Molecular tomographic interferometry

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Wave properties of particles are established by fundamental experiments, such as the double-slit interference of electrons. These effects can be described by the wave-particle duality with the de Broglie wavelength of a matter wave. Similar experiments with neutral atoms and molecules [1,2] have shown an additional effect, namely that the matter waves are accumulating phases that depend sensitively on the particle-grating distance. These phases are facilitated by the Casimir-Polder potential between scatterer and particles, which results from the fluctuations of the quantized electromagnetic field [3].

In many experiments in which dispersion forces play an important role, the exact shape of the dispersion potential needs to be known. For example, measurements of the Casimir force between a metallic sphere and a plate [4] require detailed knowledge of the response properties of the involved bodies. However, the dispersion potentials are not additive, and the mode density between the bodies depends sensitively on their distance. Approximate calculation methods exist for complex geometries, such as the Rayleigh expansion [5,6] for periodic gratings or the Born series expansion [3,7] for more irregular shaped objects. Molecular tomographic interferometry is a useful tool to reconstruct such dispersion potentials. We present a tomographic reconstruction method that alleviates the need for stringent assumptions on the form of the potential [2,8].

References:

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