Cross sections for the formation of H(2p) atom via doubly excited states in photoexcitation of rotationally cold H_2

Y. Abe*[1], T. Odagiri*[2], S. Ohrui*, T. Taniguchi*, T. Shiratori*, M. Kaida*, K. Yachi†, Y. Kumagai†, K. Hosaka†, M. Kitajima†, and N. Kouchi†

*Dept. of Materials and Life Sciences, Sophia University, Chiyoda-ku, Tokyo 102-8554, Japan

†Dept. of Chemistry, Tokyo Institute of Technology, Meguro-ku, Tokyo 152-8551, Japan

Synopsis Cross sections for the formation of H(2p) atom in photoexcitation were measured for H_2 in the lowest rotational level in the energy range of the doubly excited states for examining contribution of the non-adiabatic transition between the ${}^1\Sigma_u - {}^1\Pi_u$ doubly excited states.

Competing decay of doubly excited states of H_2 has been theoretically and experimentally investigated [1]. Recently, it was found that the non-adiabatic transition would play a role in the dissociation of the $Q_2\,{}^1\Pi_u$ doubly excited states of H_2 and D_2 [2,3]. In the present study, we measured cross sections for the formation of H(2p) fragment in photoexcitation of para-H_2 in the lowest rotational level, $J''=0$, for a detailed piece of information against the non-adiabatic transition. Only the ${}^1\Pi_u^+$ states as well as the ${}^1\Sigma_u^+$ states are populated in photoexcitation from the lowest rotational level of the ${}^1\Sigma_g^+$ ground state [4]. On the other hand, many rotational level ($J''=0,1,2,3$) are involved for ordinary-H_2 at room temperature and all the dipole allowed states (${}^1\Pi_u^\pm$ and ${}^1\Sigma_u^+$) can be formed in photoexcitation. It is thus expected that the cross section for the rotationally cold H_2 could be different from those for ordinary-H_2 since the ${}^1\Pi_u^\pm$ states interact with the ${}^1\Sigma_u^+$ states differently with each other due to the Kronig's selection rule [4].

The experiments were carried out at BL20A of the photon factory, KEK. A gas of H_2 in the lowest rotational level was obtained by a cryogenic ortho-para hydrogen converter. The gas cell was kept at approximately -186℃ by using liquid-N_2 during the measurement. The rotational distribution in the sample was checked through measuring high-resolution photo-ion yield spectra.

Figure 1 shows the cross sections for the formation of H(2p) fragment for H_2 in the lowest rotational level, $J''=0$. The shape of the cross section curve agrees with that for ordinary-H_2 at room temperature within the statistical uncertainty.

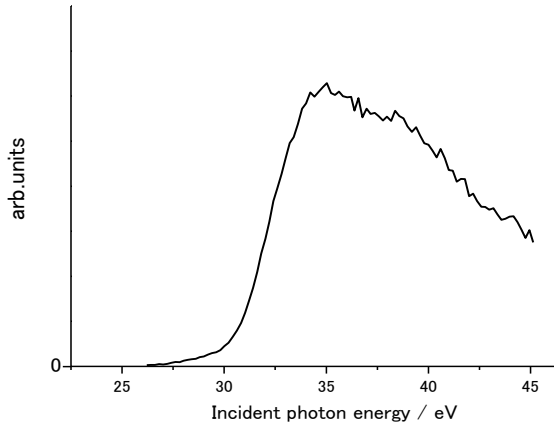

Figure 1. Cross sections for the formation of H(2p) fragment in photoexcitation of H_2 in the lowest rotational level

References

[1] N. Kouchi *et al*., J. Phys. B **30**, 2319(1997); M.Glass-aujean and H. Schmoranzer, J. Phys. B **38**, 1093(2005)
[2] T. Odagiri *et al*., Phys. Rev. A **84**, 053401 (2011)
[3] K. Hosaka *et al*., Phys. Rev. A **93**, 063423 (2016)
[4] G. Herzberg, Molecular spectra and molecular structure: I. Spectra of Diatomic molecules (New York: Van Nostrand)

[1] E-mail: yuta-abe.64@eagle.sophia.ac.jp
[2] E-mail: odagiri.t@sophia.ac.jp