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Weak measurements of atomic momentum in a matter-wave interferometer

There is currently considerable interest in the use of weak measurements, first introduced by Aharonov, Albert and Vaidman[1], to explore fundamental quantum processes and for quantum metrology. Of particular impact has been the experiment of Kocsis et al. [2] that employed weak measurements of photon momentum followed by a strong measurement of position to reconstruct average trajectories of photons. Here, the polarization of the photon was used as a pointer that weakly coupled to the transverse photon momentum. To date this type of experiment has only been performed on photons, of which a classical wave optics interpretation can be also applied [3].
In this presentation I will describe the development of a two-slit, matter-wave interferometer that uses non-relativistic particles (argon atoms) to perform weak measurements of momentum. Here, the pointer that weakly couples to momentum is the spin of the 5 Zeeman states of the laser cooled metastable (4S[3/2]2) argon atoms which are dropped through two slits formed within a metallic film. This experiment will also allow the reconstruction of average trajectories of the atoms within the interferometer, but unlike the interference of photons, this effect can only be described by a quantum analysis.
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[3] K. Y. Bliokh, A. Y. Bekshaev, A. G. Kofman, F. Nori, New J. Phys. 15, 073022 (2013)

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