Correlations and nonlocal electrons distribution function.

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Many processes occurring in discharge plasma in strongly non-equilibrium. The particles distribution function in phasal space can differ from of Maxwell`s function and Druyvesteyn`s function. Nondiffusion character of transfer high-speed electrons researched with help autocorrelation function of velocity $K(t)$. Let us get integral equation for ballistic electron distribution function: $K(t) = \int_0^{v<r/t} W(vt)F(v)dv$. Let us get solution this equation in form Levi's function: $F(V) \propto \frac{1}{V^{a}} \exp(-\frac{1}{V^{\beta}})$. Using the idea of probability theory, one can to show how degrees asymptotics go in "complete" particles distribution function. This will extend "class" of used in kinetic of discharge distribution function.

1.Ballistic particles and "tails"

Maxwell's distribution requires a great number of collisions of particles. Collisions are "destroying" correlation. In case of rare collisions, particles distribution function by velocity must be connected with autocorrelation function. We consider utmost case: particles are moving without collisions in one-dimensional space with R- dimension. The autocorrelations: B(t)=$\frac{\langle v v_0 \rangle}{(v_0)^2}$ for a particle which has reached the wall in the time t, here $v_0 = \frac{R}{t}$, is: $B(t) = \int_0^{v<v_0} \frac{vt}{R} F(v)dv$. Notice, that Klausius probability is: $W = \exp\left(-\frac{vt}{R}\right) \approx \left(1 - \frac{vt}{R}\right)^N \Big|_{N\to\infty}$. In our case $N \to 1$. Then functional adopts form:

$$K(t) = \int_0^{v<v_0} \left\{1 - \frac{vt}{R}\right\} F(v)dv = 1 - B(t)$$

K(t) - describes the correlation of the velocity for particles flying from region's border. Let us find the decision of this integral equation:

$$F(v) = \frac{R^2}{2v^3} \frac{d^2}{dt^2}\left(1 - B(t)\right) \Big|_{t=R/v}$$

The method of emitting particles is "source" of the nonequlibrium.

In ballistic case we expect effects with great correlation. Then : $K(t) \propto \left(\frac{t_0}{t}\right)^{\beta}$, $F(v) \propto \frac{1}{v^{1-\beta}}$

In case of Markov's process of emitting particles: $K(t) \propto \exp\left(-\frac{t}{t_0}\right)$, $F(v) \propto \frac{1}{v^3}\exp\left(-\frac{1}{v}\right)$

These calculations shows how degree's "tails" are appearing at nonlocal particles distribution function. Notice, that the function $F(v) \propto \frac{1}{v^3}\exp\left(-\frac{1}{v}\right)$ is nonanalytic. This function cannot be calculated decomposition of kinetic equation.

2. Klausius particles and Levy function.

Let us consider the case of Klausius: $N \to \infty$

$$K(t) = \int_0^{\infty} \exp\left(-\frac{vt}{R}\right) F(V)dv$$

Then F(v) is the Mellin's transformation of the correlation function K(t). Now it is possible to use mathematical tables. Let us mark at once that for the Klausius case ($N \to \infty$) Maxwell's distribution function becomes for K(t) in form of probability integral.

As an example let us choose K(t) in Kolrauch's form (takes into consideration "memory" effects) : $K(t) \propto \exp\left(-\beta t^{1/2}\right)$, $F(v) \propto \frac{1}{v^{3/2}}\exp\left(-\frac{1}{v}\right)$

This function F(v) is called Levy function in probability theory. This function is used to describe the nonlocal diffusion in the coordinates space: $\frac{\partial n(x,t)}{\partial t} = \int_{-\infty}^{\infty} G(x-x')n(x',t)dx'$

Using Furie transformation by x and degree's model for G, we get: $n(k,t) \propto \exp\left(-|k|^a Ct\right)$

Here : a=2 -Gauss case diffusion, a=1/2 -Levy flights. In velocity space model problems for nonlocal transfer also have degree's "tail".