Properties of Raman beamsplitters using phase modulated light in an optical cavity

Sofus Laguna Kristensen

Niels Bohr Institute, Copenhagen
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Using an optical cavity to perform atom interferometry offers several advantages; the high-quality wavefronts allows for very long coherence time (20 s) of a spatially seperated superposition held in an optical lattice, and the resonant power enhancement allows the use of simpler laser systems with a fiber optical modulator to generate laser frequency pairs that are needed for performing Raman beamsplitters.

However, these frequency components form multiple standing waves in the cavity, resulting in a periodic spatial variation of the properties of the atom-light interaction along the cavity axis. Here, we will describe this spatial dependence and calculate two-photon Rabi frequencies and ac Stark shifts, and confront the model to measurements performed with varying cavity and pulse parameters.

We show how the transfer function of the cavity can be utilized to increase the performance of our atom interferometer, by boosting the Raman transition efficiency at all positions in the cavity. This can almost double the contrast in a Mach-Zehnder cavity atom interferometer in comparison to the unoptimized case.