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Metrology and many-body physics with strontium in a 2D tweezer array[1] NATHAN SCHINE, WILLIAM ECKNER, AARON YOUNG, WILLIAM MILLNER, DHRUV KEDAR, MATTHEW NORCIA, JUN YE, ADAM KAUFMAN, JILA, University of Colorado and NIST, and Department of Physics, University of Colorado, Boulder, CO 80309, USA — Arrays of neutral atoms trapped in optical tweezers are a powerful platform for single-particle-controlled quantum gas assembly, entanglement generation, and many-body physics. Alkaline-earth atoms, such as strontium, offer a rich singlet-triplet electronic structure which enhances the capabilities of tweezer arrays—principally via high-fidelity low-loss imaging and ultra-narrow 'clock' transitions with direct applications in metrology and quantum information science. Indeed, our tweezer array clock establishes a new, state-of-the-art platform for comparisons of atomic ensembles' clock frequencies. Now, we are working to introduce off-resonant Rydberg excitation—Rydberg dressing—of the clock state introduces strong long-range interactions between atoms in a low-entropy two-dimensional array. The resulting transverse field Ising Hamiltonian enables spin-squeezing on the clock transition, leveraging quantum entanglement for improved metrological sensitivity. This also offers a rich many-body system in which entanglement may propagate beyond the range of the underlying interactions. These goals demonstrate the power and versatility of combining controllable long-range interactions with single particle manipulation of highly coherent quantum systems.

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