

High-resolution total cross section measurements for electron scattering from hydrogen molecule at around the Feshbach resonances

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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. Electron scattering from hydrogen molecule has been extensively studied both theoretical and experimentally as a simplest system for electron scattering from a molecule. A large number of papers have been published to report data for the total cross sections and differential cross sections for electron scattering from H₂ and several recommended cross section data set were also published such as Ref. [1]. Total cross section curve for low-energy electron scattering from H₂ is dominated by a wide structure-less maximum at around 3 eV known as the ²Σ shape resonance which is a consequence of the formation of temporary negative ion, i.e., H₂⁻ with very short lifetime. At higher energies, a series of weak sharp structures due to another type of resonance, i.e., Feshbach resonances have been observed in the transmission experiments. Feshbach resonances of H₂ at around 11- 15 eV have attracted number of theoretical work up to now [2]. In the present work, measurements of total cross sections of electron scattering from H₂ at electron energies including the Feshbach resonance region with a very high resolution were carried out,

2 Experiment

The experiment has been carried out at the beamline 20A of the Photon Factory, KEK. Present experiment employs the threshold photoelectron source [3] utilizing the synchrotron radiation (SR) which utilizes the penetrating field technique together with the threshold photoionization of noble gas atoms by the SR. 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 was detected by the channel electron multiplier. The counting rates of the detected electrons were measured as a function of the number density of the target gas filled in the gas cell in order to

obtain the total cross section for electron scattering according to the attenuation law.

3 Results and Discussion

Total cross sections for electron scattering from H₂ at electron energies from 20 eV down to about 100 meV obtained in the present work are shown in Fig. 1 together with previously reported experimental cross sections. A reasonable agreement was obtained between present cross-section values and the previous results. In the present measurement, the oscillatory structure of the Feshbach resonance at around 11 - 13 eV was successfully observed on the total cross-section curve. The observed structure consists of at least two negative ion states with vibrational progressions.

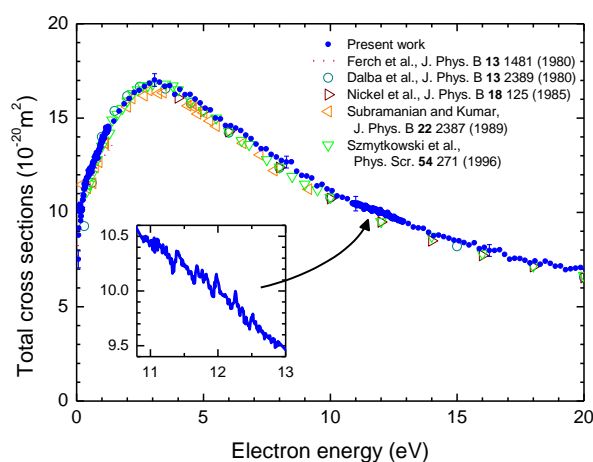


Fig. 1 Comparison of the total cross sections for electron scattering from H₂. Inset shows blow up of the total cross sections obtained at around the Feshbach resonance region.

References

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