Investigation of electron runaway process on the basis of effective potential taking into account dynamic screening

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Synopsis In this work, the phenomenon of electron runaway in dense semiclassical plasma was investigated on the basis of the effective interaction potential, which takes into account dynamic screening and the quantum mechanical effect of diffraction. Using the method of phase functions, the transport cross sections for scattering of electrons by ions and other electrons were calculated; on their basis, the mean free path of electrons was determined for various values of the density and coupling parameters.

The electron runaway phenomenon has attracted great attention in many areas of plasma physics. In astrophysics, the role of high-energy electrons in a gamma-ray burst during a supernova is well known. Also energetic electrons can appear as a result of the acceleration of electrons during a solar flare. Under atmospheric conditions, runaway electrons are observed in electrical discharges associated with thunderstorms, where they can cause electrical breakdown. It was also found that electrons with energy $\geq MeV$ can cause serious problems in power plants, for example, the presence of runaway electrons in the plasma of fusion reactors, namely in a tokamak, under certain circumstances is one of the main obstacles to the implementation of the production of fusion energy. It should be noted that these fast electrons underlie many studies in modern laser physics. This is due to the fact that in the interaction of laser radiation of relativistic intensity with a plasma, most of the energy is spent on accelerating electrons.

In the work, we used the original potential for interaction between an electron and an atom that we developed earlier in [1–5]. This effective potential takes into account the quantum mechanical effect of diffraction at small distances, because of which it has a finite value at distances close to zero.

Figure 1 show the reduced Dreiser's critical electric field as a function of the coupling parameter at a fixed value of rs = 4. The dependences show that with decreasing temperature, higher values of the Dreiser's critical field are required for electron runaway.

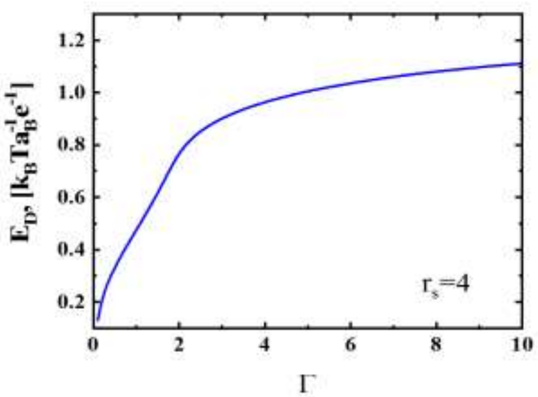

Figure 1. Electric field as a function of the communication parameter.

References

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