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Quantum Information and Coherence in Cavity Quantum Electrodynamics

Cavity QED provides an ideal setting for quantum information science with atoms and photons. The strong atom-cavity coupling attainable in a high-finesse microresonator allows one to achieve unprecedented control over both the optical and the motional properties of a free atom. First, this makes possible to realize novel interfaces between classical and quantum light fields. For example, single photons with adjustable amplitude, frequency and polarization have been generated. The coherence properties of these photons as deduced from a time-resolved photon correlation experiment make them suitable for applications in linear-optical quantum computing. Second, the novel intracavity light forces can be employed to beat the disastrous effect of cavity-mediated momentum diffusion and cool an atom into a ground state of the motion. The extremely long trapping times thus achieved in combination with the ability to precisely control the position of an atom or an atomic array are important steps towards quantum networking with stationary atoms and flying photons.