Resummation of diagrammatic series with zero convergence radius for a strongly correlated Fermi gas

Riccardo Rossi[a,b], Takahiro Ohgoe[c], Kris Van Houcke[a] et Félix Werner[d*]

a. Laboratoire de Physique Statistique, Ecole Normale Supérieure, Sorbonne Université, Université Paris Diderot, CNRS, Paris Sciences et Lettres, Paris, France
b. Center for Computational Quantum Physics, The Flatiron Institute, New York, USA
c. Department of Applied Physics, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656, Japan
d. Laboratoire Kastler Brossel, Ecole Normale Supérieure, CNRS, Sorbonne Université, Collège de France, Paris Sciences et Lettres, Paris, France

∗ werner@lkb.ens.fr

Making accurate predictions for strongly correlated fermions is a long-standing theoretical challenge. A new approach is being developed since 10 years. All connected Feynman diagrams are sampled efficiently up to a certain order $N_{\max}$ using diagrammatic Monte Carlo algorithms. Convergence of the diagrammatic series for $N_{\max} \to \infty$ was observed in several interesting situations for fermions on a lattice or frustrated spins. Here we consider a continuous-space model, where the series diverges strongly (the convergence radius is zero), and there is no small parameter in the strongly correlated regime. Nevertheless, we obtain accurate results by resumming the series using a conformal-Borel transformation that incorporates the large-order behavior and the analytic structure in the Borel plane, which we obtain by the instanton approach [1]. The specific model we consider is the unitary Fermi gas, a model of non-relativistic fermions in 3 space dimensions. We compare with ultracold-atom experimental data for the equation of state and the contact parameter.

[1] R. Rossi, T. Ohgoe, K. Van Houcke, F. Werner, arXiv:1802.07717
[2] M. J. H. Ku, A. Sommer, L. W. Cheuk, and M. W. Zwierlein, Science **335**, 563 (2012).

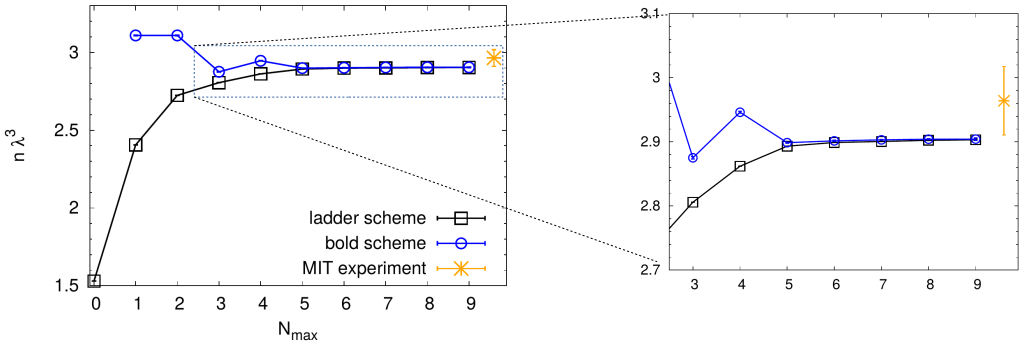

Figure 1: Theory-experiment comparison for the equation of state (dimensionless density $n\lambda^3$, here at zero chemical potential). Open squares and circles: resummed diagrammatic series up to order $N_{\max}$ for two diagrammatic schemes, star: experimental data [2].