Research activity in Tübingen with connection to the Casimir network

Our research activity in Tübingen can be summarized as Surface Quantum Optics. This is a new field of physics combining ultracold atoms with solid surfaces in order to investigate surface phenomena, generate novel surface traps for cold atoms and build hybrid atom - solid state systems [1]. For that reason we have set up an experiment which allows us to bring Bose-Einstein condensates to sub-micron distances from a dielectric glass prism, where the atoms can interact with evanescent waves. One particularly interesting topic which can be investigated with this setup is that of dispersive surface potentials. In this context we have developed a new method for measuring Casimir-Polder potentials in a model-free way. Recently, by applying this method in our setup, we achieved to measure the Casimir-Polder potential directly in the so-called transition regime [2]. This regime is of special interest because here deviations from the simple power law formulas which are valid in the limiting cases of short and large distances are expected. Our data confirm these deviations and agree best with a full QED calculation. In one of our next steps we will address questions on the non-additivity of Casimir-forces. For that reason we have integrated gold nanostructures on the surface of a sapphire substrate and we will investigate the Casimir-force of this composite system. A very interesting feature of these nanostructures is the possibility to excite surface plasmons on the gold surface. This will allow us to enhance the evanescent wave intensity and by that tailor the transverse profile of the optical near-field at the surface. The goal here is to generate optical nanopotentials for cold atoms with the prospect to build nano-traps and elements for nano atom-optics on surfaces.

[1] H. Bender, Ph.W. Courteille, C. Zimmermann, and S. Slama,
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[2] H. Bender, Ph. W. Courteille, C. Marzok, C. Zimmermann, and S. Slama,
Direct measurement of Intermediate-Range Casimir-Polder Potentials,
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