Borromean Binding in Two Dimensions

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We study bound three-boson and three-fermion systems without bound two-body subsystems. Appearence of such systems is a quantum phenomenon that does not have a counterpart in the classical world is called Borromean binding. This binding has been throughly investigated in three-dimensional geometry in the context of nuclear physics [1,2]. However, current experiments with cold atomic gases allow us to build and probe such systems in different confining geometries [2,3] for which we lack the theoretical description. Here we investigate the possibility for Borromean binding to appear in two-dimensional geometry.

For identical bosons the two- and three-body thresholds often coincide ruling out Borromean systems. However, we show that Borromean states can appear for potentials with substantial attractive and repulsive parts. Our extensive numerical search did not reveal Borromean states for potentials without an outside barrier so we conclude that Borromean states are most easily found when a barrier is present outside an attractive pocket.

For identical spinless fermions we show that two- and three-body thresholds do not coincide so Borromean systems are present at the two-body threshold. We provide numerical examples of such states and discuss their properties.

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