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A Fermi-degenerate three-dimentional optical lattice clock[1] AKIHISA GOBAN, SARA CAMPBELL, ROSS HUTSON, JILA, CU Boulder, G. EDWARD MARTI, JILA, NIST, CU Boulder, LINDSAY SONDERHOUSE, JOHN ROBINSON, CU, Boulder, WEI ZHANG, JUN YE, JILA, NIST, CU Boulder —
The pursuit of better atomic clocks has advanced many research areas, providing better quantum state control, tighter limits on fundamental constant variation, and improved tests of relativity. Recent progress in optical lattice clock to the accuracy of 2E-18 has benefited from the understanding of atomic interactions. Also the precision of clock spectroscopy has been applied to explore many-body interactions including SU(N) symmetry. In our previous 1D optical lattice, atomic interactions cause suppression and broadening of the atomic resonance, limiting the clock stability. To overcome this limitation, we demonstrate a scalable solution that takes advantage of the high density of a degenerate Fermi gas in a three-dimensional optical lattice to protect against on-site interaction shifts. Using an ultrastable laser, we achieve an unprecedented level of atom-light coherence, reaching a spectroscopic quality factor 5.2E15. We investigate clock systematics unique to this design; on-site interactions are resolved so that their contribution to clock shifts is orders of magnitude suppressed compared to the 1D optical lattice experiments. Also, we measure the combined scalar and tensor magic wavelengths for state-independent trapping along all three lattice axes.

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