Fermi gas with attractive potential and arbitrary spin in highly elongated trap

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Abstract

A gas of ultracold ^{6}Li atoms confined to an elongated trap with one-dimensional properties is a candidate to display three different phases: (i) fermions bound in Cooper-pair-like states, (ii) unbound spin-polarized particles, and (iii) a mixed phase with some resemblance to the FFLO pairing [1,2]. So far theoretical studies are restricted to spin-1/2 atoms, but it is possible to extend these to fermionic atoms with higher spin, e.g. for ^{43}Ca, ^{87}Sr or ^{173}Yb. We investigated the μ vs. H phase diagram for $S = 3/2$ (μ is the chemical potential and H the external magnetic field) for the ground state using the exact Bethe *Ansatz* solution of the one-dimensional Fermi gas interacting with an attractive δ-function potential [3]. The subtle differences between open and periodic boundary conditions on the four nested Bethe *Ansätze* are discussed. There are four fundamental states: The particles can be either unpaired or clustered in bound states of two, three and four fermions. The rich phase diagram consists of these four states and various mixed phases in which combinations of the fundamental states coexist. Bound states of four fermions are not favorable in high magnetic fields, but always present if the field is low. This calculation extends the FFLO picture in one-dimension to $S = 3/2$-particles.

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