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Revealing the origin of super-Efimov states in the hyperspherical formalism CHAO GAO, Institute for Advanced Study, Tsinghua University, Beijing 100084, China, JIA WANG, Department of Physics, University of Connecticut, Storrs, Connecticut 06269, USA, ZHENHUA YU, Institute for Advanced Study, Tsinghua University, Beijing 100084, China — Quantum effects can give rise to exotic Borromean three-body bound states even when any two-body subsystems can not bound. An outstanding example is the Efimov states for certain three-body systems with resonant s-wave interactions in three dimensions. These Efimov states obey a universal exponential scaling that the ratio between the binding energies of successive Efimov states is a universal number. Recently a field-theoretic calculation predicted a new kind of universal three-body bound states for three identical fermions with resonant p-wave interactions in two dimensions. These states were called "super-Efimov" states due to their binding energies $E_n = E_* \exp(-2e^{\pi n/s_0+\theta})$ obeying an even more dramatic double exponential scaling. The scaling $s_0 = 4/3$ was found to be universal while E_* and θ are the three-body parameters. Here we use the hyperspherical formalism and show that the "super-Efimov" states originate from an emergent effective potential $-1/4\rho^2 - (s_0^2 + 1/4)/\rho^2 \ln^2(\rho)$ at large hyperradius ρ. Moreover, our numerical calculation indicates that the three-body parameters E_* and θ are also universal for pairwise interparticle potentials with a van der Waals tail.

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