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Discrete and Continuous Scale Invariance in Quantum Few-Body Systems: Applications to Cold Atoms and Two-Neutron Halo Nuclei

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Efimov universality describes three-body systems near unitarity, where large scattering lengths make their properties essentially independent of short-range interaction details. This regime is marked by discrete scale invariance, reflected in a geometric spectrum of trimers. In ultracold atomic gases, external magnetic fields allow precise tuning of interactions to the resonant regime, while confinement in traps enables the exploration of extreme spatial compression. Theoretical studies model this compression through an effective continuous dimension, showing that beyond a critical value the discrete scale invariance of three dimensions is suppressed and replaced by continuous scale invariance. Remarkably, nuclear physics offers a natural analogue: two-neutron halo nuclei are weakly bound systems sustained by a fine-tuned neutron–core interaction, leading to a very large scattering length. In this context, Efimov physics provides the framework to analyze their geometry, including the mean distances among constituents, governed by scaling laws set by a single three-body parameter.

Topic

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