NUCLEAR INSTRUMENTS AND METHODS 120 (1974) 199–200; © NORTH-HOLLAND PUBLISHING CO.

# FAST CALIBRATION OF LARGE Si(Li) ELECTRON DETECTORS FROM 511.0 TO 4564.0 keV USING DOUBLE-ESCAPE PEAKS AND COMPTON EDGES FROM $^{66}$Ga

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Received 13 December 1973

Double-escape peaks and Compton edges from the $\gamma$-rays of 9.5-h $^{66}$Ga have been used to allow fast, precise calibration of Si(Li) electron detectors. They allow a direct calibration up to 4564.0 keV, and the calibration curve is linear enough that it can probably be extrapolated safely to even higher energies.

In order to use the larger Si(Li) detectors (5–10 mm active depth) for $\beta$ and conversion-electron spectroscopy far from the region of $\beta$ stability, it is desirable to have a means of rapid energy calibration over a broad energy range. Although conversion electrons and Compton edges can provide quick calibrations up to 2 MeV, the use of $\beta$ endpoints to calibrate to higher energies is quite tedious. This occurs mainly because, in order to find a precise endpoint, one requires a knowledge of the spectrum shape as well as the efficiency for the detector.

The problem of having to use $\beta$ endpoints for calibration to higher energies can be obviated by use of the double-escape spectrum of $^{66}$Ga. $^{66}$Ga is a well-known high-energy $\gamma$-ray standard[1,2]) with transitions up to 4806.6 keV. Double-escape events are therefore observed up to 3784.6 keV, and a Compton

* Alfred P. Sloan Fellow, 1972-1974.

† Work supported in part by the U.S. Atomic Energy Commission.

** Work supported in part by the U.S. National Science Foundation.

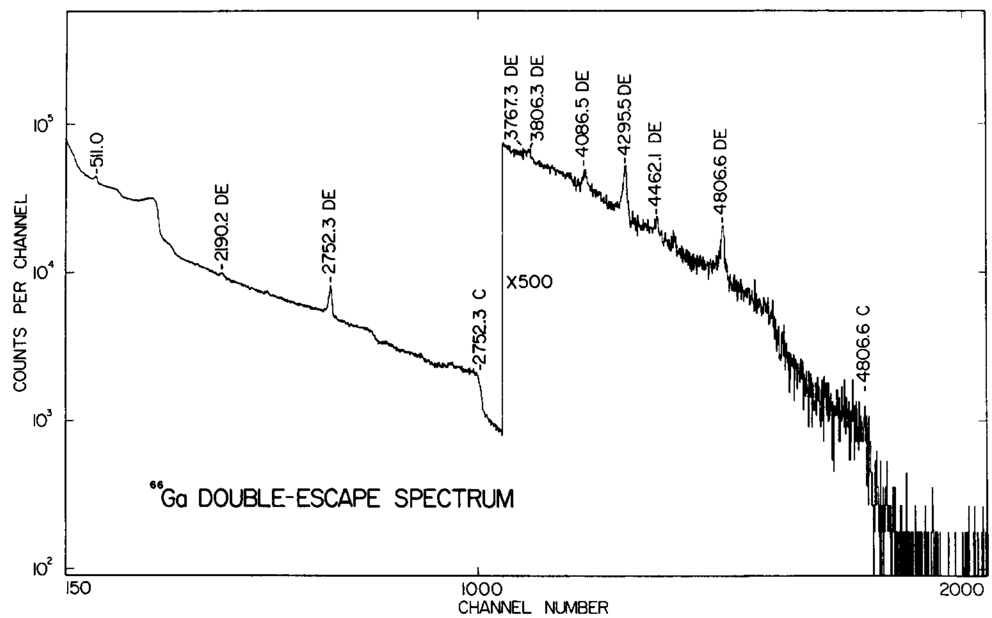


Fig. 1. $\gamma$-ray spectrum of $^{66}$Ga taken with a 100-mm$^2$ × 10-mm deep Si(Li) electron detector. This spectrum shows clearly the double-escape peaks and Compton edges that are useful for calibration.

edge for the highest-energy transition occurs at 4564.0 keV. An additional advantage of using $^{66}Ga$ $\gamma$-rays is that both the double-escape and Compton events occur within the detector, so the source can be located anywhere outside the $\beta$-detection system without any loss of resolution.

*Experimental*

$^{66}Ga$ ($t_{\frac{1}{2}}$ = 9.5 h) was produced with the Michigan State University sector-focused cyclotron by the $^{66}Zn(p, n)^{66}Ga$ reaction using 15-MeV protons and a natural Zn target. Although numerous extraneous activities were produced, 12 hours after bombardment a virtually pure source of $^{66}Ga$ remained, so no chemical separation was deemed necessary.

A spectrum of $^{66}Ga$ was obtained with a SIMTEC Si(Li) detector whose area is 100 $mm^2$ and whose active depth is 10 mm. The detector was near liquid nitrogen temperature and gave 12-keV fwhm resolution for $^{137}Cs$ conversion electrons under experimental conditions. Iron shielding was used to eliminate the $\beta$ background. The resulting $^{66}Ga$ double-escape spectrum is shown in fig. 1.

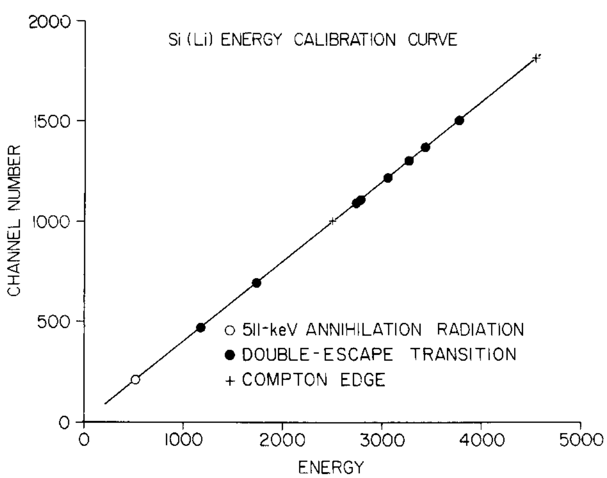


Fig. 2. Calibration curve for a 100-$mm^2$ × 10-mm deep Si(Li) electron detector. (Std. dev. = 2.6 keV.)

TABLE 1

Calibration energies from $^{66}Ga$.

| Energy[a] (keV) | Event |
|---|---|
| 511.0 | $\gamma^{\pm}$ |
| 1168.2 | 2190.2-keV D.E. |
| 1730.3 | 2752.3-keV D.E. |
| 2518.5 | 2752.3-keV Compton |
| 2745.3 | 3767.3-keV D.E. |
| 2784.3 | 3806.3-keV D.E. |
| 3064.5 | 4086.5-keV D.E. |
| 3273.5 | 4295.5-keV D.E. |
| 3440.1 | 4462.1-keV D.E. |
| 3784.6 | 4806.6-keV D.E. |
| 4564.0 | 4806.6-keV Compton |

[a] Values from ref. 2.

*Results*

The double-escape peaks and Compton edges useful for calibration are listed in table 1. The 511-keV $\gamma^{\pm}$ peak was sufficiently strong that it, also, was included. The analysis of peak centroids was done with the computer code SAMPO described elsewhere[3]). Compton edges were analyzed visually, although more exact methods are available[4,5]). A plot of energy versus channel number is given in fig. 2. This plot is quite linear (standard deviation of the fit is 2.6 keV) making interpolation convenient. In addition, it seems clear that extrapolation to higher energies can be performed with some confidence.

Is is evident that $^{66}Ga$ can be a useful calibration standard over the range 511 to 4565 keV. It offers a rapid and precise calibration of large Si(Li) detectors for use in $\beta$ spectroscopy.

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