(γ, n) *REACTION THRESHOLDS FOR SILICON ISOTOPES*

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The thresholds of the (γ, n) reaction are determined for the three silicon isotopes Si^{28}, Si^{29}, and Si^{30}.

OWING to the large neutron binding energy of the most abundant of the silicone isotopes, Si^{28}, direct measurement of the yield of the (γ, n) reaction close to threshold is made difficult by the large neutron background. On the other hand the short half-life of Si^{27} (4.07 sec) and the low intensity of the present day circular accelerators lead to large statistical fluctuations in the obtained saturation activity. It is thus impossible to use the method of induced activity in the region of interest to us with the usual experimental setup in which the counting of the reaction products is performed after the irradiation of the sample (during a time interval of 10 to 12 $T_{1/2}$).

In order to obtain trustworthy data we performed the counting of the induced activity in between the pulses of the betatron. The advantages of this system were pointed out earlier.[1] The apparatus used for the measurements has been described by one of the authors.[2]

Since it is advantageous to prolong the counting time for the measurement of a 4.07-sec activity, the control system of the betatron was connected to the counting system. The channel duration of the 16-channel time analyzer was chosen to be 4096 μsec, which gives a repetition rate of 14 cps. In order to account for the background from short-lived activities [principally due to the (γ, n) reaction in the bismuth contained in the material used to shield the detector from the direct bremsstrahlung beam] the count in the first channels was made separately. The contribution of long-lived activities was determined by measuring the background after turning on the apparatus.

The decay products of Si^{27} were detected by a stilbene crystal and a photomultiplier. The smallness of the scintillator light flash produced upon incidence of the bremsstrahlung on the sample ensured very good reproducibility of the results, for in this case gain changes of the photomultiplier are negligible.[3]

The precision of the measurement at a sufficient distance from the threshold is limited by the accuracy of the reproducibility of the dose received by the sample. A calculation has shown that the possible fluctuations in the yield of the accelerator and the finite time constant of the dosimeter can lead to a relative error not exceeding $\pm 0.3\%$. The reliability of the data close to threshold is considerably smaller.

All measurements were performed with samples of natural isotopic composition. The thresholds for the (γ, n) reaction of the two other isotopes was determined by direct measurement. The betatron energy control system is basically the same as described earlier.[4] It contains a multivibrator with a response level of the order of millivolts. This leads to higher stability than obtainable with a dc amplifier. In order to compensate for slow drifts the control system was regularly checked. The following (γ, n) thresholds were used as energy calibration points: H^2 (2.226 $\pm$ 0.02 Mev), Bi^{209} (7.43 $\pm$ 0.05 Mev), Cu^{63} (10.826 $\pm$ 0.02 Mev), and also the kink in the photoneutron yield curve from oxygen at 17.27 $\pm$ 0.04 Mev.

The measurements were performed after the setup reached thermal equilibrium. The extrapolation to threshold was performed in the usual manner. The following values were obtained for the threshold energies:

$$Si^{28} = 17{,}14 \pm 0{,}12 \text{ Mev}, \quad Si^{29} = 8{,}47 \pm 0.07 \text{ Mev}, \quad Si^{30} = 10{,}618 \pm 0.07 \text{ Mev}.$$

These values agree well with values recently reported in the literature.[5]

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