Experiments with finite Fermi systems in the crossover from few to many-body physics

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We study the crossover from few- to many-body physics by investigating an ultracold atom system that consists of one single impurity atom and an increasing number of majority atoms in a different spin state.

The experiments are performed with a system of fermionic ^{6}Li atoms in two different spin states. Due to the elongated shape of our optical dipole trap the system is well described by the one-dimensional framework. Starting from the two-particle system where the single impurity atom interacts with only one majority atom, we measure the interaction energy as a function of the number of majority atoms by means of radio-frequency spectroscopy. In the two-particle case the experimentally determined interaction energies are in good agreement with the analytical prediction from T. Busch *et al.* [1]. For systems with more majority atoms, the interaction energy shows good agreement with numerical few-body calculations. Already for more than three majority atoms, the normalized interaction energies converge quickly towards a many body-limit. This limit coincides with the analytic prediction for an infinite number of majority atoms which we obtain by adapting the homogeneous solution of J. McGuire [2] to a trapped system.

References

[1] T. Busch *et al.*, Found. of Phys. **28**, 549 (1998).

[2] J. McGuire, JMP 6, 432 (1965).