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High resolution total cross section measurements of e^- - Kr collision utilizing the threshold photoelectrons

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Introduction

Collisions between electrons and atoms or molecules at very low-energy, where the de Broglie wavelength of an electron become much longer than the typical size of target particles, show unique quantum effects[1]. Recently, experimental technique for measuring the total cross section of the electron-molecule collisions at very low energy of below a few hundred meV (a few thousand kelvin) was developed by Field *et al.* In their technique, mono-energetic photoelectrons produced in the photo-ionization of atoms by monochromatized Synchrotron Radiation (SR) were used as an electron beam source, instead of a conventional hot filament. The photoelectrons were collected with a weak constant field applied across the photoionization region. However, it is necessary for their technique to use a special beamline dedicated for the electron beam production, because the energy width of the electron beam depends on the spot size and the band width of the monochromatized SR, which are trade-off between the photon flux of the excitation photon beam.

Here we present a new setup, which, utilizes the threshold photo-electron produced by SR, in order to achieve both high intensity and narrow energy width of the low energy electron beam, without using a specially constructed SR beamline.

The apparatus

The photon beam for the production of the threshold photoelectrons was provided by the synchrotron radiation source of the KEK-PF BL-20A. In the present technique, the penetration field was applied to correct only the “0” energy photoelectrons which was developed as a highly efficient spectroscopic tool known as threshold electron spectroscopy[2]. A weak and wide potential well, formed in the interaction region by field penetration from the potential of an extraction electrode through a screening electrode, collects only the low-energy electrons and produce a beam with very small emittance. Because of the high selectivity for the low-energy electrons of this technique, the energy broadening of the electron beam does not depend on the size of the SR beam so much. Electron beam are focus into the collision cell filled with the target atoms or molecules. Total cross section for electron collisions with target can be obtained by the bean attenuation method.

Results

Figure 1 shows the total cross section of Kr over the energy range from 20meV to 12eV obtained in the present work, together with previous experimental works. As can be seen in figure1, the present results agree well with the known cross sections including the Ramsauer–Townsend minimum appeared in the low energy region below 1 eV. A weak Fano type structure due to the Feshbach resonance of Kr was also clearly seen in figure 1. The resonant structure of the Feshbach resonance of the total cross section of Kr has been obtained for the first time.

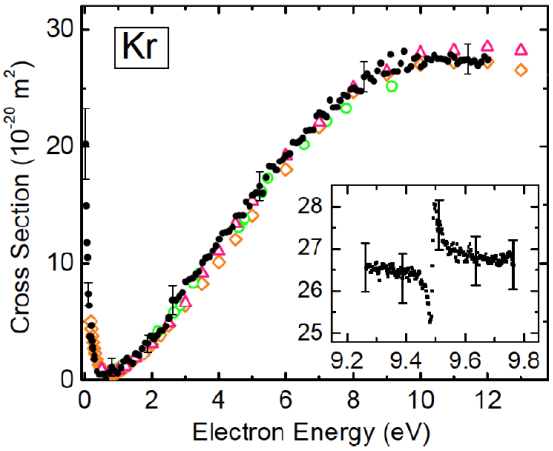

Figure1. Total cross section of Kr. ● ; present result, ○ ; Ref[3], ◊ ; Ref[4], Δ; Ref[5]. Blow up of the measured cross section at around the Feshbach resonance is shown in the insert.

References

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