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Dissociation Processes of the Xe_2^+ II(1/2u) state

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Introduction

Studies on the photoionization of rare gas dimers and their ions are important to understand the nature of the van der Waals interaction. We have already measured threshold photoelectron (TPE) spectra of Xe and observed vibrational structures of Xe_2^+[1]. After that, we found the II(1/2u) state of Xe_2^+ dissociates via optical transition to the I(1/2g) state[2].

Experiment

The measurements were carried out at the beamline 20A of the Photon Factory. The experimental setup and technique were same as our previous study [2]. In brief, photoelectrons extracted by a penetrating field were focused by a lens system and then led to a hemispherical electrostatic analyzer. The Time-of-Flight (TOF) ion mass analyzer enable us to select mass-identified photoions. The threshold photoelectron and photoion signals were fed into a time-to-amplitude-converter (TAC) as start and stop signals, respectively. Output signals of the TAC give TOF spectra.

Results

In contrast to our previous study on Kr_2^+[3], we could not eliminate the contamination of Xe trimer. To obtain the spectrum only from Xe_2^+, the TOF spectrum observed at the top of the peak of the vibrational progression of the Xe_2^+ II(1/2u) state was compared with that observed at the tail. In Fig. 1(a) are shown the TOF spectra at the top (blue) and tail (pink) of the vibrational peak of the Xe_2^+ II(1/2u) state (v=1). Although Xe_2^+ and Xe_3^+ contribute to the spectrum at the top, Xe_2^+ contributes to that at the tail. The subtraction of these spectra, therefore, gives the TOF spectrum for the dissociation products only from Xe_2^+. The obtained TOF spectrum for Xe_2^+ was shown in Fig. 1(b).

Discussions

Similar to our previous study [3], the kinetic energy of the fragment Xe^+ from the Xe_2^+ II(1/2u) state in the ionization region should be dominated by only one energy, which reflects the potential energy of the I(1/2g) state. In these cases, the TOF spectrum would have a rectangular peak, the width of which is decided by the kinetic energy of fragment ions. We found that the shape of the observed TOF peak could be made up by accumulation of the rectangular spectrum under considering the effect of the life time.

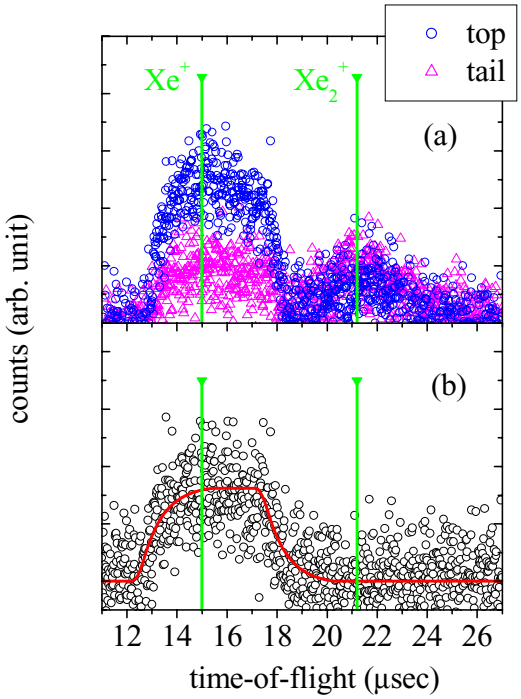

Figure 1. (a) The observed TOF spectrum at the top and tail of the vibrational peak of the Xe_2^+ II(1/2u) state. (b) The TOF spectrum for the dissociation products only from Xe_2^+ obtained by subtraction of the spectra in (a)

The result of the fitting is also shown in Fig. 1(b). From the fitting, the potential energy of the I(1/2g) state from the first dissociation limit and the life time of the radiative transition were obtained as ~73 meV and ~1.7 μsec. The obtained potential energy of the I(1/2g) state is comparable with the theoretical prediction[4].

References

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