Spectroscopic measurements of free particles by matter-wave interferometry

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Matter-wave interference experiments with large particles have provided a wealth of insight into the particle-wave duality that is at the heart of our physical understanding. Experiments with material gratings [1,2,3] showed that the matter wave collects an additional phase shift caused by the Casimir–Polder interaction between the particles and the grating surface [2,4]. Casimir–Polder forces are a subclass of dispersion forces that are caused by the ground-state fluctuation of the electromagnetic field, and whose strength is determined by the polarisability of the particles [5].

We present an experimental setup which uses the far-field interference of matter waves and which has the surprising feature that a reconstrution of the Casimir–Polder potential can be done very easily. With the knowledge of the used geometry that includes all scattering properties — geometric shape and dielectric response — we present an algorithm for the determination of the polarisability of the particle. The advantage of this setup is a spectroscopic measurement of the polarisability of the particle in free space that covers the entire electromagnetic spectrum in one measurement.

References

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