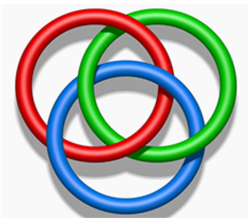
Physics

Synopsis: Knots for All Occasions



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Universal Borromean Binding in Spin-Orbit-Coupled Ultracold Fermi Gases

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Once the emblems of blue-blooded families or symbols of religious trinity, Borromean rings—three-ring configurations that cannot be separated although no pair of rings is linked—have returned to the spotlight in physics with the recent realization of Efimov states. These are bound states of three bosons for which the two-particle attraction is too weak to allow the formation of a bound pair. Efimov states occur in various atomic systems, but, so far, their formation seems to depend on the system's microscopic details, only occurring when short-range interactions fulfill specific conditions. But are Borromean bindings universal, i.e., can they occur in a variety of atomic systems, independently of the details of short-range binding forces? As reported in Physical Review X, researchers have predicted that a universal class of Borromean rings could form in fermionic systems.

Xiaoling Cui at the Chinese Academy of Sciences in Beijing, and Wei Yi at the University of Science and Technology of China, Hefei, have calculated the conditions in which dimers and trimers could form in ultracold gases of lithium and potassium. In such gases, a coupling between the atoms' spins and their movements, which can be artificially engineered with the use of lasers, can provide a useful control knob for tuning interparticle forces. The authors' predictions suggest that a new three-body bound state can be created under a wide combination of parameters that only depend on long-range and spin-orbit interactions, whose features are identical in all systems. Such Borromean rings, which could be observed under conditions currently achievable in cold-atom experiments, would thus be a universal phenomenon, connecting a wide variety of physical systems, including atoms, nuclei, and perhaps even more fundamental particles. – Matteo Rini