Overcoming loss of contrast in open atom interferometers

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Abstract.

Light-pulse atom interferometers are based on the coherent splitting and recombination of a cloud of atoms (wave packet) by means of counter-propagating laser fields. Due to the photon recoil, two paths are generated that can accumulate a relative phase being especially sensitive to external potentials. In the two exit ports of such an interferometer, a variation of this phase shift can be detected as an oscillation in the integrated density, that is the particle number. By determining the phase from this interference pattern with high accuracy, matter-wave interferometers have been demonstrated to be one of the most precise methods to measure accelerations, rotations and fundamental constants. However, the accuracy of the phase extraction strongly depends on the amplitude of the oscillation which we define as the contrast.

In this talk, we focus on open atom interferometers, that is the two paths do not perfectly overlap (in phase space) after the last beam splitter. This can be caused for example by gravity gradients. We provide an intuitive description for the fringes in the spatial density profile appearing in such open interferometers. These fringes in turn imply a loss of contrast and therefore reduce the sensitivity of the interferometer, especially for interferometry with long interrogation times. In order to overcome this loss of contrast, we present an elementary strategy which is based on the control of the fringe pattern analogous to demonstrations in recent experiments [1,2,3].

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