



Stephan Dürr

(Max-Planck-Institut für Quantenoptik, Garching)

Remote Entanglement between a Single Atom and a Bose-Einstein Condensate

Entanglement between stationary systems at remote locations is a key resource for quantum networks. We report on the experimental generation of remote entanglement between a single atom inside an optical cavity and a Bose-Einstein condensate (BEC). To produce this, a single photon is created in the atom-cavity system, thereby generating atom-photon entanglement. The photon is transported to the BEC and converted into a collective excitation in the BEC, thus establishing matter-matter entanglement. After a variable delay, this entanglement is converted into photon-photon entanglement. The matter-matter entanglement lifetime of 100 microseconds exceeds the photon duration by two orders of magnitude. The total fidelity of all concatenated operations is 95%. This hybrid system opens up promising perspectives in the field of quantum information. [M. Lettner et al. PRL, 106, 210503 (2011)].

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Universität Ulm, Raum N24/ 252
Albert-Einstein-Allee 11, 89081 Ulm

