Electron runaway in the dense semiclassical plasma based on the effective interaction potentials

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The importance of runaway electron production in plasma was recognized more than a half century ago in the seminal work by Dreicer [1], followed by enlightening subsequent studies by Gurevich [2]. The initial nonrelativistic results [1-2] have been generalized to the relativistic case by Connor and Hastie [3]. The mechanism of runaway electron formation in plasmas has recently become of particular importance for reaching subnanosecond electron beams with large current amplitudes at atmospheric pressure. In this connection one needs to analyze the probability of the electron runaway in a system when investigating the physical properties of nonideal plasma under an external electric field.

In recent years, we have developed effective interaction potentials [4] that take into account the quantum-mechanical diffraction effect and the dynamic screening effect (depending on the velocity of colliding particles). The collisional (particle scattering cross section, collision frequency), transport (electrical conductivity) and optical (reflection coefficient) characteristics of the dense nonideal plasma based on these effective interaction potentials of the particles were investigated. In this work the electron runaway in partially ionized hydrogen plasma has been investigated on the basis of the effective interaction potential (taking into account static or dynamic screening and diffraction effects) [4-5]. In the framework of these effective potential models for the particle interactions, the scattering phase shifts were calculated on the basis of the Calogero equation [6] . Phase shifts enabled us to calculate the transport scattering cross section. Semiclassical method was used for the calculation of the collision frequency. Dependences of the electron free path on plasma density and nonideality parameters were obtained. The impact of the relative number of runaway electrons on their velocity and temperature was considered. It was shown that for the defined intervals of the strongly coupled plasma parameters, the relative numbers of runaway electron is very important. The comparison of the results obtained with taking into account of static or dynamic screening was maid.

References

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