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F. Carbonara and R. Rinzivillo : PHOTOFISSION OF U^{235} BETWEEN 300 AND 1000 MeV. -

The ratio of U^{235} photofission cross section to that of U^{238} was measured using the bremsstrahlung γ rays beam from the Frascati electronsynchrotron. The head energy was varied between 300 and 1000 MeV and a photon difference method was applied.

I. EXPERIMENTAL PROCEDURE.

We used a mica detection technique, which is particulary suitable for fission fragment detection. It has been already successfully used by several authors in this and in similar fields(1).

Our layout was a very simple one. Extended uranium targets in form of U-acetate layers were placed in front of mica sheets used as detectors. It was used always the same target for a given nuclide. The two layers were obtained by electrospraying on an 1 mm thick aluminum disc U^{235} and U^{238} acetate for an overall target thickness of about 900 $\mu g/cm^2$. Their diameter was $\emptyset$ = 2.0 cm, the content was known at 2.0% and their uniformity was better than 10%. The γ rays beam was collimated to a diameter of $\emptyset$ = 1.4 cm and its head energy was measured to less than 10 MeV by means of a pair spectrometer. Each plate was exposed singly and the normalisation was made by the help of a Wilson type quantameter.

The mica surface used for detection was freshly cleaved and pre-etched for about 4^h in 50% hydrofluoric acid solution at room temperature. In this way "fossil tracks" from background fissile materials were enlarged to an hole diameter of about 10 μm. The development, that is the etching of photofission tracks, was carried out of 40 minuts only, so that the γ rays induced fission events were easily recognisable. To avoid difficulties with the detection of grazing fragments[1, 2, 3], the scanning was limited to a region of the plate for which the angle of incidence of the particle was $\geq 23^{o}$. In this manner also self-absorption in the target was quite negligible. The distance of the mica surface from the target was 8.5 mm and both were kept in vacuum. In this manner the percentage of detected events was about 42 %, provided that their distribution in space was isotropic. This last statement was assumed to be true for U^{235} and indipendently checked[(x)] for U^{238}. The scanning was performed by means of optical microscope in the emulsion standard way. Its efficiency was as high as 97 %. To check a possible contamination from spallation tracks, some mica sandwiched thin targets were exposed with the same layout. This technique is described elsewhere[2, 3]. At 1000 MeV head energy only 3 % of not correlated tracks was found in these sandwiches. Such a small number is easily explained as the number of fission events for which one track is lost[5].

Some out of beam plates were used to check the presence of a possible background source of fission inducing particles, but no evidence was found.

II. - RESULTS.

In Fig. 1 the cross sections per equivalent quantum σ_Q are shown in arbitrary units at various energies. The errors are purely statistical. σ_Q is calculated as if the number of incident photons causing the process were $Q = \frac{1}{E}\int_0^E k\, n(k, E) dk$, where k is the photon energy and E the head energy. Obviously $\sigma_Q = \frac{1}{Q}\int_0^E \sigma_k n(k, E) dk$ where σ_k is the cross section per photon. In the hypothesis of a square spectrum, that is $n(k, E) = \frac{Q}{k}$, then $\sigma_k = \frac{d\,\sigma_Q}{d \ln E}$. Least square straight lines are fitted through our experimental points, assuming a constant value of σ_k in this energy range. The ratio of the relative slopes is $\frac{\sigma_k(U^{235})}{\sigma_k(U^{238})} = 1.11 \pm 0.15$. From known U^{238} cross section[4] a value $\sigma_k(U^{235}) = 74 \pm 13$ mb is drawn.

(x) - In this laboratory, by means of loaded emulsion irradiations, the forward-backward anysotropy was found to be < 10 %.

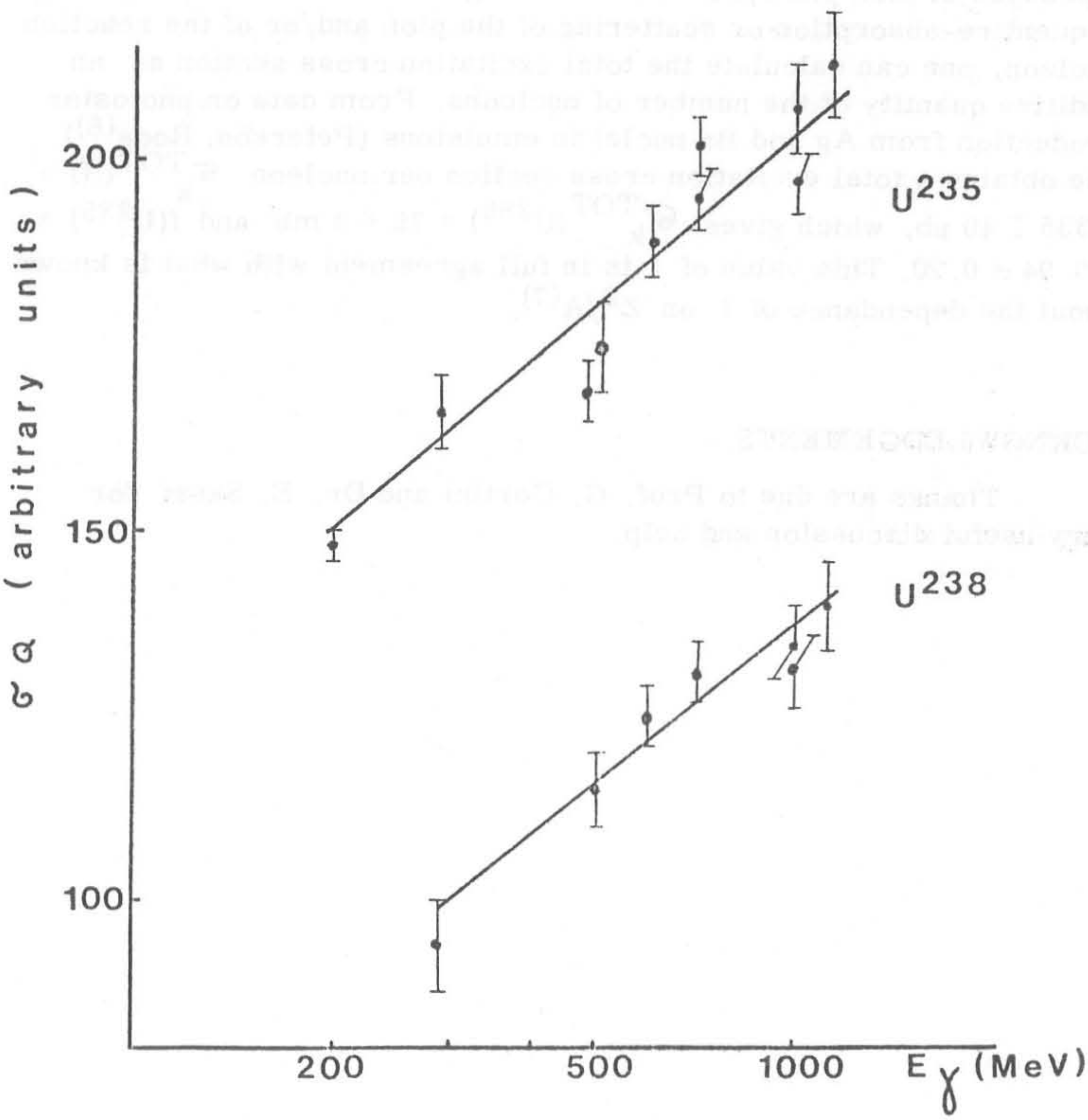

FIG. 1 - The experimental yields of fission cross section per equivalent quantum (σ_Q) at different spectrum head energies fitted by least-squares straight lines.

III. - CONCLUSIONS.

These measurements allow us to calculate the fraction f (fissility) of disexcitation via fission of the U^{235} nucleus.

In the hypothesis that the excitation energy is absorbed through a process of pion photoproduction off single nucleons followed by subsequent re-absorption or scattering of the pion and/or of the reaction nucleon, one can calculate the total excitation cross section as an additive quantity of the number of nucleons. From data on photostar production from Ag and Br nuclei in emulsions (Peterson, Roos[6]) one obtains a total excitation cross section per nucleon $\sigma_k^{TOT}(N) = 335 \pm 40\ \mu b$, which gives $\sigma_k^{TOT}(U^{235}) = 79 + 9$ mb and $f(U^{235}) = 0.94 + 0.20$. This value of f is in full agreement with what is known about the dependance of f on Z^2/A[7].

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