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Cold electron collision of He, Ne and H_2

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1 Introduction

The scattering of low-energy electrons by atoms and molecules has been the subject of extensive experimental and theoretical investigations. The cross-section data concerning electron-atom or -molecule scattering are of great importance in understanding fundamental physics of the electron collisions and applications in many fields. When the collision energy becomes very low such as less than 100 meV, the de Broglie wavelength of the electron becomes very much greater than the typical size of an atom or a molecule. In this area so called "cold electron collisions" [1], the interaction tend to be governed by asymptotic long range potentials and the scattering of cold electron is a subject closely related to the field of cold atom collision.

Recently, we have developed a new method for producing an electron beam at very low energy for a cold electron collision experiment employing the synchrotron radiation (SR), i.e., the threshold photoelectron source [2-4]. In the present project, we have measured total cross-sections of electron scattering from He and Ne at very low energies [5]. Electron scattering from He and Ne provide ideal testing grounds for developing a general method for treating electron scattering from atomic targets. As a simplest collision system and due to its importance, a number of experimental and theoretical cross sections for low-energy-electron scattering from He have been reported. The theoretical cross sections which are now regarded as reference cross sections, have been confirmed at collision energies above 100 meV, only where conventional beam experiments using hot-filament electron sources can access. Since theoretical treatment becomes very difficult due to strong contribution of electron correlation and polarization at very low energies close to the zero energy limit, comparison of experimental and theoretical cross sections at very low energies would be necessary for critical assessment of the theoretical treatment. In addition, we also have extended the target to H_2, which is the simplest molecule.

2 Experiment

The experiment has been carried out at the beamline 20A of the Photon Factory, KEK. Present experiment utilizes the penetrating field technique together with the threshold photoionizaion of atoms by the synchrotron radiation. The threshold photoelectrons produced by the threshold photoionization of Ar are extracted by a weak electrostatic field formed by the penetrating field technique and formed into a beam. The intensity of the electron beam passing through the collision cell without any collision with the target are detected by the channel electron multiplier. The counting rates of the detected electrons in the presence and absence of target gas are converted to the total cross section for electron scattering according to the attenuation law.

3 Results and Discussion

Total cross sections for electron scattering from He and Ne at electron energies down to about 5 meV are shown in Fig. 1. A reasonable agreement was obtained between our cross-section values and the theoretically predicted cross sections even at the energies below 100 meV. The good overall agreement between present experimental cross sections and the standard theoretical cross sections for He in the cold electron collision regime show that modern treatment of the scattering calculation of the few body systems represents the asymptotic behavior of the interactions in an adequate way.

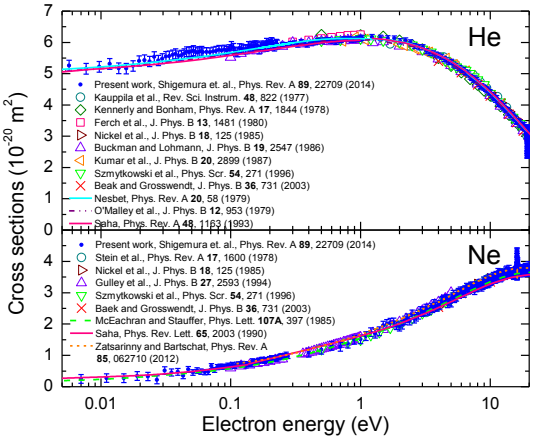

Fig. 1 Total cross sections of electron scattering from He and Ne.

References

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