Accurate measurement of atom surface Casimir-Polder interaction

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Atom surface Casimir–Polder potential is intrinsically difficult to measure due to distances between atom and surface smaller than few 100 nm. To conceive an experiment devoted to an accurate measurement in such a range of distance is complicated. We have chosen to build an hybrid system using nanotechnology facilities and cold atoms potentiality. We realised, in clean room, transmission gratings with a geometrical knowledge within few nanometers ranging from 80 to 400 nm pitch and 45 to 200 nm slit width. An adjustable low velocity atomic beam of metastable Argon in realised and sent through the grating. A Delay Line Detector gives us the produced atomic diffraction picture.

A basic analysis based on semi classical model of the diffraction picture reveals roughly that the atomic wave crosses a van der Waals potential in the grating. A more meticulous approach using the 1D Schrödinger equation solution with a reasonable Casimir-Polder potential approximation [1] leads us to clearly discriminate the right model [2]. A trustworthy error bar on the Casimir-Polder potential in the range of few percents can be then estimated opening the way to understand fundamental physics as hypothetical non-Newtonian fifth force's constraint [3] and its relevance to applications in quantum-enhanced sensing.

Thanks to ultra large atomic diffraction angles, a multi-path closed-loop interferometer would be extraordinary compact. Additionally, an interferometric effect modulates the diffraction picture substantially regards to tiny angles between the granting and the atomic beam. Consequently, a tomographic-like procedure may strongly improve the potential accuracy and make the interferometer realistic.

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