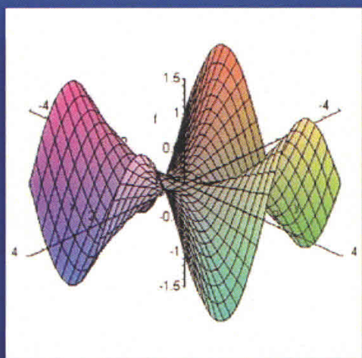
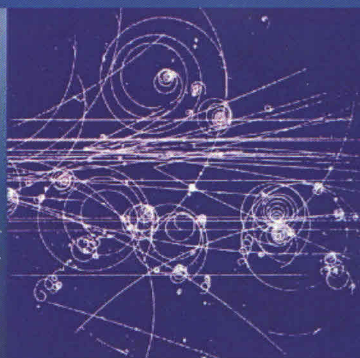
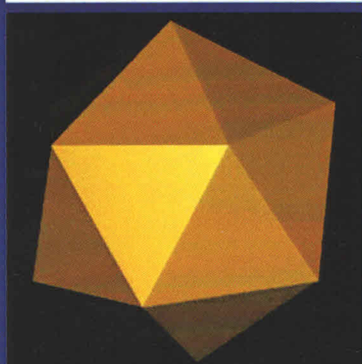
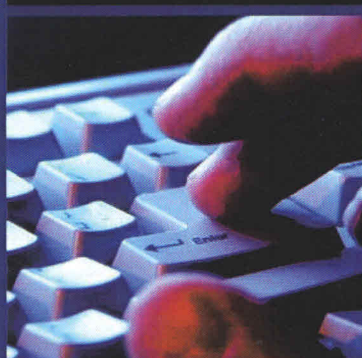
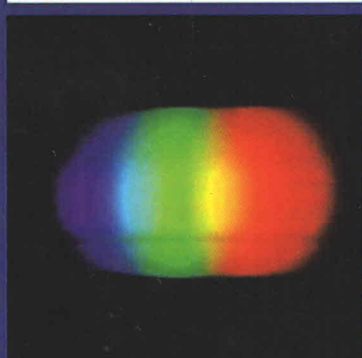
VOLUME 7 NUMBER 1 2016 ISSN 2218-7987

International Journal of Mathematics and Physics

Al-Farabi Kazakh National University

UDC 539.9.01

*Shalenov E.O., Dzhumagulova K.N., Ramazanov T.S., Gabdullina G.L.

Al-Farabi Kazakh National University, IETP, al-Farabi 71, 050040 Almaty, Kazakhstan
*e-mail: shalenov.erik@mail.ru

Influence of dynamic screening on the scattering cross sections of the particles in the dense nonideal plasmas of noble gases

Abstract: Within the dynamic screening potential model, elastic scattering processes between electrons and atoms in partially ionized plasmas were investigated using the method of phase functions. The phase shifts were calculated by solving the Calogero equation. Differential and total cross sections for the scattering of electrons on noble gas atoms were calculated and compared with experimental and other theoretical data. It was shown that the polarization potential is adequate for description the interaction between charged and neutral particles in partially ionized plasma. Analysis of the results showed that the phase shifts of electron atom scattering obtained with taking into account the dynamic screening are larger than the data obtained with consideration of static screening. The results can be used to calculate the various transport coefficients of the semiclassical dense plasma.

Key words: scattering cross section, dynamic interaction potential, dense nonideal plasma, phase shift, noble gases.

Introduction

Elastic scattering of electrons on atoms is a fundamental process that continuously attracts the attention of researchers. A large number of various theoretical and experimental studies of elementary processes is devoted to the elastic scattering of electrons on noble gas atoms. Reaction cross section are valuable since they provide information on how particles collide and interact. They are needed to describe transfer processes within partially ionized plasmas. For those practical applications where plasma is a working medium, one needs adequate data on physical properties of the system. Various theoretical methods are used in plasma investigations; one of them employs pseudopotential models that adequately describe the effective interaction between the plasma constituents. In the present work we consider collisional processes in plasmas of complex composition on the basis of the static potential and dynamic potential for the electron-atom interaction. In this work we used the effective potential of electron atom interaction presented in works [1-3] and considering the effects of screening and diffraction:

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

where

$$A^2 = \left(1+\sqrt{1-4\lambda_{ea}^2/r_D^2}\right)\Big/2\lambda_{ea}^2,$$

$$B^2 = \left(1-\sqrt{1-4\lambda_{ea}^2/r_D^2}\right)\Big/2\lambda_{ea}^2.$$

$\lambda_{ea} = \hbar\big/\sqrt{2\pi\mu_{ea}k_BT} \approx \lambda_e$ is the de Broglie thermal wavelength; $\mu_{ea} = m_e m_a/(m_e+m_a)$ is the reduced mass of the atom and the electron; $r_D = \left(k_BT/\left(8\pi e^2 n_e\right)\right)^{1/2}$ is the Debye length; n_e is the numerical density of electrons; T is the plasma temperature; k_B is the Boltzmanns constant, α is the atomic polarizability. Potential (1) is screened and has finite values at the distances close to zero.

Collision cross sections directly depend on the relative velocity of the colliding particles, contained in the equations for their calculation. The energy of the static interaction usually does not depend on this velocity. This consideration is not entirely correct, and accounting of the influence of the different dynamic effects, in particular, the dynamic screening of the incident charges field, on the interaction energy of the particles is more consistent

International Journal of Mathematics and Physics
Semiannual Journal of the al-Farabi Kazakh National University

Volume 7 Number 1 2016

Contents