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Large momentum transfer atom interferometer for a matter-wave clock and measurement of fundamental constants PEI-CHEN KUAN, SHAU-YU LAN, BRIAN ESTEY, DAMON ENGLISH, JUSTIN BROWN, MICHAEL HOHENSEE, HOLGER MÜLLER, UC Berkeley — Light-pulse atom interferometers have been used as quantum inertial sensors and for precision tests of fundamental laws of physics. We present the first clock referenced the mass of a single particle, based on combining a Ramsey-Bordé interferometrer with an optical frequency comb, demonstrating the fundamental connection between time and mass. The rest mass of a particle defines its Compton frequency, $mc^2/\hbar$ through relativity and quantum mechanics, and thereby sets a fundamental timescale. Our clock stabilizes a 10MHz radio-frequency signal to a certain fraction of the Cs Compton frequency. Future work could result in an elementary-particle (electron) or even antimatter (positron) clock, opening up new ways to test CPT symmetry and the equivalence principle. I will also report our progress towards a new determination of fine structure constant using large momentum transfer atom interferometers. We reduced the leading systematic effect by a factor of 3 and added Raman sideband cooling. This increases the overall signal about tenfold, suppresses the thermal expansion of the atom cloud and increases contrast.

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