CMT 2P TWO PARTICLE IRREDUCIBLE GREEN'S FUNCTION OF STRONGLY CORRELATED ELECTRON SYSTEMS

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As was demonstrated in our previous papers [1-6] devoted to the theory of strongly correlated electron systems the new elements of such theory are the irreducible Green's functions or Kubo cumulants. These functions contain all spin, charge and pairing quantum fluctuations.

The simplest two particles irreducible Green's function has the form

$$G_2^{(0)irr}[\sigma_1,\tau_1;\sigma_2,\tau_2\,|\,\sigma_3,\tau_3;\sigma_4,\tau_4]=G_2^{(0)}[\sigma_1,\tau_1;\sigma_2,\tau_2\,|\,\sigma_3,\tau_3;\sigma_4,\tau_4]-$$
$$-G_1^{(0)}[\sigma_1,\tau_1\,|\,\sigma_4,\tau_4]G_1^{(0)}[\sigma_2,\tau_2\,|\,\sigma_3,\tau_3]+G_1^{(0)}[\sigma_1,\tau_1\,|\,\sigma_3,\tau_3]G_1^{(0)}[\sigma_2,\tau_2\,|\,\sigma_4,\tau_4],$$

where zero order one particle and two particle Matsubara Green's functions are equal to:

$$G_1^{(0)}(\sigma_1,\tau_1;\sigma_2,\tau_2)=-\left\langle Tf_{\sigma_1}(\tau_1)\,\bar f_{\sigma_2}(\tau_2)\right\rangle_0,$$
$$G_2^{(0)}[\sigma_1,\tau_1;\sigma_2,\tau_2\,|\,\sigma_3,\tau_3;\sigma_4,\tau_4]=\left\langle Tf_{\sigma_1}(\tau_1)\,f_{\sigma_2}(\tau_2)\,\bar f_{\sigma_3}(\tau_3)\,\bar f_{\sigma_4}(\tau_4)\right\rangle_0, \tag{1}$$

with fermions operators $f,\bar f$ in interaction representation

$$f_\sigma(\tau)=\mathrm{e}^{\tau H_0}\;f_\sigma\,\mathrm{e}^{-\tau H_0},\;\bar f_\sigma(\tau)=\mathrm{e}^{\tau H_0}\;f_\sigma^{+}\,\mathrm{e}^{-\tau H_0},$$

H_0 is the local part of Hubbard or Anderson Hamiltonian operators [7-8].

The Fourier representation of irreducible two particle Green's function has the form:

$$G_2^{(0)irr}[\sigma_1,\mathrm{i}\omega_1;\sigma_2,\mathrm{i}\omega_2\,|\,\sigma_3,\mathrm{i}\omega_3;\sigma_4,\mathrm{i}\omega_4]=\delta_{\sigma_1\sigma_3}\delta_{\sigma_2\sigma_4}\{K_1[\sigma_1,\mathrm{i}\omega_1;\sigma_2,\mathrm{i}\omega_2\,|\,\sigma_1,\mathrm{i}\omega_3;\sigma_2,\mathrm{i}\omega_4]+$$
$$+\beta^2\delta_{\omega_1\omega_3}\delta_{\omega_2\omega_4}G_{\sigma_1}^{(0)}(\mathrm{i}\omega_1)G_{\sigma_2}^{(0)}(\mathrm{i}\omega_2)\}+\delta_{\sigma_1\sigma_4}\delta_{\sigma_2\sigma_3}\{K_2[\sigma_1,\mathrm{i}\omega_1;\sigma_2,\mathrm{i}\omega_2\,|\,\sigma_2,\mathrm{i}\omega_3;\sigma_1,\mathrm{i}\omega_4]-$$
$$-\beta^2\delta_{\omega_1\omega_4}\delta_{\omega_2\omega_3}G_{\sigma_1}^{(0)}(\mathrm{i}\omega_1)G_{\sigma_2}^{(0)}(\mathrm{i}\omega_2)\}-\sigma_1\sigma_3\delta_{\sigma_2,-\sigma_1}\delta_{\sigma_4,-\sigma_3}K_3[\sigma_1,\mathrm{i}\omega_1;-\sigma_1,\mathrm{i}\omega_2\,|\,\sigma_3,\mathrm{i}\omega_3;-\sigma_3,\mathrm{i}\omega_4]=$$
$$=\beta\delta(\omega_1+\omega_2-\omega_3-\omega_4)\tilde G_2^{(0)irr}[\sigma_1,\mathrm{i}\omega_1;\sigma_2,\mathrm{i}\omega_2\,|\,\sigma_3,\mathrm{i}\omega_3;\sigma_4,\mathrm{i}\omega_4],$$

where the functions $K_n(n=1,2,3)$ are determined for one of two strongly correlated models. The last equation demonstrate the low of the conservation of the frequencies.

The quadruple integrals, which contained in $K_n(n=1,2,3)$ are calculated and frequency Fourier representation of irreducible Green's function established.
The two particles irreducible Green's function is the simplest irreducible Green's function which permit to close the system of equations for Green's functions and to use them for discussing the physical properties of the system.

[1] M. I. Vladimir and V. A. Moskalenko, *Theor. Math. Phys.* **82** (1990) 301.
[2] S. I. Vakaru, M. I. Vladimir and V. A. Moskalenko, *Theor. Math. Phys.* **85** (1990) 1185.
[3] N. N. Bogoliubov and V. A. Moskalenko, *Theor. Math. Phys.* **86** (1991) 10.
[4] N. N. Bogoliubov and V. A. Moskalenko, , *Theor. Math. Phys.* **92** (1992) 820.
[5] V. A. Moskalenko, P. Entel, and D. F. Digor, *Phys. Rev.* **B59** (1999) 619.
[6] V. A. Moskalenko, *Theor. Math. Phys.* **111** (1997) 744: **113** (1997) 1559.
[7] J. H. Hubbard, *Proc. Roy. Soc.* **276A** (1963) 238; **281A**, (1964) 8401; **285A** (1965) 542.
[8] P. W. Anderson, *Phys. Rev.* **124(1)** (1961) 41.