

Transition or Crossover: Visualizing competitive few-body correlations in Fermi polarons via energy dispersion

X. Cui

Beijing National Laboratory for Condensed Matter Physics, Institute of Physics, Chinese Academy of Sciences, Beijing, 100190, China

e-mail: xlcul@iphy.ac.cn

In this talk, I will show that the destiny of Fermi polaron as increasing impurity-fermion attraction is closely related to their mass imbalance and can be directly visualized through the impurity dispersion in momentum space (Q). Specifically, small mass imbalance leads to a first-order transition from polaron to molecule, corresponding to an energy competition between $Q = 0$ and $Q = k_F$ states in the dispersion (k_F is the majority Fermi momentum); large mass imbalance gives rise to a smooth crossover from polaron to dressed clusters, where the ground state always stays at $Q = 0$ while its wavefunction gradually changes. Further, we propose to measure the impurity dispersion by engineering spin-orbit coupling (SOC) on the impurity, which induces spin flip with finite momentum transfer. The polaron and molecule states can be individually probed by setting the SOC momentum to be near zero and k_F . This method clearly identifies the nature of such a first-order transition and overcomes practical difficulty for its detection in realistic experiments due to polaron-molecule coexistence.

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