Rydberg dressing of ultracold ^{88}Sr for quantum simulation and metrology

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Off-resonant Rydberg dressing is an established tool in cold-atom quantum simulators. However, the presence of a black-body radiation-induced collective loss mechanism has in practice limited the applicability of the technique to spin models in deep lattices and dressing of continuum gases in the frozen gas regime [1]. Recently, stroboscopic dressing techniques have increased lifetimes, making it possible to implement so-called extended Bose-Hubbard models (eBHMs) [2], including both tunneling and next-to-nearest neighbour interactions, as well as spin squeezing of larger atom arrays ($N \approx 200$) in microtraps [3].

So far, eBHMs have only been implemented in 1D using alkali atoms, with higher-dimensional implementations inhibited by achievable UV laser power. We will leverage the larger dipole matrix elements in strontium to extend this to 1 and 2D arrays. In combination with our extremely versatile platform, including re-arrangeable optical tweezers and an optical lattice capable of both a traditional square and eightfold quasicrystalline geometry, this will give us experimental access to a vast range of interesting many-body physics.

We will also explore spin squeezing on the clock transition in lattices, microtraps and the continuum to develop schemes for achieving beyond-SQL sensitivity in novel detectors for gravimetry as applied to studies in geophysics and astronomy.

Here we present progress towards the implementation of Rydberg dressing on our platform.

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