Multi-photon Atom Interferometry via cavity-enhanced Bragg Diffraction

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We present our horizontal multi-photon atom interferometer driven via Bragg diffraction enhanced in an optical resonator. A large interrogation mode (4 mm $1/e^2$ diameter) is necessary in such a system, as the atoms cross the interrogation region with a ballistic trajectory. This large mode is achieved using an 80 cm degenerate cavity to mediate the light-matter interaction. Using a sub-Doppler cooled ^{87}Rb source, we observe momentum transfer up to $8\hbar k$ and demonstrate inertial sensitivity using significantly reduced optical power (<1 mW), taking advantage of the optical gain of the cavity. Our method is applicable to a vast class of measurement geometries and atomic sources - we open a new perspective not only for the realization of high sensitivity multi-axis inertial atom sensors, but also for the future realization of hybrid atom/optical gravitational wave detectors.