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Two-fermions molecules in a harmonic trap with short-range interaction

Low-particle systems constitute a direct link between the physics of one or two bodies and the physics of many bodies. This connection has important consequences related to the collective properties that originate in the interactions between particles and in the statistic that governs them. We study a system consisting of independent molecules formed by two distinguishable fermions that interact via a contact potential in an elongated harmonic trap (this was already experimentally achieved), so the system can effectively be considered as 1D. We focus on the entanglement between the constituents of the molecule. By using an ansatz of composite bosons for the fundamental state, we analyze properties such as the condensate fraction, the occupancy numbers of the Schmidt modes, and the density profile of a particle both, when adding molecules to the system and when the interaction parameter between the constituent fermions is modified. In the strongly attractive regime, the pair is maximally entangled and the molecules behave like ideal bosons (BECs). On the other hand, in the strongly repulsive regime, the system exhibits a finite but not maximum amount of entanglement. The fermionization phenomenon is also studied in this regime. Our analysis paves the way to the exploration of 1D Fermi gases with an arbitrary number of pairs across the full interaction range.

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