

## Graduate Student Research Progress Report

Title: Coupled Gross-Pitaevskii equations for Bose-Fermi mixture system

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### Abstract:

Quantum mixtures of bosons and fermions provide a versatile platform for studying the interplay of many-body correlations across interaction regimes. By tuning the interspecies interaction strength, one can access distinct dynamical behaviors. Recent experiments on the system have revealed a fermion-mediated pairing resonance that bridges the Ruderman–Kittel–Kasuya–Yosida (RKKY) and Efimov regimes, highlighting the emergence of many-body bound states in the strongly interacting limit [arXiv:2502.06266].

In this work, we investigate the non-equilibrium dynamics of a Bose–Fermi mixture subjected to a quench of the interspecies interaction. Using a hydrodynamic framework with higher-order Bose–Fermi couplings encoded in coupled Gross–Pitaevskii equations (GPE) and GPU-accelerated simulations, we analyze fluctuation dynamics near the transition and assess the conditions under which a self-bound droplet phase can be stabilized in the stronger-attraction regime.

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