Study of the phenomenon of runaway electron based on the effective interaction potentials

M.M. Seisembayeva[1], E.O. Shalenov[1], Zh. Kossymkyzy[1], T.S. Ramazanov[1], K.N.Dzhumagulova[1]

[1] *IETP, al-Farabi KazNU, Almaty, Kazakhstan*

smm93.93@mai.ru

Nowadays, the mechanism of the appearance of runaway electrons and their behavior in the system are being intensively studied by scientists from many countries. Since the phenomenon of electron runaway occurs in different conditions such as in atmospheric (thunderstorms), in some astrophysical objects and also it takes place in power installations. It is an important problem in the realization of the thermonuclear fusion since the appearance of runaway electrons under certain circumstances can damage plasma installations. In order to prevent (mitigate) this, extensive theoretical and computer studies of the electron runaway phenomenon are required. This problem was firstly considered and analyzed numerically in Dreiser's works [1].

In the work [2], the influence of electron-ion, electron-electron collisions on the friction force acting on runaway electrons in plasma is investigated. To describe pair interactions of electrons with plasma particles (electrons, ions), effective interaction potentials were used. These potentials take into account the effects of diffraction at short distances and the effect of dynamic screening at large distances. On the basis of these effective potentials, the collisional properties of the dense nonideal plasma were investigated, namely, the scattering cross sections of particles and the collision frequency. The method of phase functions was used, where phase shifts were calculated based on the solution of the Calogero equation. In turn, the phase shifts made it possible to calculate the transport scattering cross sections. As a result of the numerical investigation, the dependences of the electron mean free path and the friction force on the plasma density and the coupling parameter are calculated. Dreicer electric field was obtained by friction force acting on the electrons. A comparison of the data obtained taking into account static or dynamic screening was also carried out. The results are shown that in the case of dynamic screening the runaway of electrons requires higher values of the minimum electric field than for the case of static screening.

[1] H. Dreicer, Phys. Rev. 115, 238 (1959); 238, 329 (1960).

[2] M.N. Jumagulov, M.M. Seisembayeva, E.O. Shalenov, Zh. Kossymkyzy, T.S. Ramazanov, K.N. Dzhumagulova, High Energy Density Physics 36, 100832 (2020).