A Fermi-degenerate three-dimensional optical lattice clock

ROSS HUTSON, SARA CAMPBELL, EDWARD MARTI, AKIHISA GOBAN, WEI ZHANG, JOHN ROBINSON, LINDSAY SONDERHOUSE, JUN YE, JILA, NIST and University of Colorado Boulder — Ongoing advances in atomic clocks enable table top searches of dark matter and other physics beyond the Standard Model. Currently the most accurate and stable clocks are based on alkaline-earth(-like) neutral atoms confined to one-dimensional optical lattices. A major obstacle in improving clock stability and accuracy is mitigating density-dependent frequency shifts due to contact interactions. We overcome this limitation by loading a two spin component degenerate Fermi gas of strontium atoms into a three-dimensional optical lattice. By tuning the thermal, kinetic, and interaction energy scales, we operate in the half-filled Mott insulating regime that suppresses atomic collisions and leaves any residual contact interactions spectroscopically resolvable. Additionally, we demonstrate control of the scalar, vector, and tensor components of the three-dimensional lattice induced ac Stark shifts, enabling the observation of a 6 second atom-light coherence time.