Radiations from Uranium (239) and Neptunium (239)

IN a recent communication¹ Slätis has reported on experiments on the β - and γ -radiations from ^{239}U and ^{239}Np , using magnetic analysis and absorption methods for the two types of radiation respectively.

For ^{239}U the nuclear γ -radiation of 76 ± 3 keV. energy, first reported by Feather and Krishnan², has been confirmed, and its energy fixed as 73.2 ± 0.3 keV. by measurements on the line spectrum of L - and M -photo-electrons. Also, there is satisfactory agreement between the new value for the energy-limit of the main β -spectrum (1.12 MeV.) and the value (1.20 ± 0.02 MeV.) deduced from the absorption curve. But a serious discrepancy is evident between the conclusions indicated by the level scheme of Fig. 2 of Slätis's paper and the earlier results. The level scheme in question indicates that a γ -radiation of energy 870 keV. is emitted in cascade with the 73 keV. transition. Now it would appear that the only evidence for the assumption that a quantum of 870 keV. radiation is emitted in nearly every disintegration (as distinct from occasionally) is in the results of the analysis of the continuous β -spectrum by the Fermi method. This analysis is reported to yield a second high-energy component of feeble intensity and limiting energy 2.06 MeV. No such component was detected by the absorption method (it would have been a simple matter to have detected a high-energy component of intensity 0.05 in this way); furthermore, the published results of Feather and Krishnan set an upper limit of about the same magnitude (0.05) to the emission probability of a possible 870 keV. quantum.

We also observed a second γ -radiation, and estimated its intensity at about 0.10 per disintegration on the assumption that the quantum energy was of the order of 300–600 keV. If the energy were assumed to be twice as great, the calculated intensity would be roughly halved. It would seem, therefore, that the level scheme of Slätis's Fig. 2 cannot be substantiated, and that the total disintegration energy of ^{239}U is 1.20 ± 0.05 MeV., not 2.06 MeV. The β -spectrum which was observed to have the latter energy limit must, in this case, have another origin.

As regards ^{239}Np , it is interesting to compare the results of the Fermi analysis of Slätis with unpublished results which I obtained by the absorption method early in 1941³. Analysing the complete absorption curve of the β - and γ -radiation by standard methods⁴, it was then concluded that the β -radiation of ^{239}Np was constituted as follows:

	Energy (keV.)	Intensity
Photo-electrons	—	~ 0.6
Partial spectrum 1	140 ± 25	~ 0.2
" " 2	400 ± 20	0.7
" " 3	630 ± 20	0.1
" " 4	> 1000	< 0.05

Slätis's analysis leads to maximum energies of 288, 403, 676 and 1,179 keV., and, as concerns intensities, the preliminary report merely indicates that the second partial spectrum with end-point at 403 keV. is the most intense.

The general similarity of the results is not without significance, particularly in relation to the claim that, under suitable control, the absorption method can be of real use in the analysis of complex β -spectra, so long as sufficiently detailed observations are made. It might be mentioned in this connexion that the

absorption measurements on the β -radiation of ^{239}Np were made using sources of less than 10^{-4} mC. strength obtained from the decay of ^{239}U produced by the (d, p) reaction with uranium on the Cambridge cyclotron. Chemical separations were made under the direction of Dr. E. Bretscher, to whom belated thanks are now recorded.

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¹ Slätis, *Nature*, **160**, 579 (1947).

² Feather and Krishnan, *Proc. Camb. Phil. Soc.*, **43**, 267 (1947).

³ Feather, British Atomic Energy Report, Br 46 (now declassified).

⁴ Feather, *Proc. Camb. Phil. Soc.*, **34**, 599 (1938).

Autoradiograph Technique

EXPERIMENTS aiming at an improvement of the resolution obtained with the autoradiograph technique were recently carried out, and a short outline of the methods used is given here.

15 μC . of radioactive iodine (I^{131}) were injected subcutaneously into a rat (wt. 125 gm.). The thyroid was fixed in alcohol and sections 5 μ thick were cut after embedding in paraffin. Fig. 1 shows a photomicrograph of a stained section of the thyroid. After dissolving the paraffin, sections were brought into contact with the photographic film or plate, and the two pressed together in a printing frame and left there for a suitable time of exposure. The sections were not coated with 'Colloidin' before exposure. The film or plate was then developed and fixed^{1,2}. Of the various emulsions tried, Ilford Line film showed the best resolution. Fig. 2 shows an autoradiograph made from the section shown in Fig. 1 before staining, the well-known fact that iodine is concentrated in the colloid of the thyroid follicles appearing clearly in the autoradiograph. Colloid particles 10 μ apart can still be distinguished as separate units; if the distance is 15 μ the separation is very clear. The exposure is about twenty times that needed for a fast X-ray film.

In order to improve resolution, stripping emulsion was removed from its base and immersed in water. A slide carrying a section was placed underneath the emulsion, both lifted out of the water and dried quickly in front of a fan. The slides were then left

Fig. 1

Fig. 2

Fig. 3

Fig. 4