

Surface Quantum Optics: from Casimir-Polder forces to tailored optical near-fields

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Abstract

Surface Quantum Optics is a new field of physics which combines ultracold atoms with solid surfaces in order to generate surface nanotraps for cold atoms and build hybrid atom - solid state systems [1]. Along this way physical effects have to be faced like Casimir Polder forces which are typically strongly attractive. Such forces are one of the few examples where the vacuum energy leads to measurable effects and can be used for tests of QED. The precise knowledge of Casimir forces is also important for the development of nanomechanical systems. Therefore, measurements of Casimir-like forces have gained enormous interest in the last few years. Our surface quantum optics group in Tübingen recently directly measured the Casimir-Polder force in the so-called transition regime.[2] This regime is of special interest because here deviations from the power law formulas which are valid in the limiting cases of short and large distances are expected. The measurement was performed by balancing the unknown surface potential with the known dipole potential of an evanescent wave. Such potentials are steep enough to compensate Casimir forces at distances down to hundred nanometers from the surface. Even smaller distances could be reached when the optical near-field is enhanced by surface plasmon resonances. These are collective excitations of electrons in a thin metal film on the surface. By structuring the metal film the optical near field can also be shaped in the transverse direction above the surface. This will be one of our next steps. This technique will allow us to generate optical nanopotentials for cold atoms with the

prospect to build nano-traps and elements for nano atom-optics on surfaces.

Keywords: cold atoms, surfaces, QED, Casimir force, evanescent wave

References

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