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Impurities strongly interacting with a Fermi sea[1]

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Impurities immersed in a Fermi sea show a wealth of exciting phenomena when the interaction is tuned via a Feshbach resonance. We report on experiments with fermionic or bosonic potassium atoms in a large, deeply degenerate Fermi sea of ^{6}Li. In the case of fermionic impurities (^{41}K), we focus on the low-concentration limit and apply a Ramsey technique to study the fast response of the impurities to sudden changes of the interaction strength [Cetina et al., Science 354, 96 (2016)]. For near-resonant conditons, we observe the formation dynamics of quasiparticles (Fermi polarons) in real time and, in the resonance case, an interference between the repulsive and the attractive quasiparticle branch. For bosons (^{41}K) in the Fermi sea, a small condensate is formed, which then acts as a mesoscopic impurity. For strongly repulsive conditions we find phase separation, such that the condensate is in the center of the Fermi sea and compressed by the fermion pressure. We show that three-body recombination can be used to probe the spatial overlap at the interface between the two species. The comparison with a theoretical model reveals behavior beyond the local-density approximation. We also study collective modes of the BEC in the Fermi gas across the transition to the phase-separated state, demonstrating dramatic changes of the collective mode frequencies.

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