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Precision measurement and few-body physics with lattice-trapped Fermi-degenerate gases of strontium ROSS B. HUTSON, AKIHISA GOBAN, G. EDWARD MARTI, SARA L. CAMPBELL, MICHAEL A. PERLIN, JOSE P. D'INCAO, JILA, NIST and University of Colorado Boulder, PAUL S. JULIENNE, Joint Quantum Institute, NIST and University of Maryland, ANA MARIA REY, JUN YE, JILA, NIST and University of Colorado Boulder — We implement high resolution clock spectroscopy and spatially resolved readout of Fermi-degenerate strontium in a three-dimensional optical lattice. Here, correlations in the atomic signal between different spatial regions of the sample enable the most rapid evaluation of lattice induced clock shifts and a record fractional frequency precision of 2.5×10^{-19}. Additionally, spectrally resolved interactions enable us to isolate n-atom lattice sites, where we observe the onset of multi-body interactions as both a density-dependent clock shift that is non-linear in the occupation-number, and three-body recombination loss. Furthermore, careful characterization of the lattice potential enables a precise extraction of the two- and three-body interaction parameters. In future work, these techniques can be directly applied to tests of general relativity at the millimeter scale and studies of magnetic correlations in large-spin quantum materials.

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