RICE QUANTUM GROUP MEETING SEMINAR SERIES

Presenter: **Sagarika Basak**

Research Group: Prof. Han Pu's group

Date: September 01, 2023, Friday

Time: 4PM – 5PM

Venue: SST 301

A Generalized Effective Spin-Chain Formalism

Abstract:

Ultracold spinor gases are ideal for the exploration of novel many-body physics such as Stoner's itinerant ferromagnetism, spin-incoherent Luttinger liquids, 'flavor-selective' Mott insulators, and novel highly entangled states. For investigations of multi-flavor spinor gases in the strong interaction limit, present theoretical and numerical tools are limited to lower accuracy and to smaller system sizes (computing- and memory-intensive). Studies using approximate analytic methods have remained focused on spin-$^1/_2$ fermions, and for large spin fermions limited to the Heisenberg limit. In this talk, I present a generalized effective spin-chain formalism developed to study strongly interacting spinor gases in a 1D lattice. Here, a system of N-component bosons/fermions is mapped to a system of spinless fermions and a spin-chain, and defined is a generalized effective spin-chain Hamiltonian that acts on the mapped system. The developed model permits the study of gases with arbitrary spin and statistics, providing a generalized approach for 1D strongly interacting gases. Over existing theoretical models, this formalism is accessible (computationally and analytically easier), flexible (to system parameters), and inherently confers a vantage point to separate the effects of spin and charge degrees of freedom. In combination with the generalized Bose-Fermi mapping defined previously for continuum systems (Phys. Rev. A **91**, 043634, 2015; Phys. Rev. A **95**, 043630, 2017), this model completes a unified framework. Using this formalism, I demonstrate the successful reproduction of the ground state of spinor gases. Furthermore, I present the time evolution of a quenched spin-$^1/_2$ Fermi gas in a lattice, where the model successfully captures its dynamical properties. I will conclude with a discussion of future avenues using this formalism.

Short Bio:

Sagarika Basak is a final year PhD candidate in Prof. Han Pu's research group. She holds a dual-degree BS-MS in Physics from the Indian Institute of Science Education and Research (IISER) Pune. An AMO theoretical physicist interested in strongly interacting ultracold gases in lower dimensions, her research using quantum simulations aims to uncover novel physics and understand emergent properties. Her previous works have uncovered novel behaviors emerging from the periodic driving of Rydberg atoms and the coupling of two-component bosons. She has recently developed a theoretical tool to study strongly interacting spinor gases in 1D optical lattices, which is the focus of this talk. This formalism is currently being used to investigate new physics in SU(N) fermions and anyons.

Note: *Snacks and Coffee will be served during the event Wine & cheese will be served after the talk. Everyone is welcome to stay around after the seminar for further informal discussions.*