Instrumentation and Technique

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Development of a toroidal photoelectron spectrometer

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Introduction

A toroidal photoelectron spectrometer is developing to study atomic and molecular physics in the Photon Factory. In the initial work, high detection-efficiency of electrons could be verified experimentally in the toroidal photoelectron spectrometer, however, the energy resolution of the spectrometer could not be exceeded 100 ($=E_{path}/\Delta E$) [1]. In the following work, it was verified by a two-dimensional position-sensitive detection (PSD) system of the spectrometer that the low energy-resolution is due to poor alignment of exit slits of the spectrometer [2]. In the present work, the high energy-resolution of 300 is achieved by realignment of the spectrometer and software techniques.

Experimental method

Experiments were carried out at the undulator beamline BL-2C. Auger electrons ejected by photoexcitation to the $1\pi^*$ (v=0) resonance of N_2 molecules were observed by the two-dimensional PSD system in the toroidal photoelectron spectrometer.

Results and discussion

Figure 1 shows a typical spectrum obtained by the observation. The two-dimensional image of the spectrum forms nearly a circular ring. The center of the ring is situated on the symmetrical axis of the toroidal electrodes, and the center corresponds to the ionization position crossing gases and photons. This ring disappears in four directions corresponding to shadows of four poles supporting the toroidal electrodes. If electrons ejected by photoexcitation have homogeneous angular-distribution, the image on the ring should be uniform distribution. It is expected that the image is uniform distribution in the present work. However, the ring exhibits heterogeneous distribution of four parts. It is conceivable that each image of the four parts arises from different path-energy of electrons in the inside of the spectrometer. To achieve the high energy-resolution, electron spectra of the four parts were measured separately. Figure 2 shows the four Auger electron spectra. Those spectra were calibrated to the A $^2\Pi_u$ Auger electrons, and were summed. The high energy-resolution of 300 is recognized in the sum spectra.

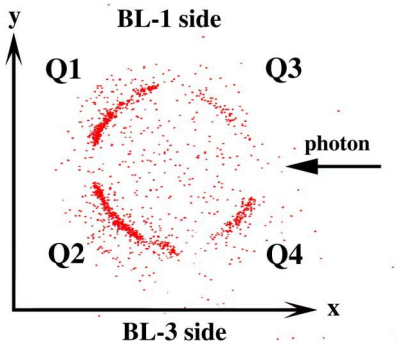

Figure 1. A typical spectrum of the A $^2\Pi_u$ Auger electrons observed by the two-dimensional PSD system. Symbols Q1, Q2, Q3 and Q4 signify four directions of the output signals from the PSD system. The directions of Q1 and Q3 are the side of BL-1, and those of Q2 and Q3 are the side of BL-3. The photon incident on the spectrometer is opposite in direction to the x-axis.

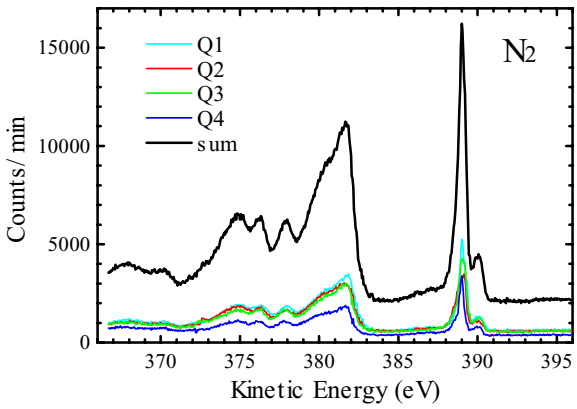

Figure 2. Auger electron spectra yield by photoexcitation to the $1\pi^*$ (v=0) resonance of N_2 molecules.

References

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[2] T. Hayaishi *et al.*, PF Activity Rep. **18**, 288 (2000).

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