QUANTUM ENTANGLEMENT AND DECOHERENCE

Quantum entanglement expresses the inherent non-locality to quantum mechanics and forms a precious resource for quantum computation and quantum information. Entanglement arises when the state of two or more subsystems of a compound quantum system cannot be factorized into pure local states of the subsystems . The exploitation of quantum entanglement resulted in encoding, processing and distribution of nformation in ways impossible with classical means. Hence the possibility of implementing entangled resources resulted in futuristic proposals (quantum teleportation, quantum cryptography, quantum computation, etc.) which are now made, to a certain extent, into reality. Despite its prominent role in the microspic but also macroscopic systems, it still stands an open issue to achieve a conclusive characterization and quantification of entanglement. On a broader perspective, it is now recognized that entanglement plays a fundamental role in the physics of many-body systems, in particular in critical phenomena like quantum phase transitions and in the understanding of decoherence phenomena. The strength of correlations of fluctuations of observables (such as density, magnetization, etc.) in a many-body system is a reflection of the degree of entanglement (for pure states).

Decoherence is the fundamental mechanism by which fragile superpositions are destroyed thereby producing a quantum to classical transition . The fragility of entanglement is due to the coupling between a quantum system and its environment; such a coupling leads to decoherence, the process by which information is degraded. The decreasing of entanglement due to decoherence may induce failure of the algorithms and various protocols of quantum information processing. In fact, decoherence is one of the main obstacles for the preparation, observation, and implementation of multi-qubit entangled states. The intensive work on quantum information and computing in recent years has tremendously increased the interest in exploring and controlling decoherence effects.

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