DAMOP05-2005-000134

Abstract for an Invited Paper
for the DAMOP05 Meeting of
the American Physical Society

Novel methods for matter interferometry with nanosized objects

MARKUS ARNDT, Experimentalphysik, Universität Wien

We discuss the current status and prospects for novel experimental methods for coherence[1,2] and decoherence[3] experiments with large molecules. Quantum interferometry with nanosized objects is interesting for the exploration of the quantum-classical transition. The same experimental setup is also promising for metrology applications and molecular nanolithography. Our coherence experiments with macromolecules employ a Talbot-Lau interferometer. We discuss some modifications to this scheme, which are required to extend it to particles with masses in excess of several thousand mass units. In particular, the detection in all previous interference experiments with large clusters and molecules, was based on either laser ionization[1] (e.g. Fullerenes) or electron impact ionization[2] (e.g. Porphyrins etc.). However, most ionization schemes run into efficiency limits when the mass and complexity of the target particle increases. Here we present experimental results for an interference detector which is truly scalable, i.e. one which will even improve with increasing particle size and complexity. "Mechanically magnified fluorescence imaging" (MMFI), combines the high spatial resolution, which is intrinsic to Talbot Lau interferometry with the high detection efficiency of fluorophores adsorbed onto a substrate. In the Talbot Lau setup a molecular interference pattern is revealed by scanning the 3^{rd} grating across the molecular beam[1]. The number of transmitted molecules is a function of the relative position between the mask and the molecular density pattern. Both the particle interference pattern and the mechanical mask structure may be far smaller than any optical resolution limit. After mechanical magnification by an arbitrary factor, in our case a factor 5000, the interference pattern can still be inspected in fluorescence microscopy. The fluorescent molecules are collected on a surface which is scanned collinearly and synchronously behind the 3rd grating. The resulting image of the interference pattern is by far large enough to be easily seen by the unaided eye. High contrast interference fringes could be recorded with dyes molecules. [1]B. Brezger et al. , Phys. Rev. Lett. **88**, 100404 (2002). [2]L. Hackermüller et al. Phys. Rev. Lett **91**, 90408 (2003). [3]L. Hackermüller et al. Nature 427, 711 (2004).