Green's functions for the theoretical description of strongly correlated electrons systems

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Green's functions represent one of the most useful tools for the theoretical description of correlated lattice electrons. In particular, the one-particle Green's function contains information about the spectral properties of the system and can be directly compared to (angular resolved) photoemission spectroscopy experiments. However, also two-particle correlation functions provide very interesting insights into the properties of correlated electron systems as they contain crucial information on response functions such as the magnetic susceptibility or the optical conductivity. In my talk, I will present an overview about the physical content as well as the applications of one- and two-particle Green's and vertex functions in frontier condensed matter research. First, I will demonstrate how the inclusion of local correlation effects into the one-particle Green's function by means of dynamical mean field theory (DMFT) can lead to a breakdown of the topological quantization of the Hall conductivity in the Hubbard model in a magnetic field. The limitations of the purely local description of DMFT leads me to the discussion how local frequency-dependent vertices can be used to include also non-local correlations effects in interacting many-electron systems beyond DMFT. While these so-called diagrammatic extensions[1] of DMFT have been successfully exploited to describe collective phenomena such as magnetism and superconductivity, their predictive power is still limited by specific inconsistencies between the one- and the two-particle level[2]. In the final part of my talk, I will present possible solutions to these problems[3] which I will address in the framework of my Emmy Noether project at the university of Hamburg.

[1] G. Rohringer et al., Rev. Mod. Phys. 90, 025003 (2018).
[2] E. G. C. P. van Loon et al., Phys. Rev. B 93, 155162 (2016).
[3] G. Rohringer, and A. Toschi, Phys. Rev. B 94, 125144 (2016).