Contribution ID : 24 Type : Invited oral

Neural-network quantum states for ultra-cold Fermi gases

Monday, 23 September 2024 15:50 (30)

Ultra-cold Fermi gases exhibit a rich array of quantum mechanical properties, including the transition from a fermionic superfluid Bardeen-Cooper-Schrieffer (BCS) state to a bosonic superfluid Bose-Einstein condensate (BEC). While these properties can be precisely probed experimentally, accurately describing them poses significant theoretical challenges due to strong pairing correlations and the non-perturbative nature of particle interactions. In this talk, I will introduce our recent development—a Pfaffian-Jastrow neural-network quantum state featuring a message-passing architecture, designed to efficiently capture pairing and backflow correlations. We benchmark our approach on existing Slater-Jastrow frameworks and state-of-the-art diffusion Monte Carlo methods, demonstrating a performance advantage and the scalability of our scheme. We show that transfer learning stabilizes the training process in the presence of strong, short-ranged interactions, and allows for an effective exploration of the BCS-BEC crossover region. Our findings highlight the potential of neural-network quantum states as a promising strategy for investigating ultra-cold Fermi gases. Finally, I will discuss initial results applying this ansatz to nuclear matter and nuclei.

Primary author(s) : Dr KIM, Jane (Ohio University)

Co-author(s) : Mr PESCIA, Gabriel (École Polytechnique Fédérale de Lausanne); Dr NYS, Jannes (École Polytechnique Fédérale de Lausanne); Dr FORE, Bryce (Argonne National Laboratory); Dr LOVATO, Alessandro (Argonne National Laboratory); Prof. HJORTH-JENSEN, Morten (University of Oslo); Prof. CARLEO, Giuseppe (École Polytechnique Fédérale de Lausanne)

Presenter(s) : Dr KIM, Jane (Ohio University)

Session Classification : Session

Track Classification : Quantum fluids and ultracold gases