Dispersive phase shifts due to atom-surface interactions

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Abstract

We used the Toulouse atom interferometer to study how Van der Waals (VdW) interactions between atoms and surfaces cause velocity-dependent phase shifts for atomic de Broglie waves [1]. By introducing a thin nano-grating in one branch of this interferometer, we observed a phase shift (see Figure 1) that depends on velocity to the power -0.49. This dispersion serves to measure both the strength and the position dependence of the atom-surface potential in the range from 5 to 10 nm from the surface, and it can also set new limits on non-Newtonian gravity in the 2 nm range.

Related work is described in references [2, 3]

Keywords: Nanostructures, atom interferometry, van der Waals

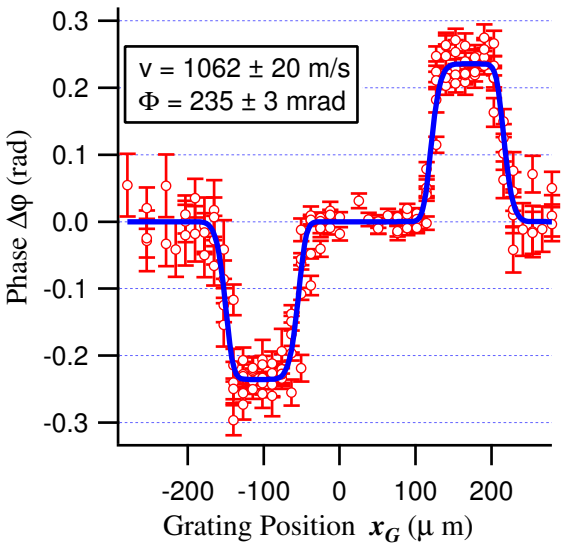

Figure 1: Measured phase shift $\Delta\varphi$ due to transmission through a nano-grating. Phase shift data are shown as a function of the interaction grating position x_G, for a lithium beam velocity $v = 1062 \pm 20$ m/s. At the reference position, $x_G = 0$, both interferometer arms go through the gap, so they are unaffected by the grating. When $65 < |x_G| < 190$ μm only one arm goes through the grating and we observe opposite phase shifts. When $|x_G| > 190\mu$m both arms go through the grating, the phase shift returns to 0. The best fit is represented by the continuous line and the parameter Φ.

References

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