Calculations of three body recombination and dimer product distributions from ultracold atomic collisions

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The three-body physics of ultracold atoms has proven to be a very rich area of theoretical and experimental studies. This talk describes numerical calculations of three-body recombination based on a simple van der Waals model of two- and three-body interactions that is applicable in the near-threshold region [1]. The model uses pairwise additive long-range dispersion potentials cut off at short range to support a small number $1 \leq N \leq 6$ of s-wave bound states. It accurately represents magnetically tunable multispin two-body Feshbach resonance interactions through a simple parameterization based on known resonance parameters. We demonstrate the power of the method by numerical solution of the three-body scattering problem in the adiabatic hyperspherical representation for several quite different 3-body systems. The model gives a qualitatively similar account to measured product distributions of dimer vibrational-rotational states with binding energies up to E/h = 15 GHz for recombination of three ultracold ^{87}Rb atoms [2]. The model gives an accurate value for the measured three-body recombination coefficient of three unlike-spin ^{87}Sr fermions held in optical lattice cells with precisely 3-atom occupancy [3]. Finally, we develop a multispin model to compare to recent very precise measurement of the Efimov peak of magnetically tunable three-body recombination near the moderately strong 33.5803(14) G two-body Feshbach resonance of ^{39}K atoms in the f = 1, m_f = -1 Zeeman state [4]. Our multispin model accurately represents the variation of two-body scattering length with magnetic field for this resonance and predicts an Efimov feature at a scattering length of -13.1 r_{vdW}, where r_{vdW} is the van der Waals length of the two-body potential. Our calculation is in substantially better agreement with the measured value, -14.08(17) r_{vdW} [4], than the prediction, -9.7 r_{vdW}, based on a single-channel model of "van der Waals universality" for cold atomic systems.

References

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