Dynamics and Thermodynamics of Rabi-driven Fermi gases

Monday 2 September 2024 17:00 (2 hours)

In this work we present our investigations on Rabi coupled Fermi gases. Specifically, the behavior of a mobile spin-1/2 impurity atom immersed in a Fermi gas, where the interacting spin-$\uparrow$ and non-interacting spin-$\downarrow$ states of the impurity are Rabi coupled via an external field. This scenario resembles the classic problem of a two-state system interacting with a dissipative environment but with an added dimension provided by the impurity momentum degree of freedom. In this context, the impurity can become "dressed"by excitations of the Fermi sea to form a Fermi polaron quasiparticle.

For the steady-state system, where the impurity has thermalized with the medium, we derive exact thermodynamic relations that connect the impurity magnetization with quasiparticle properties such as the number of fermions in the dressing cloud. We show how the thermodynamic properties evolve with increasing Rabi coupling and present exact analytical results in the limits of weak and strong Rabi coupling.

For the dynamics of the Rabi-driven Fermi polaron, we formulate a theoretical approach based on correlation functions that respects conservation laws and allows the efficient calculation of Rabi oscillations over a range of time scales and impurity momenta beyond what has been previously achieved. Our results are in good agreement with recent experiments on the Rabi oscillations of the attractive polaron, revealing how these oscillations are influenced by the interplay between the polaron and its dressing cloud.

References

Short bio (50 words) or link to website

Graduated with PhD from Melbourne University with Prof. Andy Martin, work as a postdoctoral researcher at Swinburne University with Profs. Xia-Ji Liu and Hui Hu, is a current postdoctoral researcher at Monash University with Pro. Meera Parish and Assoc. Prof Jesper Levinsen.

Relevant publications (optional)

Rabi oscillations and magnetization of a mobile spin-1/2 impurity in a Fermi sea
Brendan C. Mulkerin, Jesper Levinsen, and Meera M. Parish
Phys. Rev. A 109, 023302 (2024)

Crossover from exciton polarons to trions in doped two-dimensional semiconductors at finite temperature
Antonio Tiene, Brendan C. Mulkerin, Jesper Levinsen, Meera M. Parish, and Francesca Maria Marchetti
Phys. Rev. B 108, 125406 (2023)

Exact Quantum Virial Expansion for the Optical Response of Doped Two-Dimensional Semiconductors
Brendan C. Mulkerin, Antonio Tiene, Francesca Maria Marchetti, Meera M. Parish, and Jesper Levinsen
Phys. Rev. Lett. 131, 106901 (2023)

Career stage

Postdoc

Authors: MULKERIN, Brendan; LEVINSEN, Jesper (Monash University); PARISH, Meera; BLEU, Olivier (Monash University)

Presenter: MULKERIN, Brendan

Session Classification: Posters I

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