Heteronuclear Efimov scenario in an ultracold Bose-Fermi mixture of ^{133}Cs and ^{6}Li

J. Ulmanis[1], S. Häfner[1], R. Pires[1], E. D. Kuhnle[1], and M. Weidemüller[1,2]

[1] *Physics Institute, Heidelberg University, Im Neuenheimer Feld 226, 69120 Heidelberg, Germany*
[2] *Hefei National Laboratory for Physical Sciences at the Microscale and Department of Modern Physics and CAS Center for Excellence and Synergetic Innovation Center in Quantum Information and Quantum Physics, University of Science and Technology of China, Hefei, Anhui 230026, China*

Presenting Author: ulmanis@physi.uni-heidelberg.de

The Efimov scenario, where pairwise resonantly interacting particles form an infinite series of bound three-body states with universal scale invariance, has been a prominent topic in fundamental quantum physics for a long time. Presently the study of it mostly relies on the use of Feshbach resonances that allows one to precisely tune the interparticle interaction strength and probe these weakly bound trimers. An ultracold mixture of Cs and Li constitute a prototypical heteronuclear system with large mass imbalance, for which the scaling constant is drastically reduced. This is advantageous for the investigation of excited Efimov states under common experimental conditions.

Here we present the first observation of three consecutive Efimov resonances through measurements of three-body loss coefficients near a broad Feshbach resonance [1] (Fig. 1, left). The previous analysis of Feshbach resonances [2] is extended with radiofrequency association of LiCs Feshbach molecules [3] to precisely map the applied magnetic field onto the scattering length (Fig. 1, right). We measure dimer binding energies close to Feshbach resonances and extract Li-Cs scattering properties from them. The new parametrization allows us to quantitatively test few-body theories in the LiCsCs system. The refined positions and scaling factors of the Efimov resonances demonstrate both, universal behavior *and* non-universal deviations from the zero-range limit.

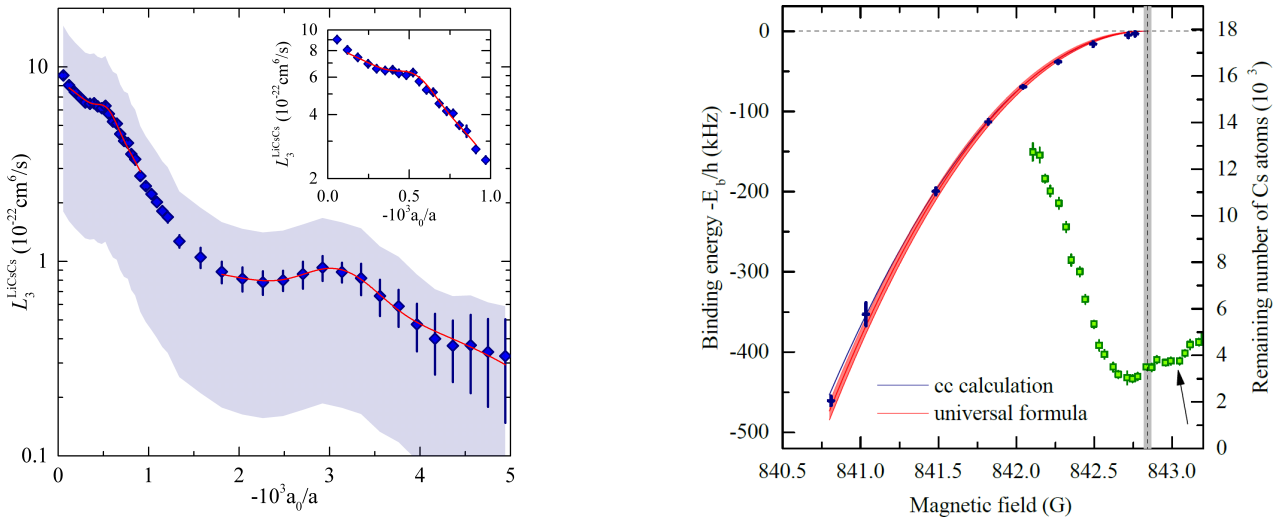

Figure 1: *Left: LiCsCs three-body loss coefficient and fits (red lines) to the Efimov resonance positions. The inset shows a zoom in to the region of the first excited Efimov resonance. Right: Measured binding energies (blue crosses), molecular state energies from the coupled-channels model (blue line), and the universal binding energy $E_b = \hbar^2/(2\mu a^2)$ (red line) of LiCs Feshbach molecules near 843 G. The remaining Cs atom number (green squares) [1] indicates the second excited Efimov resonance. The vertical dashed line displays the determined Feshbach resonance pole position and its uncertainty.*

References

[1] R. Pires, J. Ulmanis, S. Häfner, E. D. Kuhnle and M. Weidemüller, Phys. Rev. Lett **112**, 250404 (2014)

[2] R. Pires, J. Ulmanis, M. Repp, E. D. Kuhnle, M. Weidemüller, T. Tiecke, B. Ruzic, C. Greene, J. Bohn and E. Tiemann, Phys. Rev. A **90**, 012710 (2014)

[3] J. Ulmanis, S. Häfner, R. Pires, E. D. Kuhnle, M. Weidemüller, E. Tiemann, New J. Phys. **17**, 055009 (2015)