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Angle-resolved detection of metastable H(2s) fragment for investigating superexcited states of acetylene

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1 Introduction

Superexcited states of molecules play critical roles as intermediates in a wide range of reactions such as dissociative recombinations, associative ionizations and Penning ionizations. The spectroscopical and dynamical studies of the superexcited states are of great importance in understanding these reactions. Recently, we have developed a new method based on the angle-resolved detection of metastable H(2s) atom as a dissociation fragment for investigating the formation and decay of the superexcited states. Since, for liner molecules, $\Sigma \rightarrow \Sigma$ and $\Sigma \rightarrow \Pi$ transitions are likely to occur when the molecular axis is parallel and perpendicular, respectively, to the electric field vector of the incident light, the method enables us to obtain the cross sections, σ_{2s}, as a function of the incident photon energy with the symmetry of the electronic states of the intermediate superexcited states, Σ or Π, being selected [1]. In the present study we have applied the method to acetylene.

2 Experiment

The experiment was carried out at BL-20A of the Photon Factory, KEK. Linearly polarized synchrotron light was introduced into the gas cell equipped with the detection system for H(2s) atoms which is composed of a stack of parallel plate electrodes creating a localized electric field and triggers the emission of the Lyman-α photon from the atom and a chevron pair of microchannel plates that detects the photon (see Fig.1) [1]. The gas cell and the detection system can be rotated around the axis of the incident photon beam.

3 Results and Discussion

The cross sections for the formation of H(2s) fragment of C_2H_2 are shown in Fig. 2 as a function of the incident photon energy due to the $\Sigma \rightarrow \Sigma$ transition. From energy positions of $C_2H_2^+$ [2, 3] as the ion core of the superexcited states, the states around 23 eV seen in Fig. 2 would be the $(2\sigma_g)^{-1}(np\sigma_u)$ state of C_2H_2.

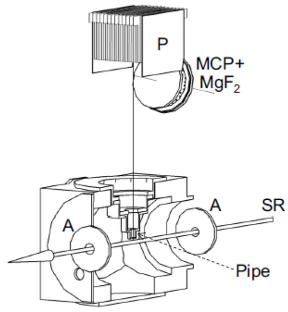

Fig. 1 Schematic of the experimental apparatus.

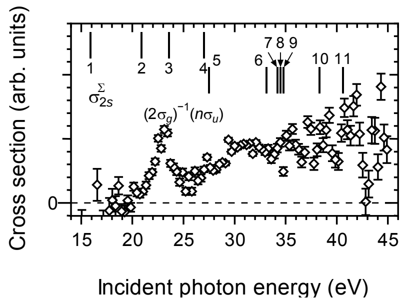

Fig. 2 The cross sections for the formation of H(2s) fragment, σ_{2s}, of C_2H_2 due to the $\Sigma \rightarrow \Sigma$ transition. Vertical bars represent dissociation limits to form H(2s) fragment.

References

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