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Nambu-Covariant Many-Body Theory

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In an attempt to tackle systematically the complexity of strongly correlated quantum many-body systems, modern *ab initio* approaches have grown more and more sophisticated, both formally and numerically. One standard strategy consists in combining several pre-existing many-body schemes such as symmetry-breaking mean-field calculations with non-perturbative corrections. In this particular case, the additional formal complexity appears as anomalous propagators and/or anomalous vertices in the diagrammatic.

In this talk, I will show how the introduction of a new tensorial structure enables the reformulation of many-body approximations, such as Self-consistent Green's Functions (SCGFs), in a way that is invariant with respect to any Bogoliubov transformation. As a result, symmetry-breaking extensions of many-body approximations become formally as simple as their symmetric counterpart.

To illustrate the simplifications that occur, I will showcase the set of equations formulating the self-consistent ladder approximation of symmetry-breaking Green's functions at finite temperature, in a general basis. Application of such general expression for a many-body system of interest will then be presented by considering the example of superfluid polarized asymmetric nuclear matter in a plane-wave basis.

Finally, I will revisit the celebrated Thouless'criterion linking the convergence of the series of ladder diagrams at vanishing energy with the stability of the Bardeen-Cooper-Schrieffer (BCS) self-energy for homogeneous matter. Taking advantage of the Nambu-covariant formalism, I will show how Thouless'criterion trivially extends to the case of a complex general Hartree-Fock-Bogoliubov (HFB) self-energy when one considers a general many-body system. Last, as an attempt to make up for the shortcoming of Thouless'criterion, I will introduce a new condition on the stability of the HFB self-energy which is sufficient to ensure the convergence of the series of ladder diagrams at any energy.

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