Three-body recombination for vanishing scattering lengths

S. Kokkelmans[1], Z. Shotan[2], O. Machtey[2], and L. Khaykovich[2]

[1] *Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven, The Netherlands*
[2] *Department of Physics, Bar-Ilan University, Ramat-Gan, 52900 Israel*

Presenting Author: s.kokkelmans@tue.nl

Efimov physics in ultracold gases is described very well by universal scaling laws, based on the scattering length. Another important parameter in this respect is the van der Waals length, which was only recently found to define the binding energies of the Efimov trimers. While the scattering length can be tuned magnetically via a Feshbach resonance, the van der Waals length is constant and connected to the radial range of the potential. However, experimental hints at non-universal behavior, when going away from resonance, are quite badly understood. The next leading coefficient in the scattering phase shift, the effective range parameter, gives an indication of this non-universality, but at the same time it can also be strongly dependent on the magnetic field. An extreme case in the non-universal regime is the zero-crossing of a Feshbach resonance. Here the scattering length vanishes, while the effective range goes to infinity. Therefore both parameters cannot directly describe three-body recombination at this point.

We investige both experimentally and theoretically three-body recombination, for two different zero crossings in an ultracold gas of ^{7}Li. One zero crossing is associated to a broad resonance, while the other one is connected to a narrow resonance. We see a clear experimental difference for the two resonances, and we give an explanation for the behavior in terms of a new theoretical effective length parameter. This parameter is described in terms of the finite range of the two-body potential, given by the van der Waals length, and by the width of the resonance.