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Probing gravity by holding atoms for 20 seconds VICTORIA XU, University of California, Berkeley, MATT JAFFE, University of Chicago, CRISTIAN PANDA, University of California, Berkeley, SOFUS KRISTENSEN, Niels Bohr Institute, University of Copenhagen, LOGAN CLARK, University of Chicago, JAMES EGELHOFF, HOLGER MUELLER, University of California, Berkeley — Atom interferometers have proven to be powerful tools for probing fundamental physics and for inertial sensing applications. However, their performance has been limited by the available interrogation time of atoms freely falling in Earth's gravitational field. We demonstrate a trapped atom interferometer with visible interference fringes after 20 seconds of interrogation time. This coherence time is enabled by holding the spatially-separated wave packets in the resonant mode of an optical cavity, whose spatial mode filtering enforces a highly homogeneous trap geometry between the interferometer arms. This suspended interferometer geometry allows potentials to be measured by holding, rather than dropping, atoms. After seconds of hold time, the gravitational potential energy differences from micrometers of vertical separation can generate megaradians of interferometer phase. In addition, this trapped geometry can strongly suppress the phase variance caused by vibrations, thus addressing the dominant noise source in atom-interferometric gravimeters.

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