Dynamics of Condensate as a Subsystem of Superfluid Bose Gas

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Consideration is based on closed set of equations which describe nonequilibrium state of superfluid Bose gas by parameters: amplitude $\eta(x,t)$ of condensate wave function, velocity $\upsilon_n(x,t)$ of the condensate, the Wigner distribution function $f_p(x,t)$ of the Bogolyubov quasi-particles in local reference system (RS) of the condensate rest K with spectrum $\varepsilon_p(\eta)$. These equations were obtained in our paper[1] in perturbation theory in interaction and gradients of the mentioned variables. By this way time equation for phase $\varphi(x,t)$ of the condensate wave function was obtained too. In fact we start from the Gross-Pitaevskii equation generalized for the case of presence of the quasi-particles in kinetic state. Here we build the Gross-Pitaevskii equation for the case of presence of the quasi-particles in hydrodynamic state in which they are described with drift velocity $\omega_n(x,t)$ in the RS K and temperature $T(x,t)$. One can consider this set of equations as a modification of the Landau-Khalatnikov hydrodynamic equations. The construction is based on a generalization of the Chapman-Enskog method in which distribution function $f_p(x,t)$ is considered as a functional $f_p(x,\eta(t),\upsilon(t),T(t),\omega(t))$. The temperature $T(x,t)$ and the drift velocity $\omega_n(x,t)$ are defined by standard relations using the Planck distribution. On the base of these results stability of equilibrium subsystem of the quasi-particles and possibility of creation of the quasi-particles by the condensate in the evolution of the Bose gas have been discussed.

[1]S. V. Peletminskii, A. I. Sokolovskii and V. S. Shchelokov, Theor. Math. Phys. **30**, 35 (1977).