Mapping the Occupied Spectral Function of a Fermi gas in the BCS-BEC Crossover

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Ultracold gases of fermionic atoms with tunable interactions provide a powerful tool for investigating and understanding strong correlations in fermions. In such systems, it is possible to tune the scattering length through a Feshbach resonance, thereby realizing a smooth crossover from the physics of Cooper pairs to that of condensed bosonic molecules (BCS-BEC crossover). While the ground state of this crossover is always a condensate of paired fermions, the normal state must evolve from a Fermi liquid on the BCS side to a Bose gas of molecules on the BEC side. How this occurs is still largely unknown. We explore this question using atom photoemission spectroscopy of a nearly homogeneous gas above Tc at many interaction strengths in the crossover. Inspired by angle-resolved photoemission spectroscopy (ARPES) used to probe condensed matter systems, atom photoemission spectroscopy probes the distribution of single particle energies and momenta in an ultracold gas. We find that our data fit well to a function that includes a positively dispersing peak and a broad, asymmetric background. The spectral weight of the positively dispersing park vanishes as the strength of interactions are modified, signaling a breakdown of a Fermi liquid description.