

## Hydrodynamic states of photons in equilibrium medium

G. Orlovsky, A. Sokolovsky and A. Stupka

*Dnipropetrovsk National University, Department of Theoretical Physics, 72  
Gagarin Ave, 49010 Dnipropetrovsk, Ukraine, E-mail: alexsokolovsky@mail.ru*

Hydrodynamic states of photons in equilibrium plasma medium are investigated on the basis of kinetic equations for photon distribution function (DF)  $f_p^{\alpha\alpha'}(x, t)$  obtained in papers [1,2]. In the present work state of the photon system is described by temperature  $T(x, t)$  and drift velocity  $u_n(x, t)$  (variables  $\xi_\mu(x, t)$ ). The consideration starts from energy and momentum conservation laws which contain sources that leads to relaxations  $T \rightarrow T_0, u_n \rightarrow 0$  where  $T_0$  is temperature of the plasma. Temperature  $T(x, t)$  and drift velocity  $u_n(x, t)$  of the photon system are defined with the Plank distribution  $n_p(\xi) = (e^{\frac{\epsilon_p - p_n u_n}{T}} - 1)^{-1}$  connecting them with energy and momentum densities. In hydrodynamic states gradients of these variables are considered as small ones. Our investigation based on the Chapman-Enskog method in the framework of which DF  $f_p^{\alpha\alpha'}(x, t)$  is found in the form  $f_p^{\alpha\alpha'}(x, \xi(t))$  and is a functional of variables  $\xi_\mu(x, t)$ . Standard consideration in the presence of relaxation processes [3] assumes that zero order in the gradients contribution  $f_p^{\alpha\alpha'(0)}(x, \xi)$  to DF  $f_p^{\alpha\alpha'}(x, \xi)$  is given by the Plank distribution  $\delta_{\alpha\alpha'} n_p(\xi(x))$  (the local equilibrium assumption). Contrary to this idea, in the present work DF  $f_p^{\alpha\alpha'(0)}(x, \xi)$  is calculated in a perturbation theory in  $T - T_0, u_n$  considered as small quantities of the same order. It was found that  $f_p^{\alpha\alpha'(0)}(x, \xi) \neq \delta_{\alpha\alpha'} n_p(\xi)$  and *the local equilibrium assumption is not true*. This means that the above used *standard definition of variables  $T(x), u_n(x)$  should be changed*.

On this basis equation of photon hydrodynamics have been built. It was shown that self-consistent theory can be constructed only taking into account contribution of the Compton process into photon-charged particles collision integral obtained by Kompaneets [2].

[1] A.I. Akhiezer, S.V. Peletminsky, Doklady AN SSSR, 200, 1317 (1971)(in Russian).

[2] A.S. Kompaneets, ZhETF, 31, 876 (1956) (in Russian).

[3] A.I. Akhiezer, V.F. Aleksin, V.D. Khodusov, Low Temp.Phys., 20, 939 (1994); 21, 1 (1995).