglement** [3,4], since the entanglement is a key resource to the various ideas of quantum information like quantum computation. We show in a simple model a possibility of establishing an entangled state (a Bell state) by the present distillation scheme.

(ii) We also show that a slight modification of our scheme enables us to establish an **entanglement between distant systems** [5,6], which is necessary for quantum teleportation.

(iii) Another important application is **initialization of multiple qubits** [4], which is required for quantum computation. By simply repeating measurements on a qubit, one can reset a series of qubits.

As a possible physical system to apply our scheme in reality, we also discuss a system of semiconductor quantum dots, which is now eagerly investigated experimentally towards a realization of a quantum computer with multiple qubits, and clarify the robustness of the scheme against nonideal features in actual experiments.

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