Physikalisches Institut
Fakultät für Mathematik und Physik
Albert-Ludwigs-Universität Freiburg

IRTG-Seminar

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"Atom-polariton coupling at finite temperatures"

Since the pioneering works of Casimir and Polder [1], the interaction between a quantum polarisable particle (atom or molecule) and a reflecting surface is understood to be a consequence of vacuum fluctuations. In this seminar, I will give an overview of some important experimental measurements of the fundamental Casimir-Polder interaction, at distances ranging from a few cm down to 100 nm. I will focus on spectroscopic experiments in atomic vapour cells that have been developed at the University of Paris13 over the last two decades. Our experiments probe excited state atoms in the nanometric range and are particularly sensitive to the coupling of atomic dipole transitions to surface resonances (polaritons). At zero temperature, atom-polariton coupling was shown to change the sign of atom-surface interaction (vdW repulsion) [2] and modify the lifetime of atomic levels [3]. More recent experiments performed in our group show that the thermal excitation of surface polaritons, that strongly modifies thermal fields in the vicinity of surfaces (near field thermal emission), can exalt, or in principle reduce, the atom-surface interaction [4] depending on the nature of the atom-polariton coupling. I will also describe our experiment underway that aim at demonstrating direct energy transfer from thermally excited polaritons to atoms. This experiment, a 'quantum' equivalent of near field heat transfer between macroscopic objects [5], can shed light on how quantum particles thermalize with their environment [6].

1. H.B.G. Casimir and D. Polder 'The influence of retardation on the London-van der Waals forces', *Phys. Rev.* **73** (1947).
2. H. Failache et al. 'Resonant van der Waals repulsion between excited Cs and a sapphire surface' *Phys. Rev. Lett.* (1999)
3. H. Failache et al. 'Resonant quenching of gas-phase Cs atoms induced by surface polaritons', *Phys. Rev. Lett.*, **28**, 243603, (2002).
4. A. Laliotis et al. 'Casimir-Polder interactions in the presence of thermally excited surface modes', *Nat. Commun.* **5,** 4364 (2014).
5. Kim et al. 'Radiative heat transfer in the extreme near field', *Nature*, **528**, 387, (2015).
6. S. Hoekstra et al. 'Optical pumping of neutral molecules by blackbody radiation' *Phys. Rev. Lett*. **98**, 133001 (2007); S. Y. Buhmann et al. 'Surface induced heating pof polar molecules', *Phys. Rev. A*, **78** 052901 (2008).

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