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(I) Quantum Sensing with Matter-Wave Interferometers

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Over the past decade, significant progress has been made in the commercialization of quantum sensors based on ultra-cold atoms and matter-wave interferometry. Nowadays, the first absolute quantum gravimeters have reached the market and there is even a cold-atom machine on the International Space Station. Matter-wave interferometers utilize the wave nature of atoms and their interaction with laser light to create interference between different quantum-mechanical states. Compared to an optical interferometer, the roles of matter and light are reversed: light is used as the "optic" to split, reflect, and recombine matter-waves. The resulting interference contains precise information about the atom's motion, such as its acceleration, as well as the electro-magnetic fields that permeate its environment. These atom interferometers can be designed as extremely sensitive instruments and have already led to breakthroughs in time-keeping, gravimetry, and tests of fundamental physics. In this talk, I will give an overview of laser-cooling and matter-wave interferometry and its applications as a versatile tool, for example, to test Einstein's Equivalence Principle, map the Earth's gravitational field, or aid future navigation systems.

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