

# CM / AMO Seminar

← Condensed Matter & Atomic Molecular Optical →

Tuesday, February 20, 2018

→ 705 Pupin Hall

→ 12:15 PM



## Peter Asenbaum, Stanford University

### "Probing gravity with macroscopic quantum states"

Freely falling particles are ideal test masses to study gravitational interactions. We use light pulse interferometry to study the propagation of ultra-cold atoms in free fall. So far quantum experiments have been carried out in locally flat space and can be summarized as testing the equivalence principle. Precision tests of the equivalence principle do not only test the geometrical nature of gravity but also serve as extraordinarily sensitive probes for new, ultra-weak interactions. Our current efforts focus on a test of the weak equivalence principle at the  $10^{-13}$  level with two rubidium isotopes. We suppress gravity gradient systematic errors to below one part in  $10^{13}$  and demonstrate a relative precision of  $\Delta g/g \approx 3 \times 10^{-11}$  per shot, which improves the state of the art the best previous result for a dual-species atom interferometer by more than three orders of magnitude [1].

With the help of the large momentum transfer techniques [2] we can now create macroscopic quantum states on the order of tens of cm. The large spatial extent allows us to go beyond the equivalence principle and observe genuine gravity effects in a quantum system [3].

[1] *Effective inertial frame in an atom interferometric test of the equivalence principle*

C. Overstreet, P. Asenbaum, T. Kovachy, R. Notermans, J. M. Hogan, M. A. Kasevich  
arXiv:1711.09986 (2017)

[2] *Quantum superposition at the half-meter scale*

T. Kovachy, P. Asenbaum, C. Overstreet, C. A. Donnelly, S. Dickerson, A. Sugarbaker, J. Hogan, M. Kasevich  
Nature **528**, 530–533 (2015)

[3] *Phase shift in atom interferometry due to spacetime curvature across its wave function*

P. Asenbaum, C. Overstreet, T. Kovachy, D.D. Brown, J. M. Hogan, and M. A. Kasevich  
Phys. Rev. Lett. **118**, 183602 (2017)