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A clock referenced to the rest mass of a single particle CHENGHUI YU, SHAU-YU LAN, PEI-CHEN KUAN, BRIAN ESTEY, DAMON ENGLISH, JUSTIN M. BROWN, MICHAEL A. HOHENSEE, HOLGER MÜLLER, University of California, Berkeley — We demonstrate the operation of a Compton clock, one whose frequency is referenced to the mass of a single particle. Though it is well known that the wave function of a massive particle accumulates phase at the Compton frequency $\omega_0 = mc^2/\hbar$ in its rest frame, such oscillations are too fast to directly detect (3×10^{25} Hz for 133Cs). We use an optical frequency comb and a Ramsey-Bordé matter-wave interferometer to stabilize an oscillator to a chosen subharmonic of ω_0 with a precision of 4 parts per billion (at 6 hours timescale). Although this is far below the precision of modern frequency standards, its precision is sufficient, in combination with the spheres constructed by the Avogadro Project, to calibrate macroscopic masses with an accuracy of 30 ppb, in terms of the second. This clock may be useful for testing fundamental physics by demonstrating that its frequency redshifts in a gravitational potential in the same way that conventional frequency standards do. Implementation of a clock referenced to the mass of an elementary particle, such as an electron or positron, could also enable new experimental tests of Lorentz and CPT symmetry.

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