A time domain matter-wave interferometer 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 increasingly heavy and large particles [1,2]. The interferometer operates in the near-field regime and utilizes three pulsed standing laser wave gratings. These imprint, on the one hand, a periodic phase pattern on to the traversing matter waves and, on the other hand, 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 optical polarizability such gratings thus act as absorptive masks and phase gratings with an exceptionally small grating period of less than 80nm [3,4]. The pulsed scheme of the experiment facilitates interference measurements in the time domain which offers high count rate, visibility and measuring precision [5]. Since the action of 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 and objective collapse mechanisms such as continuous spontaneous localization [2]. Experiments with various organic clusters and monomers have demonstrated the functionality of the interferometer and serve as a motivation for investigating the wave-particle character of particles with masses up to 10^5 amu and beyond.

References

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