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Rydberg blockade schemes for entanglement of atoms and light

KLAUS MOLMER, University of Aarhus

Exciting two nearby atoms from their ground states to Rydberg excited states induces a 10-12 order magnitude increase in their mutual dipolar interaction. This controllable interaction provides a promising basis for quantum computing with neutral atoms. In this presentation we will describe a number of proposals for generation of entanglement assuming the use of Rydberg interactions in atomic ensembles. We will show that even without the ability to address individual atoms it is possible to produce a variety of entangled atomic states, it is possible to perform quantum computing with collectively stored quantum bits, and it is possible to use the atomic ensembles as deterministic, directional sources of single photons and multi-photon non-classical states of light.