Kinetic formation of trimers in a spinless fermionic chain

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Abstract

The formation of bound states with more than two particles is a transverse topic in physics, from few to many-body physics, and from nuclear and particle physics to condensed matter and cold atom gases. The versatility of cold atom platforms in terms of internal degrees of freedom and interactions has led to several proposals aiming at the observation of trimer signatures in spinful fermionic systems [1-3]. On the other hand, trimer formation in systems with a unique fermionic species has proven conceptually challenging and the mechanisms and phase transitions exhibited by such systems have not been thoroughly unveiled yet [4].

In our work, we show the stabilization of two trimer phases in a chain of spinless fermions with a correlated hopping term. A trimer fluid forms due to a gain in trimer kinetic energy and competes with a fluid of unbound fermions. Furthermore, we observe two intermediate phases where these two fluids coexist and do not spatially separate. Depending on the way trimers are created out of the Fermi sea, hybridization can occur, in which case the onset of correlations between the two fluids is well captured by a generalised BCS ansatz. These results are finally extended to the formation of larger multimers, which highlights the peculiarities of pair and trimer formation.

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