Universal Properties of p-Wave Fermi Gases

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The successful application of *s*-wave "contact" to unitary Fermi gases exemplifies the importance of few-body correlations in understanding strongly interacting many-body systems. Recent experimentally measured radio-frequency spectrum and momentum distribution of three-dimensional Fermi gases close to a *p*-wave Feshbach Resonance show universal tails different from the *s*-wave case [1]. We emphasise that the difference is due to the necessity of using both the scattering volume v and the effective range R to parameterise the two-body *p*-wave interatomic interaction, and show that by including two-body correlations at short range, the interaction effects of the system are captured by two contacts, C_v and C_R, which are related to the variation of energy with v and R in two adiabatic theorems [2]. Based on the two contacts, we derive the universal properties of the system regarding momentum distribution, radio-frequency and photo-association spectroscopies, and pressure and virial relations. We also establish coupled rate equations to explain the time evolution of the p-wave contacts observed in the quench experiment [1].

Beyond two-body correlations at short range, *p*-wave resonances are predicted to give rise to universal super Efimov three-body bound states in two-dimensions [3]. We use the hyper-spherical formalism and show that these new universal states originate from an emergent effective potential, which is different from the one responsible for the familiar Efimov states [4]. In the many-body context, we introduce a new thermodynamic quantity, the three-body contact C_θ, to quantify the three-body correlations due to the super Efimov Effect [5]. We determine how C_θ affects various physical observables; signature of the elusive super Efimov effect in the thermodynamic system can be pinned down by the detection of the three-body contact C_θ via these observables.

References

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