I. 20 Reduction of the Neutron-Induced $\gamma$-Ray Background in an ISOL Experiment by Making Use of a Beam Chopper

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When we study the nuclear decay of short-lived isotopes by means of ISOL (isotope separator on-line), $\gamma$-rays induced by the neutrons originating from the collision of the incident beam with the target and ion-source assembly make significant backgrounds to $\beta$- and $\gamma$-ray measurements. For reduction of these backgrounds it is expected to be useful to stop the incident beam at an upstream place distant from the isotope separator during the period as long as the life of the nucleus in question.

In an ISOL experiment of the decay of $^{59}$Zn ($T_{1/2}=182$ ms), produced by the $^{58}$Ni($^3$He,2n)$^{59}$Zn reaction, we have been successful in reducing the neutron-induced $\gamma$-ray background by chopping the $^3$He beam incident on a Ni target by making use of a "P chopper", an electrostatic beam deflector operated by applying rectangular voltage pulses.\(^{1}\) In correlation with the operation of P chopper, a micro-computer controlled the collection of mass-separated isotopes, the motion of collection tape and the measurement of activity.

Figure 1 shows a growth-decay curve of the A = 59 activities measured by counting the $\beta$-rays with a 75 cm$^3$ Ge(HP) detector. The curve was recorded by multi-channel scaling. During the first 0.4 s period of a cycle of 1.6 s, the $^3$He beam irradiated the target, and the mass-separated isotopes were accumulated on the tape at rest and the activities were measured with the detector fixed just behind the collection position. During the second period of 0.95 s, the $^3$He beam was intercepted from the target by the P chopper and the mass-separated isotopes from the collection tape by an electric deflector installed in the separator. At the beginning of the last period of 0.2 s the activities were removed from the detection position by moving the tape, and the irradiation of target started. The collection of isotopes on the tape started at the end of the cycle, i.e. at the beginning of the next cycle.

The present method is considered to be useful for ISOL study of short-lived isotopes having half-lives longer than ~30 ms.

Reference
Fig. 1. A growth-decay curve of $A = 59$ activities measured with the ISOL system operated as indicated in the upper part of the figure. B.G. stands for the background due to the $\gamma$-rays produced in the Ge(HP) detector by the neutrons generated at the target ion source.