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Pulsed matter-wave interferometry for testing the mass limits of quantum mechanics

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We demonstrate a matter-wave interferometer in the time domain (OTIMA) as a powerful tool for testing the validity of quantum theory for large particles [1,2]. The interferometer operates in the near-field regime and utilizes three pulsed standing laser wave gratings. These imprint a periodic phase pattern on to the traversing matter waves and the photo depletion probability is modulated periodically with the distance from the reflecting mirror. Depending on the particle's ionization or fragmentation cross section and their optical polarizability the gratings thus act as absorptive masks and phase gratings with an exceptionally small grating period of less than 80nm [3,4]. The pulsed experimental scheme facilitates interference measurements in the time domain which offers high count rate, visibility and measuring precision [3]. Since the action of pulsed optical gratings is non-dispersive the experiment is well suited for interference experiments on an increasingly large mass scale in the quest for novel decoherence effects, such as continuous spontaneous localization [4]. Additionally, the ability to resolve fringe shifts as small as a fraction of the grating period opens up to measuring optical and electrical nanoparticle properties in the OTIMA interferometer with time domain enhanced precision [6]. Experiments with various organic clusters and monomers have demonstrated the functionality of the interferometer and serve as a motivation for exploring the wave-particle character of particles with masses up to 105 amu and beyond.

References

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