PAUL SCHERRER INSTITUT

CONDENSED MATTER THEORY SEMINAR

Rotation of Quantum Impurities in the Presence of a Many-Body Environment

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WHGA/121 (PSI-West)

Abstract:

In several settings of physics and chemistry one has to deal with molecules interacting with some kind of an external environment, be it a gas, a solution, or a ultracold gas of atoms. Understanding molecular processes in the presence of such a many-particle bath is challenging, and usually requires large-scale numerical computations. Here, we present an alternative approach to this challenge that is based on a condensed matter perspective on the problem. Specifically, we develop a microscopic theory describing a quantum impurity whose rotational degree of freedom is coupled to a many-particle bath. In this talk I will show how the problem can be approached by introducing the concept of an angulon a quantum rotor dressed by a quantum field. Our theory allows to predict the angulon quasiparticle properties using a combination of variational and diagrammatic techniques and I will relate the observed physics to other instances of polaron formation usually discussed in condensed matter systems. For rotating impurities our theory predicts a renormalization of the impurity rotational structure in terms of a rotational Lamb shift induced by the many-particle environment. We show that molecules rotating inside superfluid helium nanodroplets and Bose-Einstein Condensates form angulons, and therefore can be described by solutions of a simple microscopic Hamiltonian. Casting the problem in the language of angulons allows not only to simplify the problem, but also to gain insights into the origins of the observed phenomena and to make predictions for future experimental studies.

References

[1] R. Schmidt, and M. Lemeshko, Phys. Rev. Lett. 114, 203001 (2015).
[2] R. Schmidt, and M. Lemeshko, Phys. Rev. X 6, 011012 (2016).
[3] review article: M. Lemeshko and R. Schmidt, arXiv:1703.06753 (2017).

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