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Non-perturbative corrections to the weakly interacting two component Fermi gas

Wednesday 4 September 2024 17:00 (2 hours)

A simplified mean-field description of fermionic systems relies on the Hartree-Fock-Bogoliubov (HFB) approach, where the two-particle interaction is decomposed into three distinct channels. A major issue with this method is that the separation between the channels is somewhat arbitrary. Depending on the physical situation to be described, different channels turn out to be important.
In this poster, we present a self-consistently generalized mean-field theory, which is based on introducing a separate weighting factor for each channel. This ansatz removes the arbitrariness of the channel separation by providing an extremization principle for their optimal partitioning.
The power of our technique is illustrated by considering the example of two unpolarized fermionic species with contact interaction. In this case the Fock contribution vanishes and we obtain a coupling between the Hartree and the Bogoliubov channel. This results non only in first beyond mean-field corrections[1,2] already at the mean-field but also decreases the critical temperature in qualitative agreement to particle-hole fluctuations [3]. Due to the non-perturbative nature of the channel coupling we also obtain results which are not captured by any fluctuation theory in one channel alone. This requires the introduction of an effective interaction range as a new length scale and should become relevant for large enough densities. With this our formalism builds a natural theoretical bridge between fermionic superfluidity in ultracold atomic gases and superconductivity in condensed matter physics as well as the realm of nuclei and neutron matter.strong text

References

[1] C. A. R. Sá de Melo, M. Randeria, J. R. Engelbrecht, Phys. Rev. Lett. 71, 3202 (1993)
[2] J. R. Engelbrecht, M. Randeria and C. A. R. Sá de Melo, Phys. Rev. B 55, 15153 (1997)
[3] L. Gor'Kov and T. Melik-Barkhudarov, Sov. Phys. JETP 13, 1018 (1961)

Short bio (50 words) or link to website

https://www-user.rhrk.uni-kl.de/~apelster

Relevant publications (optional)

Career stage

Postdoc

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