

Doubly excited states of ethylene in the vacuum ultraviolet range as studied by dispersed uv-visible fluorescence spectroscopy

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Introduction

Superexcited states play an important role in the photoabsorption of molecules in the vacuum ultraviolet range [1]. One of the hot topics concerning these states is the dynamics and spectroscopy of doubly excited states [2,3]. Less has been known about the doubly excited states of polyatomic molecules compared with those of diatomic molecules. We were successful in observing the doubly excited states of methane in the cross section curves of uv-visible fluorescences from dissociation fragments in the photoexcitation of methane [4]. In the present experiment, we have measured the cross sections for the emission of fluorescences emitted by dissociation fragments in the photoexcitation of ethylene (C₂H₄) as a function of incident photon energy in the range of 15 – 40eV.

Experimental

Synchrotron radiation dispersed by a 2400 lines/mm grating in the 3m-NIM at BL-20A was used as an incident light source. Fluorescences emitted by the neutral fragments produced in the photoexcitation of ethylene were dispersed by a 300mm uv-visible monochromator equipped with a 300lines/mm grating and a CCD detector [4]. This liquid N₂-cooled CCD detector covers the wavelength range of which width is 280nm in one frame. Several fluorescence lines and bands were observed in the fluorescence wavelength range of 350 – 680 nm. Among them, cross sections for the CH(A,B → X), Balmer-β, γ, δ, and ε, and C₂(d → a, Δv = -1, 0) fluorescences were put on an absolute scale using the N₂⁺(B) partial ionization cross section as described in reference [4].

Results and Discussions

In Fig. 1 the cross sections for the emission of (a) the CH(A → X) and (b) Balmer-β fluorescences in the photoexcitation of ethylene are plotted against the incident photon energy along with the lowest dissociation limits for the neutral dissociation and dissociative ionization processes involved.

Peaks indicated by arrows in Fig. 1 are attributed to the superexcited states of ethylene. The peaks around 27 eV in Fig. 1(b) seem to originate from doubly excited states of ethylene since they lie above the ionization threshold of the inner-most valence electron as shown in the upper part of Fig.1 (b).

References

- [1] Y. Hatano, Phys. Reports, **313**, 109 (1999)
- [2] N. Kouchi *et al.*, J. Phys B, **30**, 2319 (1997)
- [3] T. Odagiri *et al.*, J. Phys. B, **29**, 1829 (1996);
N. Uemura *et al.*, J. Phys. B, **31**, 5183 (1998)
- [4] M. Kato *et al.*, submitted to J. Phys. B

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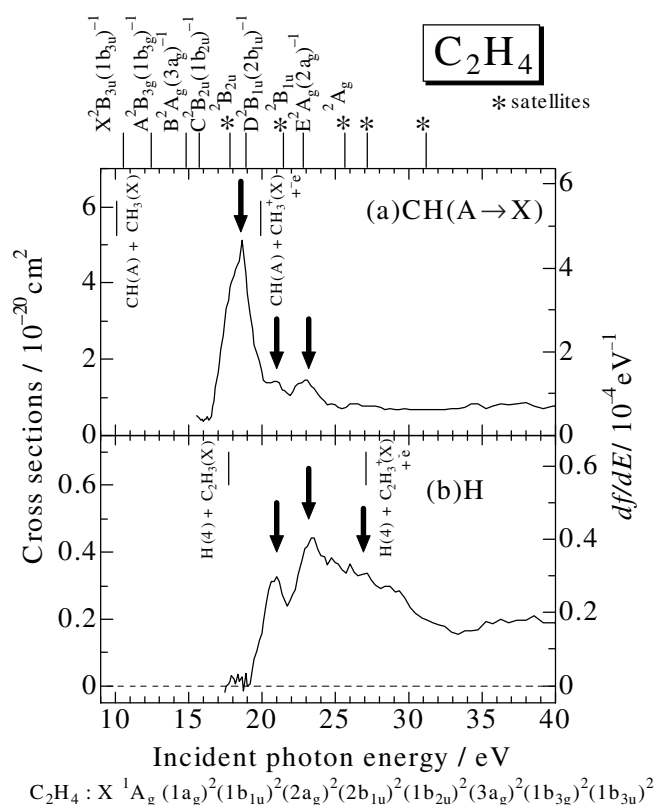


Fig.1 Cross sections for the emission of (a) the CH(A → X) and (b) Balmer-β fluorescences as a function of incident photon energy in the photoexcitation of ethylene. The oscillator strengths for the same processes are shown on the right axes. Vertical bars on the upper part of the figure indicate ionization potentials of ethylene. The lowest dissociation limits for the neutral dissociation and dissociative ionization processes involved are also indicated.