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Universality in s-wave and higher partial wave Feshbach resonances: an illustration with a single atom near two scattering centers[1]

SHANGGUO ZHU, SHINA TAN, Georgia Inst of Tech — It is well-known that cold atoms near s-wave Feshbach resonances have universal properties that are insensitive to the short-range details of the interaction. What is less known is that atoms near higher partial wave Feshbach resonances also have remarkable universal properties. We will illustrate this with a single atom interacting resonantly with two fixed static centers. At a Feshbach resonance point with orbital angular momentum $L \geq 1$, we find $2L + 1$ shallow bound states whose energies behave like $1/R^{2L+1}$ when the distance R between the two centers is large. This sheds additional light on the fundamental question whether Efimov effect exists for higher partial wave resonances. The effects of nonresonant partial-wave channels and the shape parameters in the effective range expansions enter as correction terms. Near p-wave and higher partial wave resonances, the energies can be described by a simple universal formula in terms of a parameter called "proximity parameter." We will also discuss modifications of the low energy physics due to the long range Van der Waals potential.

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