The moving Fermi polaron

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ABSTRACT

A single impurity interacting with a many-body environment represents a minimal yet powerful paradigm for exploring strongly correlated quantum systems and is described in terms of quasiparticles known as polarons. Ultracold atomic gases provide an exceptionally tunable platform for realizing and probing such impurity problems. In our experiments, we study bosonic 41K atoms immersed in a spin-polarized, degenerate Fermi gas of 6Li, forming a system of Fermi polarons in the regime of strong interactions. While previous work has largely focused on the static and dynamical properties of these quasiparticles [1,2], access to their kinetic properties—such as dispersion relations and effective masses—requires momentum-resolved probes. To this end, we recently developed a Raman setup with which we can impart a well-defined and tunable momentum to the impurities, allowing to explore the system from the paradigmatic zero-momentum polaron to the regime of large momenta, where the impurity increasingly behaves like a bare particle. We present measurements of the momentum-dependent polaron energy for different interaction strengths. For repulsive polarons, we observe a smooth and monotonic evolution between these two regimes of momenta, whereas the attractive branch exhibits a non-monotonic dispersion, which we attribute to the influence of a molecule–hole continuum and the resulting breakdown of the simple polaron picture at low momenta.

[1] Fritsche *et al.*, *Phys. Rev. A* **103**, 053314 (2021).

[2] Baroni *et al.*, *Nat. Phys.* **20**, 68–73 (2024).