Three and Four-Body Efimov States in an Ultracold Atomic Gas

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We have observed the presence of weakly-bound three and four-body Efimov molecules in an ultracold gas of trapped lithium-7 [1]. Their presence is manifested in the rate of inelastic collisions that produce a detectable loss of atoms from the trap. Efimov molecules can only exist near a two-body scattering resonance, where the $s$-wave scattering length is much larger than the characteristic length scales of the two-body potential. This universal regime is characterized by extraordinarily small binding energies (~1 neV) and large molecular sizes (~100 nm). Efimov molecules can be accessed experimentally in ultracold atomic gases by using a magnetically-tuned Feshbach resonance, which enables the scattering length to be varied over many orders of magnitude [2]. We have identified two Efimov trimers and four associated four-body tetratomicons in lithium. Efimov molecules are predicted to occur in an infinite series, whose relation are given by a discrete scale invariance. The experimental relations between Efimov states will be compared with those given by universal theory.