Diagrammatic Monte-Carlo: current status and applications to large-N field theories

Gunnar Möller
University of Kent

Abstract:
The difficulty of understanding strongly correlated matter is often related to the absence of a natural small parameter providing a starting point for a perturbative treatment. Large-N approaches provide a prominent theoretical tool, which seeks to address this issue for fermionic theories by introducing a generalised theory with many fermion flavours, that then becomes amenable to perturbative treatments.

We demonstrate how to implement this concept in conjunction with a diagrammatic Monte-Carlo approach, using a many fermion-flavour generalisation of the unitary Fermi gas [1] for illustration. This system provides an ideal test case thanks to existing diagrammatic Monte-Carlo techniques developed in [2,3], which yield a numerically exact solution thanks to explicit resummation of the high-order asymptotics [4].

We present results on the extended large-N generalisation of the theory [5,6], and demonstrate how to apply diagMC in this setting. Using the resummation technique developed by Rossi et al [4], we show that the convergence radius in the Borel plane is enlarged as a function of fermion flavours, thus facilitating the convergence of the series in the vicinity of the transition into the superfluid phase.

We argue that the combination of large-N field theory techniques with high-order numerical resummations opens up a new avenue for investigations of strongly interacting systems more generally.

To introduce the topic, we will additionally review recent developments in diagrammatic Monte-Carlo techniques.

References:

[1] W. Zwerger, Springer (2012).
[2] K. v. Houcke et al., Nat. Phys. **8**, 366 (2012).
[3] K. v. Houcke et al., Phys. Rev. B **99**, 035140 (2019).
[4] R. Rossi, et al., Phys. Rev. Lett. **121**, 130405 (2018).
[5] M.Y. Veillette, et al., Phys. Rev. A **75**, 043614 (2007).
[6] P. Nikolic and S. Sachdev, Phys. Rev. A **75**, 033608 (2007).