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Trapped Fermions across a Feshbach resonance with population imbalance WEI YI, LUMING DUAN, FOCUS center and MCTP, Department of Physics, LUMING DUAN TEAM — We investigate the phase separation of resonantly interacting fermions in a trap with imbalanced spin populations, both at zero and at finite temperatures. We directly minimize the thermodynamical potential under the local density approximation instead of using the gap equation, as the latter may give unstable solutions. At zero temperature, on the BEC side of the resonance, one may cross three different phases from the trap center to the edge: the superfluid phase (SF), where all particles are paired and there is no population imbalance; the breached gap phase (BP), where superfluid and polarized fermions coexist; and the normal Fermi sea with different Fermi surfaces for different spin components. On the BCS side or at resonance, typically only the SF and the normal phase show up. At finite temperature, we show that there exist fermionic excitations even in the superfluid phase, which carry population imbalance of the spin components. As a result, it becomes easier to satisfy the population imbalance constraint, which helps to stabilize the superfluid phase. Because of the fermionic excitations at finite temperature, the boundary between the BP phase and the SF phase becomes obscure. The phase separation between the paired phase (SF/BP) and the normal phase however, is marked by a peak in the population difference. We compare our results with a recent experiment (M.W. Zwierlein, et. al., cond-mat/0511197), and the agreement is remarkable.

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