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Thermodynamics of spin-imbalanced Fermi gases near the unitary limit

The experimental realization of the BCS-BEC crossover with ultracold fermionic atoms relies on Feshbach resonances that allow to tune the only relevant interaction parameter: the *s*-wave scattering length a. Nowadays, the underlying phase diagram is understood in terms of a strongly coupled quantum critical point, which gives rise to universal scaling functions for thermodynamic quantities, located in the unitary limit of divergent scattering length. Apart from tuning the interaction strength also the influence of a finite population imbalance between the spin states of the Fermions is a relevant question to be studied since the latter can be created and controlled within trapped neutral atoms. To obtain quantitative results for the thermodynamics throughout the crossover in the presence of spin imbalance we use a Luttinger-Ward approach that takes the strong interactions fully self-consistently into account.
After a short summary of the method and the required special Fourier transforms. I present our numerical results for the various scaling functions at finite temperatures in the normal phase. In particular, special focus is paid to the phase diagram at unitarity where we not only observe an instability towards a homogenous superfluid of *s*-wave paired Fermions but also to an inhomogeneous superfluid of FFLO-type.

References:
Frank, B., Lang, J. & Zwerger, W. Universal Phase Diagram and Scaling Functions of Imbalanced Fermi Gases. *Journal of Experimental and Theoretical Physics* **127,** 812–825 (2018) https://doi.org/10.1134/S1063776118110031