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Near Field Photon Emission and Revival in Quantum Dot Qubits[1]

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— Modeling the spontaneous emission of photons coupled to the electronic states of quantum dots is important for understanding quantum interactions and entanglement in condensed matter as applied to proposed solid-state quantum computers, quantum networks, single photon emitters, and single photon detectors. A quantum dot initially in an excited state can be experimentally observed to decay to its ground state and the observed homodyne tomography of the emitted photon can yield information about the qubit state of the emitter. Though the characteristic lifetime of photon emission is traditionally modeled via the Weisskopf-Wigner approximation, we seek to model the fully quantized spontaneous emission, including near field effects, of a photon from the excited state of a quantum dot beyond the Markovian limit. We further investigate subsequent interactions between the emitted photon and adjacent quantum dots in an effort to describe multipartite entanglement. We propose the use of discretized central-difference approximations of space and time partial derivatives, similar to finite-difference time domain models, to describe single photon states via single photon operators. Additionally, within the future scope of this model, we seek results in the Purcell and Rabi regimes for spontaneous emission events from quantum dots embedded in micro-cavities.

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