The calculation of the strong-coupled electron liquid model characteristics in frames of the reference system approach

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The new variant of the collective variables method for description the strong nonideal electron liquid model was suggested. Similarly to the Bohm-Pines method the Coulomb potential is splitted using θ-analogical functions on two parts: the long range and short range components $V_l(\mathbf{q}) = V_\mathbf{q} y(q|q_0)$; $V_s(\mathbf{q}) = V_\mathbf{q}\{1 - y(q|q_0)\}$, $V_\mathbf{q} = \frac{4\pi e^2}{q^2}$; $y(q|q_0) = 1 - \frac{2}{\pi}\mathrm{arctg}\left(\frac{q}{q_0}\right)^n$, where $n \geq 3$ and q_0 is a variative parameter.

We obtained the statistical operator representation in the extended space of individual variables (secondary quantization operators $a^+_{\mathbf{k},s}, a_{\mathbf{k},s}$) and collective coordinates using the transition operator. As the result of transition from collective variables to generation and annihilation operators of plasmons $b^+_\mathbf{q}$, $b_\mathbf{q}$ we get the electron-plasmon model of the electron liquid with the partition function $Z = \mathrm{Sp}_a\mathrm{Sp}_b\Big\{\hat{J}_{a,b}\exp[-\beta(\hat{H}_s + \hat{H}_p + \hat{H}_{ep})]\Big\}$. Where $\hat{H}_s$ is the hamiltonian of electrons with short-range interaction, $\hat{H}_p$ – the hamiltonian of interacting plasmons, $\hat{H}_{ep}$ – the operator of electron-plasmon interactions and operator $\hat{J}_{a,b}$ describe electron-plasmon relations.

To contrast to the standard perturbation theory in this approach the free electrons and noninteracting plasmons model is using as base system. Therefore in our approach the divaricate diagrams are absent and series decompositions have good convergence. The short-range interactions contribution was considered in the local-field approximation (calculations for the local-field function of electrons with short-range interactions are required).

The electron liquid model characteristics (correlation energy, binary distribution function, structure factor, local-field correction function) are calculated in $T = 0K$ case for wide range of the coupling parameter ($1 \leq r_s \leq 40$).