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Engineered Hamiltonian for high clock precision and accuracy

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Precise quantum state engineering, many-body physics, and innovative laser technology are revolutionizing the performance of atomic clocks and metrology, providing opportunities to explore emerging phenomena and probe fundamental physics. A Wannier-Stark optical lattice configuration highlights such an example. Atom-light and atom-atom interactions in the shallow optical lattice are precisely controlled and determined to the 10^{-19} level, representing key steps toward achieving inaccuracy below 10^{-18} for an optical lattice clock. On the front of clock precision, the use of microscopic imaging and cavity-QED-based nondemolition measurement has allowed us to measure gravitation time dilation across a few hundred micrometers, and demonstrate spin squeezing-enabled metrological gain for clock comparison.

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