Invited talk

Cavity-based, lattice-hold atom interferometry as a new tool for precision measurement and inertial sensing.

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Atom interferometers are powerful tools for investigating Earth's gravity,[1] the gravity gradient,[2] rotations[3] and fundamental constants[4]. In all the above examples, they use atoms in free fall in atomic fountains. However, this limits the time that the quantum state can interact with the quantity to be measured to less than 3 seconds even in 10-m tall atomic fountains. Even in microgravity, thermal expansion of the atom cloud severely limits interaction times. Even a cesium atom (which is heavy and thus has a low average thermal velocity at a given temperature) at 200 nK moves at about 3.5 mm/s Consequently, it remains within the area of a 1-cm laser beam for no longer than about 3 seconds, on average. Alternate approaches to circumvent these limitations have been explored in the form of trapping atoms in optical lattices.

Atom interferometers suspended in an optical lattice[5] have observed coherent quantum spatial superposition states for a few seconds. Recently, it has been shown that the mode of a Fabry–Perot cavity strongly reduces optical lattice imperfections, and has led to the demonstration of interaction times on the one-minute scale[6] as well as robustness against environmental influences such as tilt, linear vibrations, and magnetic fields[7]. As a result, there are now broad efforts to develop them into compact, versatile quantum sensors for applications in the field, but also for applications in fundamental physics, such as testing whether the gravitational field can be in a superposition of states[8].

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