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Ground-state cooling of a single atom at the center of an optical cavity STEPHAN RITTER, ANDREAS REISERER, CHRISTIAN NÖLLEKE, GERHARD REMPE, Max-Planck-Institute of Quantum Optics — The study of the dynamics and precise manipulation of physical systems at the quantum level requires full control over all relevant degrees of freedom. In this respect, single atoms in optical dipole traps are a well advanced system. In order to couple these atoms to single photons, optical cavities have proven very successful. However, for complete control of this coupling, the atoms have to be cooled to the ground state of the trapping potential. In our experiment, a single neutral atom is deterministically localized at the center of an optical resonator. Using a three-dimensional optical lattice with high intensities, we observe trap frequencies of several hundred kHz, such that the atom is tightly confined to the Lamb-Dicke regime. This allows us to cool the atom to the three-dimensional ground state via Raman sideband cooling. We reach the strong-coupling regime of cavity QED manifested by a clearly resolved normal-mode splitting even for a moderate cavity finesse. Thus, our system is the first to achieve simultaneous experimental control over the motional, internal and radiative properties of a single atom.

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