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Unitary Superfluidity Of Polarized Fermionic Gases In Highly Elongated Traps L. BAKSMATY, H. LU, C. BOLECH[1], H. PU, Rice University
— Recent groundbreaking experiments on resonantly interacting fermionic superfluids encountered qualitative and quantitative discrepancies which seem to be a function of the confining geometry. Despite long familiarity with BCS (Bardeen-Cooper-Schrieffer) superfluids in a wide range of physical systems such as nuclear matter, QCD, Astrophysics and Condensed Matter, these observations have defied theoretical explanation. Mindful of quantum rigidity and motivated by this impasse, we study the solution space for 3-dimensional fully self-consistent mean field formulation. Relying on numerical algorithms specifically developed for this purpose, we study realistic systems with up to 10^5 atoms. We find that for a large enough sample in a cigar-shaped trap, there are typically three types of solutions which are almost degenerate and have the ff. properties: (i) There is a solution very similar to the local density approximation (LDA) which is consistently the lowest in energy. (ii) However one of the other two solutions, connected by a smooth transition, and which are more consistent with experiment at high aspect ratio, supports a state very similar to the long sought FFLO (Fulde Ferrel Larkin Ovchinnikov) state. We submit that these solutions are relevant false vacua because, given high energy barriers and near degeneracy of the obtained solutions, the actual states observed in an experiment could be a strong function of the experimental procedure. Darpa OLE grant, ARO Grant no. W911NF-07-1-0464, Welch foundation (C-1669, C-1681) and NSF.

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