

# Anomalous propagators and the particle-particle channel of correlation

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The successful one-body Hedin equations<sup>1</sup> and two-body particle-hole Bethe-Salpeter equation<sup>2</sup> are based on the linear response to an ordinary time-dependent external potential.<sup>3</sup> In this work, it will be shown that one could alternatively consider the linear response to a pairing potential, *i.e.* a non-number-conserving one-body potential. This perturbation requires the introduction of anomalous propagators to be described and leads to a new closed set of equations for the one-body propagator which is analog to Hedin's equations. The lowest self-energy approximation of this set, *i.e.* the analog of the famous *GW* approximation, is the particle-particle *T*-matrix approximation.<sup>4</sup> This approximation is already known in the literature, but the present work sets a functional derivative framework which allows for systematic approximation beyond the *T*-matrix. Finally, considering anomalous propagators and pairing potentials also naturally leads to a two-body particle-particle Bethe-Salpeter equation. While this equation can also be formulated without anomalous propagators, the new expression of the kernel derived in this work makes it much more practical. The similarities with the particle-hole Bethe-Salpeter equation will also be discussed.

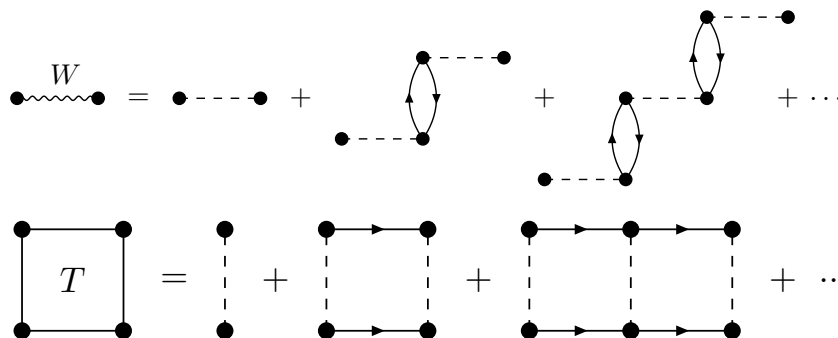


Figure 1: The screened interaction  $W$  (wiggly line) is computed as a resummation of bubble diagrams. The dashed lines correspond to the Coulomb interaction. The effective interaction  $T$  corresponds to a resummation of ladder diagrams. The exchange counterpart of each diagram represented in  $T$  should be included as well but has not been represented here.

**Keywords:** Many-body perturbation theory, Green's functions, anomalous propagators, pairing potential

<sup>1</sup>L. Hedin, Phys. Rev. A 139 (1965) A786.

<sup>2</sup>E. E. Salpeter and H. A. Bethe, Phys. Rev. 84 (1951) 1232.

<sup>3</sup>P. C. Martin and J. Schwinger, Phys. Rev. 115 (1959) 1342.

<sup>4</sup>R. M. Martin, L. Reining, and D. M. Ceperley, *Interacting Electrons: Theory and Computational Approaches* (Cambridge University Press, 2016).