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FINALIST: Atom interferometry in an optical cavity

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Matter wave interferometry has become a powerful technique for precision measurement, despite limitations stemming from the precision and uniformity of atom-laser interactions. Optical resonators offer a route to precise control of the spatial structure of a laser beam. Combining these two concepts, we have built the first atom interferometer inside of an optical cavity. In this talk, I will present a series of measurements and experimental techniques enabled by this new tool. The pristine intra-cavity optical wavefronts allow for unprecedented matter wave manipulations, including trapped interferometers of up to 20 seconds duration. The cavity interferometer has enabled us to study interactions between cesium atoms and an in-vacuum source mass. We measured the atoms' gravitational attraction to the source mass, making it the smallest source body ever probed gravitationally with an atom interferometer. Searching for additional forces due to screened fields, we tightened constraints on certain dark energy models by several orders of magnitude. Finally, we measured a novel force mediated by blackbody radiation for the first time. These results demonstrate the feasibility and utility of bringing a cavity to atom interferometry. Exploiting advantages of the cavity promises more capabilities and exciting science, such as a measurement of the gravitational Aharonov-Bohm effect.