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Generation of a pair of photons through the three-body dissociation of a multiply excited H_2O around the double ionization potential

Takeshi ODAGIRI[*1], Motoyoshi NAKANO[1], Takehiko TANABE[1],
Yoshiaki KUMAGAI[1], Isao H. SUZUKI[2,3] and Noriyuki KOUCHI[1]
[1]Dept. of Chem., Tokyo Institute of Technology, Meguro-ku, Tokyo 152-8551, Japan
[2]KEK-PF, Tsukuba, Ibaraki 305-0801, Japan
[3]AIST, Tsukuba, Ibaraki 305-8568, Japan

Introduction

We have recently measured cross sections for the generation of a photon-pair from excited fragments in photoexcitation of N_2, NO, and O_2 as a function of incident photon energy and found that there exist inner-valence excited and multiply excited neutral states of these molecules that decay through neutral dissociations even above the double ionization potentials (double-IP) [1]. The present investigation is the first attempt to measure such cross sections of polyatomic molecules in the range around the double-IP.

Experimennt

The experiments were carried out at BL-3B of the Photon Factory, KEK. Linearly polarized synchrotron light was introduced into a gas cell filled with water vapor at the pressure of approximately 2 mTorr. Fluorescence photons emitted parallel to the electric vector of the linearly polarized incident light and opposite to one another were detected in coincidence using two photon detectors. Each photon detector is composed of an MgF_2 window and a microchannel plate, which provide the filter range of 115-150 nm. The fluorescence spectra measured at 200-eV electron impact on H_2O show an intense peak due to the Lyman-α photons from H atoms and relatively weak peaks due to fluorescence photons from O atoms in the wavelength range of the present photon detector [2]. Neither the fluorescence photons from H_2 nor those from OH in the wavelength range are observed in the electron impact study.

Results and discussion

Figure 1 shows the doubly differential cross sections for the generation of a pair of fluorescence photons in the photoexcitation of H_2O as a function of incident photon energy. The resonant peak around 30-45 eV is due to neutral excited states of H_2O. From the viewpoint of the energy of the resonant peak relative to the ionization potentials [3, 4] shown in the upper part of figure 1 the peak seems to be attributed to multiply excited states of H_2O. We note that the multiply excited states of H_2O around 30-45 eV dissociate into three neutral atomic fragments and some of them lie even above the adiabatic double-IP [5] as shown in figure 1.

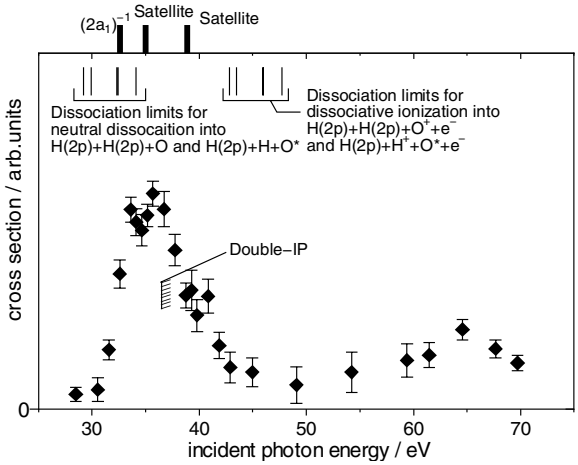

Figure 1 Cross sections for the generation of a pair of photons in photoexcitation of H_2O differential with respect to the solid angle for each photon. The vertical ionization potentials for the $(2a_1)^{-1}$ [3] and two-hole one-particle states [4] of H_2O^+ are displayed in the upper part by thick vertical bars. The adiabatic double-IP [5] and dissociation limits are indicated by thin vertical bars.

References

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* joe@chem.titech.ac.jp