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Early stage of Superradiance from Bose-Einstein condensates[1]
LUKAS BUCHMANN, University of Arizona — We investigate the dynamics of matter and optical waves at the early stage of superradiant Rayleigh scattering from Bose-Einstein condensates, an instance of four-wave-mixing of matter and optical waves. Our analysis is within a spatially dependent model which treats the matter-waves as well as the optical end-fire modes quantum mechanically and is capable of providing analytic solutions for the operators of interest. In particular, we study the statistical properties of the outgoing scattered light which provide insight into the rich internal dynamics of the system at this early stage. Furthermore, we investigate coherence properties of pairs of counter propagating atomic sidemodes produced during the process. It is shown that these clouds exhibit long-range spatial coherence and strong nonclassical density cross-correlations due to entanglement between the clouds. These findings make this scheme a promising candidate for the production of highly directional nonclassically correlated atomic pulses. Our prediction of number difference squeezing between the clouds was observed in another instance of a four-wave mixing process using metastable helium.

[1]Work performed at IESL-FORTH in Crete, Greece

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