Ultracold halo dimers and few-body physics

R. Grimm[a,b]

[a] *Institut für Experimentalphysik, Universität Innsbruck, Innsbruck, Austria*
[b] *Institut für Quantenoptik und Quanteninformation (IQOQI), Österreichische Akademie der Wissenschaften, Innsbruck, Austria*

Ultracold dimers in s-wave states are in the quantum halo regime[1], if their binding energy is much smaller than a typical energy set by the long-range van der Waals interaction. In this regime, the scattering length is very large and details of the interatomic interaction become irrelevant. Studying the interactions of halo dimers provides experimental access to universal phenomena in few-body physics[2].

We create halo dimers of identical bosons by Feshbach association in an ultracold gas of cesium atoms. In a trapped ultracold atom-dimer mixture we study inelastic atom-dimer scattering[3]. Our main result is an atom-dimer scattering resonance, which we interpret as result of a trimer state hitting the atom-dimer threshold. This phenomenon can be interpreted in terms of Efimov's scenario and provides new information on Efimov states which complements previous work on three-body recombination in an atomic gas[4].

Further experiments on dimer-dimer interactions[5] are based on a pure trapped sample of Cs_2 halo dimers. We measure the relaxation rate coefficient for decay to lower-lying molecular states and study the dependence on scattering length and temperature. We identify a pronounced loss minimum with varying scattering length along with a further suppression of loss with decreasing temperature. These observations provide insight into the physics of a few-body quantum system that consists of four identical bosons at large values of the two-body scattering length.

[1] A.S. Jensen, K. Riisager, D.V. Fedorov, and E. Garrido, Rev. Mod. Phys. **76**, 215 (2004).
[2] E. Braaten and H.W. Hammer, Phys. Rep. **428**, 259 (2006).
[3] S. Knoop, F. Ferlaino, M. Mark, M. Berninger, H. Schöbel, H.-C. Nägerl, and R. Grimm, to be published.
[4] T. Kraemer et al., Nature **440**, 315 (2006).
[5] F. Ferlaino, S. Knoop, M. Mark, M. Berninger, H. Schöbel, H.-C. Nägerl, and R. Grimm, arXiv:0803.4078.