Graduate School Seminar

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AG Quantenoptik makroskopischer Systeme

Matter-wave interferometry and its application to molecular spectroscopy

The wave-particle duality provides a wide range of interesting effects on microscopic objects such as atoms, molecules or small clusters. One of them is the possibility to create interferences by diffraction on a periodic structure, e.g. standing-wave laser fields or material gratings. Current experiments investigate the influence of the particle mass on their interference capability. At present, the wave nature of particles has been demonstrated for masses up to 10,000 a.m.u. [1].

Of particular interest is the interference of large particles at material diffraction gratings. During the diffraction process, the particles achieve very small distances to the grating bars (down to just few nanometres). Hence, the Casimir-Polder interaction of the particles with the macroscopic object becomes important [2]. To a good approximation the interaction can be described by a longitudinal shift in space which corresponds to a phase shift in the wave picture. Consequently, this phase shift is engraved in the interference pattern.

After a brief introduction into matter-wave interferometry, we will present a possible measurement set-up to fully reconstruct a matter wave by using a combination of measuring the amplitude of the interference pattern and the phase of the wave with an adapted Hartmann-Shack sensor. With the knowledge of the wave front, together with the geometry of the interferometer, we will present an algorithm for the estimation of the Casimir-Polder potential and the polarisabilty of the involved particle.

[1] S. Eibenberger, S. Gerlich et al., Phys. Chem. Chem. Phys. 15, 14696 (2013).
[2] C. Brand, J. Fiedler et al., Ann. Phys. (Berlin) 527, 580 (2015).

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