Many-body physics with quantum impurities in cold atoms and beyond

December 3, 2018 - 11:15 h
Room 8.526 (IADM)
University of Stuttgart, Pfaffenwaldring 57

Abstract
Understanding the role of interactions between an impurity and its environment is a paradigm problem of quantum many-body physics. A central concept for the description of such systems is the formation of quasiparticle excitations called polarons. 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]. I will then put particular focus on impurities interacting with bosonic quantum gases and discuss the recent 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 excitations, 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: