Data Needs for Low Temperature Plasmas and Accelerator Applications

Igor Kaganovich

Princeton Plasma Physics Laboratory, Princeton University, Princeton, NJ 08543 USA

Abstract. I will describe the needs for scattering, ionization and charge exchange cross sections for the modeling of low temperature plasmas and accelerator applications. These applications require wide range of data in an approximate form that can be used in Monte Carlo procedures. Examples of such description are given in Ref.1 for low temperature plasmas for differential electron scattering in He and Ref.2 for accelerator applications for charge changing (stripping and ionization) collisions between a fast ion and an atom. An analytical approximation for differential cross-section of electron scattering on helium atoms is introduced [1]. It is intended for Monte Carlo simulations, which, instead of angular distributions based on experimental data (or on first-principle calculations), usually rely on approximations that are accurate yet numerically efficient. The approximation is based on the screened-Coulomb differential cross-section with energy-dependent screening. For helium, a two-pole approximation of the screening parameter is found to be highly accurate over a wide range of energies. The values of ion–atom ionization and stripping cross-sections are frequently needed for many applications that utilize the propagation of fast ions through matter. When experimental data and theoretical calculations are not available, approximate formulae are frequently used. Reference [2] briefly summarizes the most important theoretical results and approaches to cross-section calculations in order to place the discussion in historical perspective and offer a concise introduction to the topic. Based on experimental data and theoretical predictions, a new fit for ionization cross-sections is proposed. The range of validity and accuracy of several frequently used approximations (classical trajectory, the Born approximation, and so forth) are discussed using, as examples, the ionization cross-sections of hydrogen and helium atoms by various fully stripped ions. A formulary of analytical approximations for cross-sections is presented.

ACKNOWLEDGMENTS

This research was supported by US Department of Energy and AFOSR.

REFERENCES

1. A. V. Khrabrov and I.D. Kaganovich, “Electron Scattering in Helium for Monte Carlo Simulations”, to be published in Phys. Plasmas (2012).
2. Igor D Kaganovich, Edward Startsev and Ronald C Davidson, New Journal of Physics **8,** 278 (2006).