Quantum states and phases underlying collective dissipation phenomena

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We introduce a new family of collective spin states which, although being *quantum* entangled states, are responsible for the emergence of *classical* macroscopic response to light. We call these states coherently radiating spin states (CRSS), study their entanglement properties, the way they are produced, and how they underlie collective dissipation phenomena. In particular, we show that CRSS are naturally realized in superradiance and underlie the dissipative Dicke phase transition, hence predicting the optimal scaling of spin squeezing in superradiance, and its classical-like radiation. In a realistic system, where individual decay competes with collective dissipation, we show how the system develops a quantum bistability, exhibiting many-body quantum jumps between CRSS and a non-entangled state. More generally, CRSS emerge as ground states of an Ising Hamiltonian and underlie its quantum phase transition. CRSS thus provide a promising concept for studying many-body spin systems in various platforms, with applications ranging from quantum metrology and lasing to phase transitions.

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