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1. FUNDAMENTALS AND MODELING OF PLASMA PROCESSES, PLASMA DYNAMICS, TRANSPORT, OPTICAL AND THERMODYNAMIC PROPERTIES OF PLASMAS

ELECTRON CAPTURE IN THE DENSE NONIDEAL PLASMA ON THE BASIS OF THE EFFECTIVE POTENTIAL

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Introduction

Investigation of the interaction between particles and plasma properties is of great interest in many areas of physics such as atomic and plasma physics. Also, it is important for the development of the plasma technologies. One of the elementary processes in plasma is the electron capture process due to electron and atom collision. The process of the electron capture by an atom was investigated in many studies /1-5, 9/. In this paper electron capture by the hydrogen atom was considered. The neutral hydrogen atom can be transformed into the negative hydrogen ion due to polarization electron capture. The negative hydrogen ion plays an important role in partially ionized plasmas; also it is used for high energy accelerators and for the neutral beam injection systems of fusion devices. In work /5/ the electron capture cross section was theoretically evaluated in the framework of the perturbation theory, where unperturbed linear trajectory of the projectile was considered.

In this work we used the interaction potential between the electron and the atom in partially ionized hydrogen plasmas, which was presented in works /6-8/. This effective potential, taking into account the quantum-mechanical effects of diffraction of particles and plasma screening effects, has finite values at the distance close to zero. It has the following form:

$$\Phi_{ea}(r) = -e^2\alpha\left(e^{-Br}(1+Br) - e^{-Ar}(1+Ar)\right)^2 \Big/ \left(2r^4\left(1-4\lambda_{ea}^2/r_d^2\right)\right), \qquad (1)$$

where $A^2 = \left(1+\sqrt{1-4\lambda_{ea}^2/r_D^2}\right)\Big/\left(2\lambda_{ea}^2\right)$, $B^2 = \left(1-\sqrt{1-4\lambda_{ea}^2/r_D^2}\right)\Big/\left(2\lambda_{ea}^2\right)$. Here, $\lambda_{ea} = \hbar/\left(2\pi\mu_{ea}k_BT\right)^{1/2}$ is the de Broglie wavelength, $r_D = \sqrt{k_BT/(4\pi ne^2)}$ is the Debye length, k_B denotes the Boltzmann constant, $\mu_{ea} = m_e m_a/\left(m_e+m_a\right) \approx m_e$ is the reduced mass of the atom and electron pair, α is the polarizability of the atom. For hydrogen atom it equals $4.5a_B^3$, $a_B = \hbar^2/\left(m_e e^2\right)$ is the Bohr radius.