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Measurements by a silicon avalanche diode for observation of NEET on ^{193}Ir

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Introduction

Nuclear excitation by electron transition (NEET) on ^{193}Ir in *K*-shell photoionization was observed with synchrotron radiation [1]. At BL-14A, measurements by a silicon avalanche diode and photodiodes were carried out to obtain parameters for NEET observation at SPring-8 and to calibrate the incident photon numbers for analysis of the NEET probability. The NEET on ^{193}Ir occurs between the $K(1S_{1/2})$: $M_I(3S_{1/2})$ atomic hole transition (72.937keV) and the 73.041-keV nuclear transition (3/2+ : 1/2+, half life: 6.09ns). Compared with NEET on ^{197}Au, the energy difference between the atomic and nuclear transitions is larger, 104 eV and the nuclear matrix element is smaller than that of ^{197}Au. Thus, the NEET probability for ^{193}Ir is expected to be 2.3×10^{-9}, less than one tenth of that of ^{197}Au [2].

Experiments

The silicon avalanche diode (Si-AD, Hamamatsu SPL4583) was used to detect internal-conversion electrons emitted from excited nuclei. The device was 3 mm in diameter and had a depletion layer 30μm thick. The energy spectra of the avalanche diodes were investigated at BL-14A. An X-ray beam from a Si(553) double crystal monochromator was defined to $^{H}1.0\times{}^{V}1.0$ mm. We used an iridium target that was made of metal powder on aluminum foil. The Si-AD was installed in a vacuum chamber for the NEET experiment and was located 2.5mm above the target. A charge-sensitive preamplifier, Canberra 2001A, was used to investigate energy spectra while a fast amplifier, Philips Scientific 6954, was used for NEET experiments. In order directly to measure a pulse-height distribution of the fast amplifier's outputs, we took a single-channel scanning method with a constant fraction discriminator and a scaler.

The estimation of the incident photon number was also important to decide the NEET probability. Photodiodes (silicon PIN-PD, 500μm thick) were used to monitor intensity of the incident X-rays. The photon numbers per PD's current were obtained from results measured at BL-14A.

Results

Figure 1(a) shows an energy spectrum measured by the charge-sensitive preamplifier at an incident X-ray energy of 73.041keV. The main peak by *L*-photoelectrons and peaks of *L* X-rays at 9-11 keV are seen. Figure 1(b) shows a pulse-height distribution by the fast amplifier, measured at the same energy of the incident X-rays. The peak of *L*-photoelectrons was seen as a main profile. By comparing the peak position of *L*-photoelectrons, the threshold level of the discriminator, which was selected for the NEET experiments and was –20mV, corresponded to 32keV. One can see that the profile of *L*-photoelectrons measured at the nuclear excited level of 73.041keV approximated to the spectrum of the *L*-internal conversion electrons. Therefore, a signal which energy was larger than 32keV contributed to the time spectrum in the *L*-internal conversion electrons detected by the Si-AD.

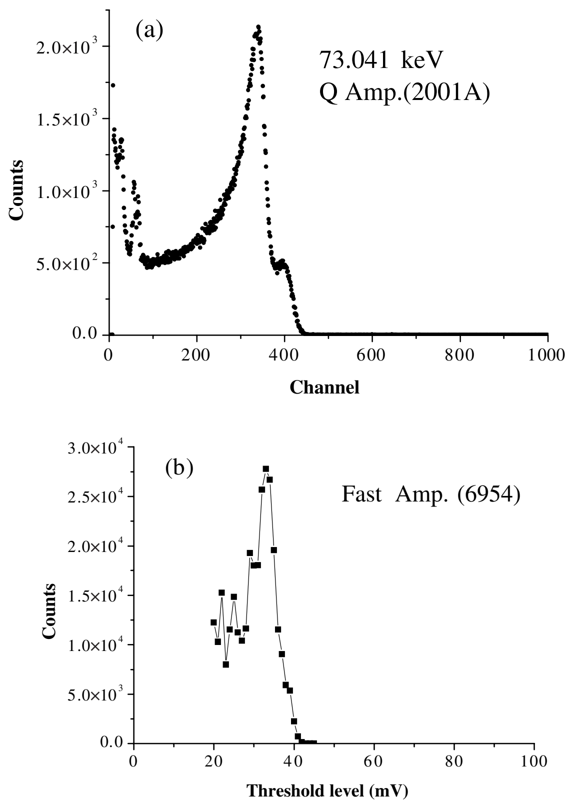

Fig. 1 Energy spectra of radiations emitted from the iridium target measured with (a) a charge-sensitive preamplifier and a normal spectroscopy system. Fig. 1(b) shows a profile measured with a fast amplifier by scanning threshold level of a discriminator. Energy of the incident X-rays was 73.041keV.

References

[1] S. Kishimoto et al., SPring-8 User Experiment Report No. 8 (2001B), p.67.
[2] E. V. Tkalya, private communications.

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