Large momentum transfer atom interferometry in a 10 m tower

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Atom interferometry with an interrogation time of $2T = 2.3\, \text{s}$ has recently been demonstrated in the Stanford 10 m drop tower [1, 2]. With $2\hbar k$ atom optics, we infer an acceleration sensitivity of $6.7 \times 10^{-12} \, \text{g}$ per shot. We have also measured Earth’s rotation rate with 200 nrad/s precision and the direction of true North with 10 mdeg precision. This talk will discuss how spatially resolved detection and atomic point sources enable multiaxis inertial sensing.

We are now extending these results with large momentum transfer atom optics [3]. This increases the sensitivity of the interferometer to inertial forces, facilitating laboratory tests of general relativity [4]. Large momentum transfer also increases the wavepacket separation between the two arms of the interferometer, probing the quantum-to-classical transition with increasingly macroscopic superposition states.

FIG. 1: Left: The Stanford 10 m atom interferometer. Top-Right: Atomic density distribution as imaged at the top of the tower (4 cm wavepacket separation from a $6\hbar k$ beamsplitter shown). Bottom-Right: Spatially-resolved interference fringes observed at the bottom of the tower after $2\hbar k$ interferometers with various beam tilts and timing asymmetries.