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Mode analysis of a single component fermion - BEC mixture¹ DEBORAH SANTAMORE, ITAMP and Department of Physics, Harvard University, EDDY TIMMERMANS, T-4 Theory Division, Los Alamos National Laboratory — We analyze the collective modes of a single component fermion - BEC mixture in the ultra-low temperature regime in which the fermions behave as a normal Fermi-liquid. If the Fermi-velocity exceeds the sound velocity of the BEC and the homogeneous mixture is mechanically stable, we find two coupled collective modes. The lowest energy mode is a damped excitation that decays by virtue of Landau damping. The higher energy mode exhibits the characteristics of a zero sound excitation in the long wavelength limit. We calculate the decay rate of the damped mode and point out that this mode terminates at a well-defined wavenumber. If a critical fermion density is exceeded, the fermions become immiscible to the BEC, and the mixture undergoes phase separation. Our analysis reveals the mechanism of the related instability. We estimate the growth rate and length scale on which the phase separation sets in. We discuss the prospects for experimental observations and the implications for other cold atom quantum liquid systems such as Cooper-pairing of a spin polarized fermion system (of different spin densities).

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