Bright and gap solitons and vortex formation in a superfluid Bose-Fermi mixture

Sadhan K. Adhikari *
Instituto de Física Teórica, UNESP − São Paulo State University, 01.405-900 Sao Paulo, Sao Paulo, Brazil

Starting from a Lagrangian density of a superfluid Bose-Fermi mixture we derive a coupled set of nonlinear Schrödinger equations for the system. In the absense of interspecies Bose-Fermi interaction the Bose component satisfies a standard Gross-Pitaevskii equation, whereas the Fermi component satisfies a Ginzburg-Landau-type equation suitable for the Fermi superfluid. To study dynamics we use the time-dependent equations. Time-independent equations are used for stationary problems. We use both full numerical as well as variational approximations to study different aspects of the mixture. We studied the bright solitons in the mixture in the presence of repulsive Bose-Bose and attractive Bose-Fermi interactions in a quasi-one-dimensional (quasi-1D) formulation. The formation of gap solitons are studied in the presence of repulsive Bose-Fermi and Bose-Bose interactions in a quasi-1D mixture. In both cases probability density and chemical potentials are well represented by a variational approximation. Finally, we study the formation of a bosonic vortex in a quasi-two-dimensional mixture. The possibility of mixing-to-demixing transition and collapse is also considered in this case.

* Email: adhikari@ift.unesp.br; URL: www.ift.unesp.br/users/adhikari