SPP 1929 – Seminar

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Technische Universität Kaiserslautern
Gebäude 46/570, Raum 46-576
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Polaron physics with ultracold atoms

When an impurity is immersed into an environment, it changes its properties due to its interactions with the surrounding medium. The impurity is dressed by many-body excitations and forms a quasiparticle, the polaron. Depending on the character of the environment and the form of interactions, different types of polarons are created. In this talk, I will review recent experimental and theoretical progress on studying the many-body physics of polarons in ultracold atomic systems [1], and discuss related polaronic phenomena encountered in two-dimensional semiconductors [2] and the study of rotating molecules in superfluid Helium [3]. In the second part of the talk I will then focus on impurities interacting with bosonic quantum gases. Specifically, I will discuss progress on the theoretical description of Rydberg excitations coupled to Bose-Einstein condensates. In such systems the interaction between the Rydberg atom and the Bose gas is mediated by the Rydberg electron. This gives rise to a new polaronic dressing mechanisms, where instead of collective ex citations, molecules of gigantic size dress the Rydberg impurity. We develop a functional determinant approach [4] to describe the dynamics of such Rydberg systems which incorporates atomic and many-body theory. Using this approach we predict the appearance of a superpolaronic state which has recently been observed in experiments [5,6].

References:

[1] R. Schmidt, M. Knap, D. A. Ivanov, J.-S. You, M. Cetina, and E. Demler, arXiv:1702.08587 (2017).

[2] M. Sidler et al., Nature Physics 13, 255 (2017)

[3] R. Schmidt, and M. Lemeshko, Phys. Rev. Lett. 114, 203001 (2015);

[4] R. Schmidt, H. Sadeghpour, and E. Demler, Phys. Rev. Lett. 116, 105302 (2016).

[5] F. Camargo et al., arXiv:1706.03717 (2017).

[6] R. Schmidt et al., arXiv:1709.01838 (2017).