Spatially nonuniform relaxation phenomena in electron-phonon subsystem of a solid

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Non-steady transport phenomena in rarefied electron gas interacting with equilibrium phonon subsystem have been considered. The investigation is based on kinetic equation obtained by us which takes into account the influence of non-homogeneity of the system on electron-phonon collisions. The developed theory is close related to polaron theory developed by Bogolyubov [1]. In spatially uniform state of the considered system there are two relaxation processes: attenuation of electron gas velocity $v_l(t)$ and relaxation of electron gas temperature $T(t)$ to phonon gas temperature T_0. The case, in which estimations $T(t)-T_0 \sim \lambda$, $v_l(t) \sim \lambda$(λ is small parameter) are true, we considered in detail. It is shown that leading contribution to nonequilibrium electron distribution function $f_p(T(t), v(t))$ is represented by Maxwell distribution $f_p^M(T(t), v(t))$ incorrect even in the linear approximation in λ:

$$f_p(T, v) = f_p^M(T_0, 0) + A_{p\,l} v_l + B_p(T - T_0) + O(\lambda^2)$$

$$A_{p\,l} \neq \left.\frac{\partial f_p^M(T, v)}{\partial v_l}\right|_{T=T_0,\, v=0}, \qquad B_p \neq \left.\frac{\partial f_p^M(T, v)}{\partial T}\right|_{T=T_0,\, v=0}.$$

Taking into account this result theory of transport phenomena in the system is constructed. In its framework electron distribution function has structure $f_p(x, T(t), v(t), n(t))$ and is a functional of variables $T(x,t)$, $v_l(x,t)$, $n(x,t)$ ($n(x,t)$ is density of the electron gas). Small parameter of this theory λ is introduced by estimations of the type $v_l \sim \lambda$, $T - T_0 \sim \lambda$, $\partial n/\partial x_n \sim \lambda$, $\partial v_l/\partial x_n \sim \lambda^2$, $\partial T/\partial x_n \sim \lambda^2$. This leads to some modification of usual theory of transport in the system [2].

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1. Bogolyubov N.N., Bogolyubov N.N.(jr.) *Aspects of polaron theory.*– Moscow: Fizmatlit, 2004, 176p.
2. Lifshitz E.M., Pitaevskii L.P. *Physical Kinetics.*– Oxford: Pergamon Press, 1981, 452p.