

Title: Correlation Length and Universality in the BCS-BEC Crossover for Energy-Dependent Resonance Superfluidity

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We consider the BCS-BEC crossover of a quantum Fermi gas at T=0 in the presence of an energy-dependent Fano-Feshbach resonance, driving the system from broad to narrow limits. We choose a minimal microscopic potential reproducing the two-particle resonance physics in terms of the scattering length a and the effective range R* representing the resonance width, and solve the BCS mean-field equations varying the scattering length a, R* and the density.

We show that the condensate fraction manifests a universal behavior when the correlation length, measuring the pair size, is used as the crossover parameter. Generally, a negative effective range has the effect of stretching the crossover region between the two extreme regimes, as evidenced by the behavior of the chemical potential. These results can be useful in view of the more recent perspectives of realizing narrow resonances also by optical means and amenable as a base Quantum Monte Carlo simulations.

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