

Fluctuation Diagnostics of Many-Electron Systems with Local and Non-Local Interactions

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In correlated many-electron systems, the description provided by the electronic spectral function or, equivalently, by the electronic self-energy is often *not* sufficient to clarify the underlying physics. For this reason, the post-processing scheme coined “*Fluctuation Diagnostics*” has been introduced [1,2] for all the theoretical approaches allowing equal footing calculations of one- and two-particle properties.

Specifically, the Fluctuation Diagnostics (FD) exploits (i) the different, but formally equivalent expressions of the Schwinger–Dyson equation for the self-energy and (ii) the possibility of performing partial summations in the corresponding physical channels to quantify, *unambiguously*, the collective mode(s), which drive the resulting spectral properties. By construction, the FD avoids all possibly divergence-issues plaguing the post-processing procedures based on the *decomposition* of two-particle diagrams.

Hitherto, the application of the FD has been strictly limited to the case of purely on-site interaction (Hubbard model) and fully symmetric phases, with the only notable, but specific exception of [3]. However, by directly linking its derivation to the Fierz ambiguity of the density-density interactions, a unified and more general perspective on the FD approach can be gained [4], allowing for its desired extension to broken-symmetry phases and non-local density-density interactions.

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[2] T. Schäfer and A. Toschi, *How to read between the lines of electronic spectra: The diagnostics of fluctuations in strongly correlated electron systems*, Jour. of Phys.: Condensed Matter, **33**, 214001 (2021).

[3] X. Dong, L. Del Re, A. Toschi, and E. Gull, *Mechanism of superconductivity in the Hubbard model at intermediate interaction strength*, **119**, e2205048119 (2022).

[4] M. Gievers, M. Patricolo, S. Andergassen, A. Toschi, and L. Del Re, *General perspective on the “Fluctuation Diagnostics”*, in preparation.