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Letters to the Editors

Activation Cross Section for Krypton-83m†

The activation cross section for Kr^{83m} is now of additional interest since the nucleus is found to be well suited to studies of the Mössbauer effect[1]. Figure 1 shows a simplified decay scheme[2]. The half-life of the 9.3-keV state is 147 nsec. The slow-neutron cross section for the production of the long-lived isomeric state at 41 keV has hitherto not been measured, largely because of the special detectors needed for the assay of such low-energy radiations as the 12.6-keV X-ray and 9.3-keV gamma ray.

Our basic tool is a proportional counter through which flows a 90% argon-10% methane mixture at atmospheric pressure. It has an elliptical cross section and a thickness of 6 cm, and is provided with 1-mil aluminum foil entrance and exit windows which are $2\frac{1}{8}$ in. square. Its efficiency for stopping 9.3-keV gamma rays is about 60%; that for the 12.6-keV X-rays is about 26%. These two lines are well resolved by the counter since their line widths are about 13% (full-width at half maximum).

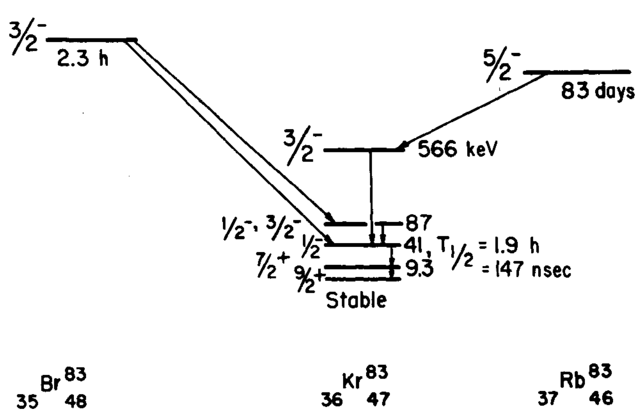

Fig. 1. Simplified decay scheme for Kr^{83}.

Our procedure was to irradiate a known quantity of krypton (normal isotopic composition) at a calibrated position[3] in the Argonne research reactor CP-5 and to quantitatively count the emitted X-rays as soon as it was removed. The gas cell was made of Lucite, sealed with 5-mil Mylar windows. The number of Kr^{83m} nuclei was not determined by counting the γ rays because the escape peak from the X-rays lies in the same energy region as the γ rays, and because the internal-conversion coefficient is not known with adequate accuracy. The counting rate was measured as a function of time after allowing the short-lived isotopes to decay. The 4.4-h activity from Kr^{85} was the major contaminant, especially in our situation where the β-ray shielding was not complete and some of the β rays could make pulses in our energy channel. Appropriate corrections were made for air absorption, fraction of counts within channel, detection efficiency, etc. Constants used in the calculations include $\omega_K = 0.6$ for the fluorescence yield, $K/LM = 0.34 \pm 0.02$, $T_{1/2} = 1.9$ h and $\alpha = \infty$ for the 32-keV transition with no cross-over radiation.

Our result for the activation cross section is 3 ± 1 barn, whereas the total cross section is 45 ± 15 barn. The rather large error results mainly from the quoted uncertainty in the neutron flux and from counting uncertainties connected with the dependence of the pulse amplitude on the counting rate. It is somewhat surprising to us that this activation cross section is such a small fraction of the total in view of the high spin of the ground state. To give an idea of possible source strengths, a $\frac{1}{2}$-h bombardment of 3 mg of ordinary krypton gas at $nv = 2 \times 10^{13}$ gives rise to 2×10^6 gamma rays/sec at the end of the bombardment.

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[1]Y. HAZONI, P. HILLMAN, M. PASTERNAK and S. RUBY, *Phys. Letters* **2**, 337 (1962).

[2]Nuclear Data Sheets, National Academy of Sciences, National Research Council (U. S. Government Printing Office, Washington, D.C.)

[3]Physics Group Report No. 8 of the Reactor Operations Division, Argonne National Laboratory, gives a thermal neutron flux of $5.37 \times 10^{12} \pm 10\%$ at a power level of 4.6 MW in isotope tray No. 1. Power during our run was 4.13 MW.