DAMOP07-2007-000208

Abstract for an Invited Paper
for the DAMOP07 Meeting of
the American Physical Society

Cavity quantum electrodynamics: From one-atom maser to single-photon server

GERHARD REMPE, Max-Planck Institute for Quantum Optics, Hans-Kopfermann Str. 1, D-85748 Garching, Germany

The first experiment demonstrating strong coupling between single Rydberg atoms and single microwave photons was performed in Herbert Walther's laboratory 20 years ago [G. Rempe, H. Walther, and N. Klein, Phys. Rev. Lett. 58, 353 (1987)]. At that time, investigation of light-matter interaction at the single-particle level was considered academic. Today, fundamentally new applications are on the horizon, in particular in the optical domain where laser cooling and trapping techniques for atoms can be implemented. New light forces have been discovered, enabling one to store atoms for such a long time that genuine quantum protocols can now be realized with just one single intracavity atom. A first example is the realization of a deterministic single-photon server with realtime control of its performance. A second experiment has achieved deterministic entanglement of an atom and a photon emitted from the cavity. Subsequent mapping of the atomic state onto a second photon makes possible to produce entangled photons on demand. Such novel experiments constitute important steps towards the production of highly entangled many-photon quantum states and scalable quantum networks of atom-cavity systems. The fascinating possibilities opened up by cavity quantum electrodynamics continue to keep the field young and exciting.