Bloch oscillations in a cavity and spin-dependent kicks

P. Hamilton[1], M. Jaffe[2], V. Xu[2], P. Haslinger[2], H. Müller[2], C. Schlupf[1], & R. Niederriter[1]
[1]University of California, Los Angeles
[2] University of California, Berkeley

I will discuss two new techniques in matter wave interferometry for experiments in development at UCLA.

The first uses an optical cavity to directly observe Bloch oscillations of ytterbium atoms trapped in an intracavity lattice. The long coherence times possible in optical lattices will allow this technique to reach high sensitivity in a small volume. In addition the non-destructive readout enables higher bandwidth measurements, allowing searches for oscillating forces such as those from low mass dark matter candidates.

The second technique, called spin-dependent kicks (SDKs), enables highly efficient large momentum transfer by dividing up the usual beam splitter into two steps. First a microwave or RF creates an internal superposition state. Next a series of optical π pulses transfer the momenta. This technique enabled a recent demonstration of a multi-loop interferometer using Raman pulses and a thermal cloud of neutral atoms[3] and will be the key to a trapped ion gyroscope in development at UCLA[4].

[3]M. Jaffe, V. Xu, P. Haslinger, H. Müller, P. Hamilton, "Efficient Adiabatic Spin-Dependent Kicks in an Atom Interferometer," *Phys. Rev. Lett.* **121**, 040402 (2018).
[4]W. C. Campbell, P. Hamilton, "Rotation sensing with trapped ions," *J. Phys. B.: At. Mol. Opt. Phys.* **50**, 064002 (2017).