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# Development of a toroidal photoelectron spectrometer

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## Introduction

A toroidal photoelectron spectrometer, well known as one of high-sensitivity spectrometers, has been developed for studying atomic and molecular physics. The toroidal photoelectron spectrometer is composed of a pair of deflecting electrodes with toroidal surfaces. Here the term toroidal surfaces means spherical surfaces of a ring shaped cylinder. High detection-efficiency of electrons could be verified experimentally in the previous study [1]. However, the energy resolution of the spectrometer could not be exceed 100 ($=E_{path}/\Delta E$). The origin of the low resolution may be due to alignment of the spectrometer. To verify the fact, we try to make a two-dimensional position-sensitive detection (PSD) system in the present spectrometer.

## Experimental method

The two-dimensional PSD system constitutes a microchannel plate (MCP) of an effective diameter of 40 mm and a PSD with four outputs. Plane coordinates (x, y) on the MCP are decided by two analog-digital converters after electron pulses caused on the MCP are divided by the PSD into the four outputs at right angles and the output signals are fed into dual-sum-and-inverters and two PSD analyzers. Experiments were carried out at the undulator beamline BL-2C. Auger electrons of A $^2\Pi_u$ ejected by photoexcitation to the $1\pi^*$ (v=0) resonance of $N_2$ molecules were observed by the two-dimensional PSD system.

## 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, however, disappears in four directions. The disappearance is ascribed to shadows of four poles supporting the toroidal electrodes. Hence, it is itself necessary. 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. Contrary to the expectation, the ring exhibits heterogeneous distribution. It is conceivable that the reason for the image is due to poor alignment of exit slits of the spectrometer. Thus, images obtained by the two-dimensional PSD measurements enable one to conjecture flight paths of electrons in the inside of the spectrometer. Consequently, we can expect to achieve high energy-resolution in the spectrometer through successive improvement of poor alignment found by the measurements.

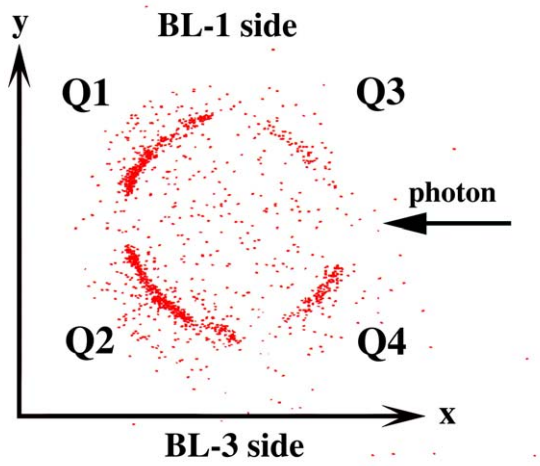


Figure 1. A typical spectrum of the A $^2\Pi_u$ Auger electrons observed by the two-dimensional PSD system. Symbols Q1, Q2, Q3 and Q4 signify four directions of the output signals from the PSD system. The directions of Q1 and Q3 are the side of BL-1, and those of Q2 and Q3 are the side of BL-3. The photon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

## References

[1] T. Hayaishi *et al.*, PF Activity Rep. **16**, 293 (1998).

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