DAMOP10-2009-000013

Abstract for an Invited Paper
for the DAMOP10 Meeting of
the American Physical Society

Studying Gravity and Gravitational Waves with Atom Interferometry

HOLGER MUELLER, UC Berkeley

Local Lorentz Invariance (LLI) has been thoroughly tested for the Standard Model fields, but not for gravity. Using an atom interferometer, we have tested the LLI of gravity by searching for anomalous variations in gravity as the Earth revolves. Expressed within the Standard Model extension, this constrains violations of LLI in gravity to within parts per billion. Another pillar of gravitational theory is Local Position Invariance (LPI): the outcome of a nongravitational experiment is independent of where and when it is performed. One of LPI's central consequences is the gravitational redshift, which has so far been measured to an accuracy of 7×10^{-5}. We show that atom interferometry confirms the predicted effect within an accuracy of 7×10^{-9}, a 10,000 fold improvement. Finally, we show that breakthroughs in atom interferometry can enable the detection of gravitational waves in the Hz frequency range, where LIGO is insensitive. In particular, we will present Large Momentum Transfer in atom interferometers using Bragg diffraction and Bloch oscillations. We have already observed interference with transfer of 24 photon momenta and anticipate reaching 100, meeting the requirements for gravitational wave detection.