A free-space Ramsey interferometer with Bose-condensed atoms

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Atom interferometry has proven to be an increasingly valuable technique for precision measurements over the last years. Compared to photons, atoms offer the advantage of having an intrinsically more complex structure and therefore allowing a larger range of possible measurements to be undertaken. There have been a number of fundamentally important experiments making use of the atomic mass to measure the Newtonian gravitational constant G [1] and the fine structure constant α [2].

Here, we show results on a free-space atom interferometer with Bose-condensed ^{87}Rb atoms, operating on the atomic clock transition $|F=1, m_F=0\rangle \rightarrow |F=2, m_F=0\rangle$ (Fig. 1) [3]. The interfering atoms are part of an atom laser that is output-coupled from a Bose-Einstein condensate and travels under gravity through a sequence of two Ramsey-type (internal state) beam splitters. The experiment offers the opportunity to make a comparison between traditional atomic beam interferometers and comparable devices using Bose-condensed atoms. Combining the existing pumped atom laser with a continuous replenishment system of the source condensate is a promising way to significantly increase the average atom flux. Furthermore, different schemes have been proposed for squeezing an atom laser, opening the route towards interferometric sensitivities below the standard quantum limit.

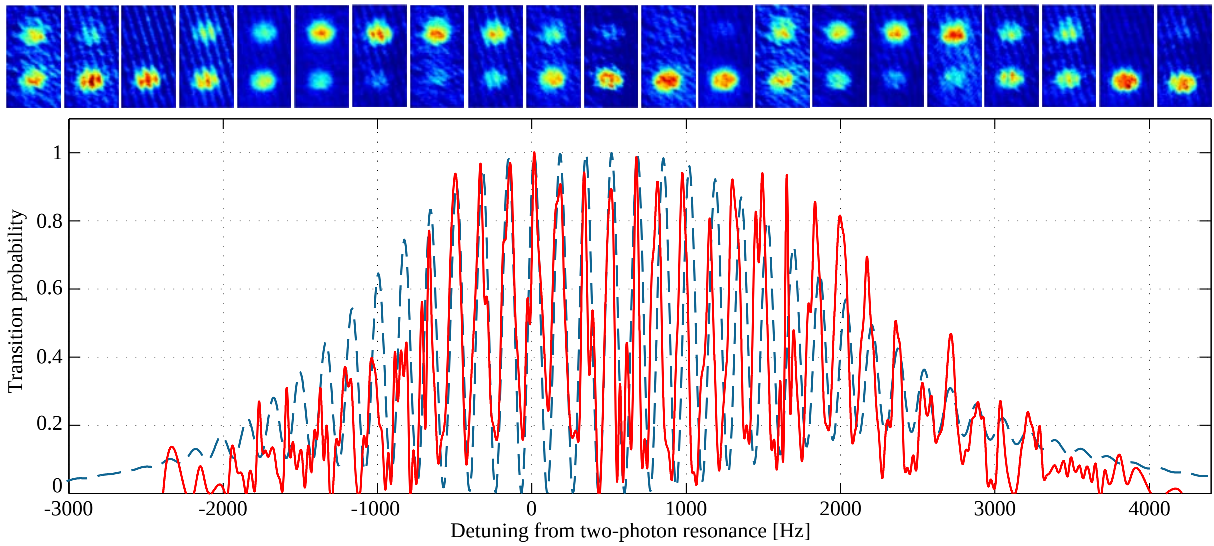

Fig. 1: Ramsey fringes measured over a range of 6.5 kHz. The red solid curve shows the experimental data set, whereas the blue dashed curve depicts calculations of the Ramsey fringes for comparable experimental conditions. The upper (lower) clouds of atoms in the absorption pictures above the graph show the population in the $|F=2, m_F=0\rangle$ ($|F=1, m_F=0\rangle$) state, for different detunings from two-photon resonance.

References

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