

Dark and bright solitons in superfluid Fermi gases in the BCS-BEC crossover

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Abstract:

We study, both analytically and numerically, the formation and propagation of dark and bright solitons in a superfluid Fermi gas in the crossover from Bardeen-Cooper-Schrieffer (BCS) superfluid to a Bose-Einstein condensate (BEC). Starting from a superfluid order-parameter equation we derive Korteweg-de Vries equations for weak nonlinear excitations in the cases of small and large particle numbers. We present dark and bright soliton solutions valid for both BCS and BEC limits and also for the crossover, and show that the solitons in different superfluid regimes possess different features. We study also the head-on collision between two solitons and demonstrate that the phase shift due to the collision changes non-monotonically along the BCS-BEC crossover. All analytical results are checked by numerical simulations and good agreements between them are found [1,2].

References:

1. Wen Wen and Guoxiang Huang, Phys.Rev. A 79, 023605 (2009).
2. Wen Wen, Shun-Qing Shen, and Guoxiang Huang, Phys. Rev.B 81, in press (2010).