PHYSIKALISCHES KOLLOQUIUM

Sommersemester 2025

Das Kolloquium findet (soweit nicht anders angegeben) **jeweils montags um 14:15 Uhr in Präsenz im Röntgen-Hörsaal** des Physikalischen Instituts, Hubland Campus Süd, Universität Würzburg **und online via Zoom statt**.
Zugangsdaten siehe https://www.physik.uni-wuerzburg.de/aktuelles/veranstaltungen-aus-der-physik/physikalisches-kolloquium/

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Atom-Surface Interaction: Theory and Computations

Abstract

One promising approach to integrated quantum technologies relies on hybrid systems where cold atoms are combined with nano-photonic or nano-plasmonic elements for on-chip applications. For instance, this allows for the realization of numerous functional devices such as compact integrated atom interferometers & spectrometers for space applications, portable high-precision gravimeters, directed single-photon sources and efficient optical isolators based on a single trapped atom, and many more. Common to these systems is the proximity of cold atoms to surfaces in general and complex photonic nano-structures in particular so that a detailed theoretical understanding of atom-surface nteractions is of paramount importance.

For rather simple systems with single atoms above planar conductive surfaces, an exactly solvable model [1, 2] allows to assess the validity of several approximation schemes for equilibrium (e.g., Casimir-Polder forces) and non-equilibrium effects (e.g., quantum friction). Further analyses [3] demonstrate the importance of the material model. In fact, when atoms are close to a metallic surface, they can spatially resolve the electron scattering processes within the metal and this effectively mandates that nonlocal material models are employed. In turn, these nonlocal effects may lead to an enhancement of atom-surface interactions

relative to local material models. For quantum friction, further enhancement strategies include the exploitation of non-additive characteristics [4,5].

Finally, these theoretical findings raise the question of how to efficiently compute equilibrium and non-equilibrium effects in atom-surface interactions for more complex geometries. Specifically, the advantageous properties of the Discontinuous Galerkin Time-Domain (DGTD) finite-element approach allow for the efficient computation of atom-surface interactions [6,7].

[1] F. Intravaia et al., Phys. Rev. Lett. 117, 100402 (2016).
[2] F. Intravaia et al., Phys. Rev. A 94, 042114 (2016).
[3] D. Reiche et al., Phys. Rev. A 95, 155448 (2017).
[4] D. Reiche, K. Busch, F. Intravaia, Phys. Rev. Lett. 124, 193603 (2020).
[5] D. Reiche, F. Intravaia, K. Busch, APL Photonics 7. 030902 (2022)
[6] P.T. Kristensen et al., Phys. Rev. B 108, 205424 (2023)
[7] C. Marti Farras et al., in preparation

Für die Dozentinnen bzw. Dozenten der Fakultät

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