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Atom Interferometry: A Matter Wave Clock and a Measurement of α BRIAN ESTEY, SHAU-YU LAN, PEI-CHEN KUAN, MICHAEL HOHENSEE, Department of Physics, University of California, Berkeley, PHILIPP HASLINGER, VCQ, Faculty of Physics, University of Vienna, Boltzmanngasse, PAULI KEHAYIAS, DAMON ENGLISH, HOLGER MÜLLER, Department of Physics, University of California, Berkeley — Developments in large-momentum transfer beamsplitters (eg. Bragg diffraction) and conjugate Ramsey-Bordé interferometers have enabled atom interferometers with unparalleled size and sensitivity. The atomic wave packet separation is large enough that the Coriolis force due to the earth's rotation reduces interferometer contrast. We compensate for this effect using a tip-tilt mirror, improving our contrast by up to a factor of 3.5, allowing pulse separations of up to 250 ms with $10\hbar k$ beamsplitters. This interferometer can be used to make a precise measurement of the recoil frequency ($\propto h/m$) and thus the fine structure constant. The interferometer also gives us indirect access to the Compton frequency ($\nu_C \equiv mc^2/h$) oscillations of the matter wave, since h/m is simply c^2/ν_C. Using an optical frequency comb we reference the interferometer's laser frequency to a multiple of a cesium atom's recoil frequency. This self-referenced interferometer thus locks a local oscillator to a specified fraction of the cesium Compton frequency, with a fractional stability of 2 pbb over several hours. This has potential application in redefining the kilogram in terms of the second. We also present a preliminary measurement of the fine structure constant.

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