Casimir force on gratings covered with graphene

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The Casimir force originates from quantum fluctuations of the electromagnetic field, resulting in an attraction between electrically neutral objects separated by a vacuum gap. When the separation is reduced to below one micrometer, the force becomes measurable. As miniaturization continues, these quantum electrodynamical effects could play a role in the operation of nanomechanical devices. One notable characteristic of the Casimir force is its non-trivial dependence on the shapes of the interacting bodies. Experiments utilizing the corrugated surfaces of gratings have shown that the Casimir force deviates from the proximity force approximation.

In addition to geometric effects, finite temperature corrections to the Casimir force have attracted considerable interest. For conventional metals, these corrections become important at relatively large separations, where the cavity becomes capable of supporting thermal photons at room temperature. It has been predicted that substituting the metallic surfaces with graphene can decrease the separation at which significant thermal effects arise, as the Fermi velocity of graphene is approximately 300 times smaller than the speed of light.

In this study, we investigate the interplay between the geometric dependence and the thermal effects in gratings made of silicon oxide. Our numerical calculations indicate that the deviations of the Casimir force from the proximity force approximation vary with temperature. Adding a layer of graphene on top of the grating can amplify the thermal effects, especially at separations below 1 micrometer where the Casimir force is large enough to be accurately measured. We will present preliminary measurements of the force gradient between a gold sphere and a silicon oxide grating covered with graphene.

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