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Creating optical cat states entangled with an atom BASTIAN HACKER, STEPHAN WELTE, SEVERIN DAISS, LUKAS HARTUNG, LIN LI, GERHARD REMPE, Max-Planck-Institute of Quantum Optics — Schrödinger's cat is a famous gedanken experiment on the existence of quantum mechanical superposition states of macroscopic objects [1]. Experimental implementations in quantum optics employ the superposition of two coherent states with opposite phase, so-called cat states. These continuous-variable states have a tunable amplitude to vary the degree of macroscopicity and study decoherence effects. Our experiment implements a strong interaction of a coherent light pulse with a single trapped Rubidium atom, provided by an optical cavity [2]. We deterministically produce a hybrid entangled state between the atomic spin and the phase of the propagating light pulse. A projective measurement of the atomic spin projects the optical state and prepares it in an optical cat state. We study the non-classical properties of the produced states and demonstrate control over all relevant degrees of freedom, using coherent control of the atom. Cat states can be employed for quantum error correction, and may thus find applications in fiber-based optical quantum networks.
[1] E. Schrödinger, Naturwissenschaften **23**, 807 (1935)
[2] B. Hacker et al., Nature Photonics **13**, 110 (2019)

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