Quantum projection noise limited interferometry with coherent atoms in a Ramsey type setup

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Atom interferometric devices are usually based on measuring the population in one of two atomic states. Every population measurement of an atomic two-level system is limited by what is known as the quantum projection noise limit [1, 2], and at any given flux it is the aim of a precision measurement to be limited by this fundamental noise limit instead of technical noise.

We present a quantum projection noise limited Ramsey type interferometer using freely propagating coherent atoms [3]. We couple two internal states of ^{87}Rb using two co-propagating Raman lasers. By scanning the frequency detuning of the two Raman lasers, we measure Ramsey fringes. The setup is an improved version of our previous Ramsey interferometer [4]. The main difference in an improved way of phase locking the two Raman lasers where we replaced the previous Mach-Zehnder type interferometer by an inherently stable Sagnac interferometer thus avoiding the need for external stabilization (see Fig. 1a). Fig. 1b shows the measured Ramsey fringes with a high visibility and noise of below 0.5% which corresponds to the quantum projection noise expected for our samples of 10^4 atoms. This experiment will pave the way towards observing squeezing effects in an atom laser, allowing for the achievement of improved sensitivity in atom interferometers surpassing the quantum projection noise limit.

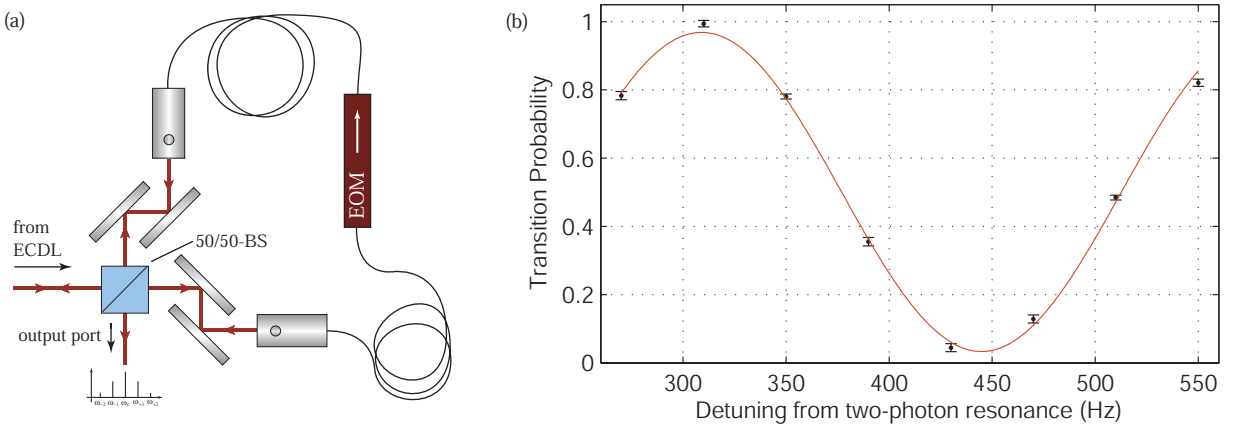

Fig. 1: Schematic of Sagnac interferometer (a). The resulting laser beam acts as a beam splitter for the atoms. ECDL: extended cavity diode laser. EOM: electro-optic modulator. BS: beam splitter. Measured Ramsey fringe (b).

References

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