Mode competition in superradiant scattering of matter waves

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Matter-wave amplification was for the first time analyzed in the phenomenon of superradiance scattering from a Bose-Einstein condensate. In this experiment, the formation of a matter grating due to initial Rayleigh scattering of a pumping beam by an elongated Bose-Einstein condensate was self amplified by resonant light diffraction. The geometry of the condensate favored absorption by each atom of a pumping photon and subsequent scattering into so-called end-fire modes along the BEC long axis.
The purpose of our research has been to go further in the study of mode competition between superradiant modes that naturally leads to prefential scattering along the long axis. For this purpose, we have characterized superradiance after previously loading and release of our BEC into an optical lattice. Pumping at the Bragg angle for diffraction by the matter grating resulting from the optical lattice modulation can lead to superradiant scattering into the Bragg mode in parallel to usual superradiant scattering into end-fire modes. In our work, mode competition has been simply analyzed by modifying the optical lattice depth for controlling the initial diffraction efficiency of the grating.