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Linear-in-gradients hydrodynamic equations for a system with small interaction

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The system under consideration is a one-component weakly non-uniform gas with small potential interaction. The investigation is based on the kinetic equation in the case of small interaction with a nonlocal collision integral [1]. In [2] it is shown that the system kinetic energy is not conserved on the basis of the nonlocal collision integral. So the system temperature should be defined on the basis on the total system energy rather than the kinetic one. The following hydrodynamic equations are obtained up to the first order in small gradients and the second order in small interaction:

$$\frac{\partial n}{\partial t} = -n\frac{\partial \upsilon_n}{\partial x_n} - \upsilon_n \frac{\partial n}{\partial x_n}, \quad \frac{\partial \upsilon_n}{\partial t} = -\upsilon_l \frac{\partial \upsilon_n}{\partial x_l} + \left[-\frac{T}{nm} - \frac{1}{m}V\left(k=0\right) + \right.$$

$$\left. + \frac{1}{2\pi^2 mT}\left(A + \frac{B}{3}\right)\right]\frac{\partial n}{\partial x_n} + \left[-\frac{1}{m} - \frac{n}{4\pi^2 mT^2}\left(A + \frac{B}{3}\right)\right]\frac{\partial T}{\partial x_n},$$

$$\frac{\partial T}{\partial t} = \left[-\frac{2}{3}T + \frac{n}{9\pi^2 T}\left(A + \frac{B}{2}\right)\right]\frac{\partial \upsilon_n}{\partial x_n} - \upsilon_n \frac{\partial T}{\partial x_n},$$

$$A = \int\limits_0^\infty dk k^2 V^2\left(k\right), \quad B = \int\limits_0^\infty dk k^3 V\left(k\right)\frac{\partial V(k)}{\partial k}$$

where n is the particle number density, υ_l is the velocity, T is the temperature, and $V(k)$ is the Fourier transform of the system pair potential. In fact, these equations are non-dissipative hydrodynamic equations and in the leading-in-interaction order they coincide with corresponding equations in the framework of standard hydrodynamics. The obtained equations may be a basis for the investigation of the system dissipative hydrodynamics and system kinetic coefficients.

[1] A.I. Akhiezer and S.V. Peletminsky, Methods of Statistical Physics, Oxford, Pergamon Press, 1981, 376 p.
[2] V.N. Gorev and A.I. Sokolovsky, Visnik Dnipropetrovs'kogo Universitetu. Seria Fizika, radioelektronika, 25, issue 24, 14 (2017).

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