LAMS--40

Series..A

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LAMS - 40 [redacted]

This document contains 10 pages

January 16, 1944 [redacted]

[redacted] REMARKS ON NUCLEAR FISSION

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1. <u>General character of fission yield curves derived from formula</u>:

$$\sigma_F = \sigma_c\left[\Gamma_F/(\Gamma_R+\Gamma_N+\Gamma_F)\right]$$

Characteristic dependance of Γ_R, Γ_N and Γ_F indicated in Figure 1. Assuming a simple course of curve for σ_c as indicated in Figure 2 one obtains curves for σ_F of the types illustrated on same figure.

Curve $\sigma_F^{(1)}$ would correspond to neutron fission of 49. Whether peculiar dip in σ_F^{49} is primarily due to competition between neutron escape and fission or whether it may be partly due to some marked minimum of σ_c in this region can of course not be decided apriori; but it is interesting that a curve for σ_c of the type assumed in a qualitative way explains not only the experimental curve for σ_F^{49} but also for σ_F^{25}. In the latter case the observation that σ_F in the region (0.1 Mev $< E_N <$ 0.5 Mev) is closely proportional to 1/v might in fact be the combined result of the gradual decrease of the σ_c curve and the competition between Γ_F and Γ_N which in this region is rapidly increasing. The observed flat part of the σ_F^{25} curve for high energies should thus correspond to the later more parallel course of the curves for Γ_F and Γ_N.

While $\sigma_F^{(3)}$ qualitatively corresponds to σ_F^{28} it is obviously necessary to discuss the curves for Γ_F and Γ_N in somewhat more detail in order to explain the observed peculiar differences between σ_F^{28} and σ_F^{02} indicated by the dotted lines in Figure 3. It is here assumed that the Γ_N

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curve has some characteristic irregularities due to the successive appearance of levels for inelastic scattering. The Γ_F^{28} and Γ_F^{02} are assumed apart from a displacement of 0.2 Mev to be essentially similar since the short lifetime of the transition state will have the effect almost entirely to efface any specific level structure.

2. Estimate of critical fission energy F and neutron binding energy W.

On the assumption that

$$F = f(Z^2/A)$$

we may in the comparatively small region of Z^2/A concerned write

$$F = a - b(Z^2/A)$$

A new possibility of estimating a and b is given by the measurements of the threshold for photo fission. Taking $F = 5.7$ Mev for 28 and $F = 6.1$ Mev for 02 one gets

$$F = -0.52(Z - 92) + 0.1(A - 238)$$

The values derived from this interpolation formula are given in the second column of the Table on page 3 where the numbers in the first column refer to the values of Z and A of the compound system. In the third column are given the values for F - W which in the case of the ~~6~~3 first isotopes are roughly estimated by comparison with the curves on Figure 1 and 2. The resultant values of W given in the fourth column would seem quite reasonable. In particular the difference in W for nuclei of even and odd values of A - Z is of the order of magnitude to be expected from general evidence as regards the radioactive properties of such nuclei.

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Z^A	F	F - W	W
U^{234}	5.3	≈ -1	6.3
Pu^{240}	4.9	≈ -1	5.9
U^{236}	5.5	$\approx -\frac{1}{2}$	6.0
U^{235}	5.4	$\approx +0.3$	5.1
Np^{238}	5.2	$+0.4$	4.8
Pa^{232}	5.6	0.5	5.1
U^{239}	5.8	1.0	4.8
Th^{233}	6.2	1.2	5.0

3. Comparison between level spectra of 28 and 25 at low energies.

The discussion is based on the disperson formulae

$$\sigma_R = \pi \lambda\!\!\!^{-2} \cdot \frac{\Gamma_N \Gamma_R}{(E - E_0)^2 + (\Gamma/2)^2} \quad ; \quad \sigma_F = \pi \lambda\!\!\!^{-2} \cdot \frac{\Gamma_N \Gamma_F}{(E - E_0)^2 + (\Gamma/2)^2}$$

Since in 28 we have $\Gamma_F = 0$ and $\Gamma_N \ll \Gamma_R$, the width of the lines will be determined by Γ_R and since in 25, $\Gamma_F > \Gamma_R$ the width will in this case be determined by Γ_F. For both cases we have, therefore,

$$B = \int \sigma dE = 4\pi \lambda\!\!\!^{-2} \Gamma_N \sim 1/v$$

From the curve for σ_F^{25} in Fig. 4 one finds that Bv for the levels below 10 ev is almost 100 times smaller than for the wellknown level at 7 ev in 28. Assuming that, as indicated in Fig. 4, the spectrum in 25 consists of both weak and strong lines with a different level spacing, the latter levels are found to have values of Bv comparable with the 28 line.

A suggested explanation of the appearance of the two level systems

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is schematically represented in Fig. 5 in which is also indicated a possible explanation of the remarkable increase in $v\bar{\sigma}_F^{25}$ in the region below 100,000 ev, where the neutrons may be able to give angular momentum to the nucleus with the result that the difficulty in forming levels of the compound state with spin S-1 may disappear. This suggestion has given rise to discussions about impact of neutrons with $\ell \neq 0$ which have not yet been concluded and which are hoped to show whether the suggested peculiar increase in $\Gamma_{N_{\bar{V}}}^{1}$ within the S-1 level system actually does take place.

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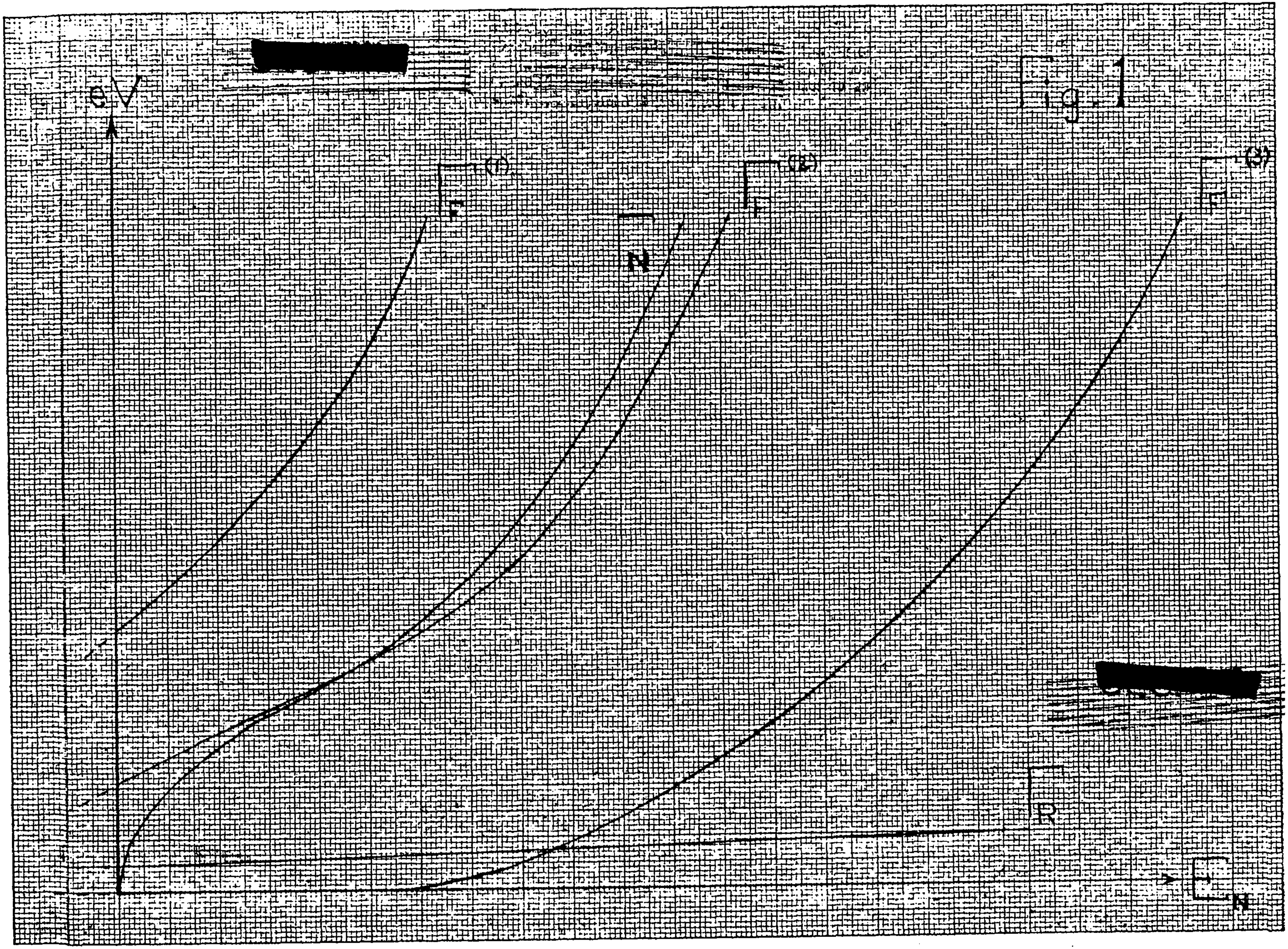

Fig. 1

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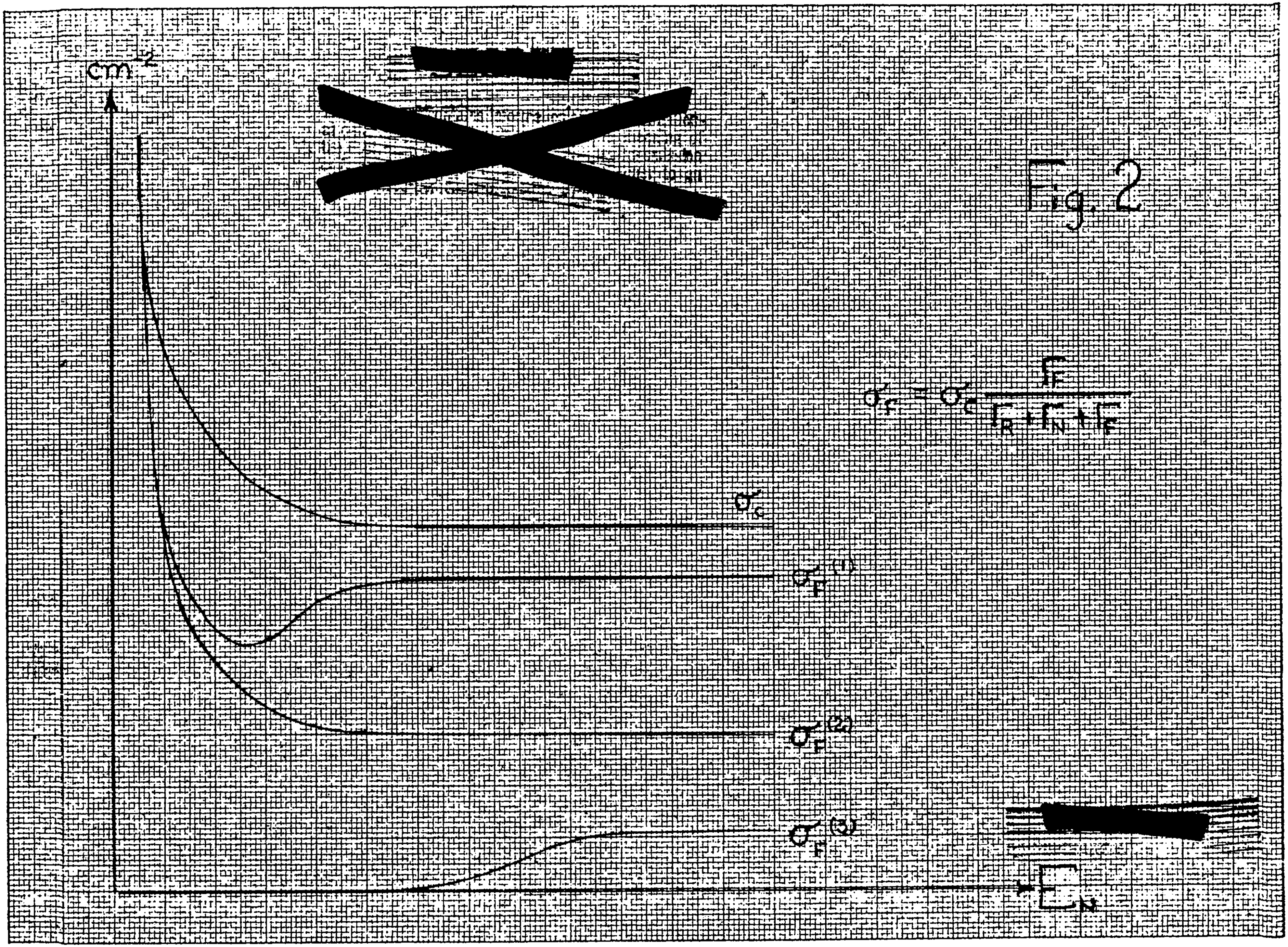

Fig. 2

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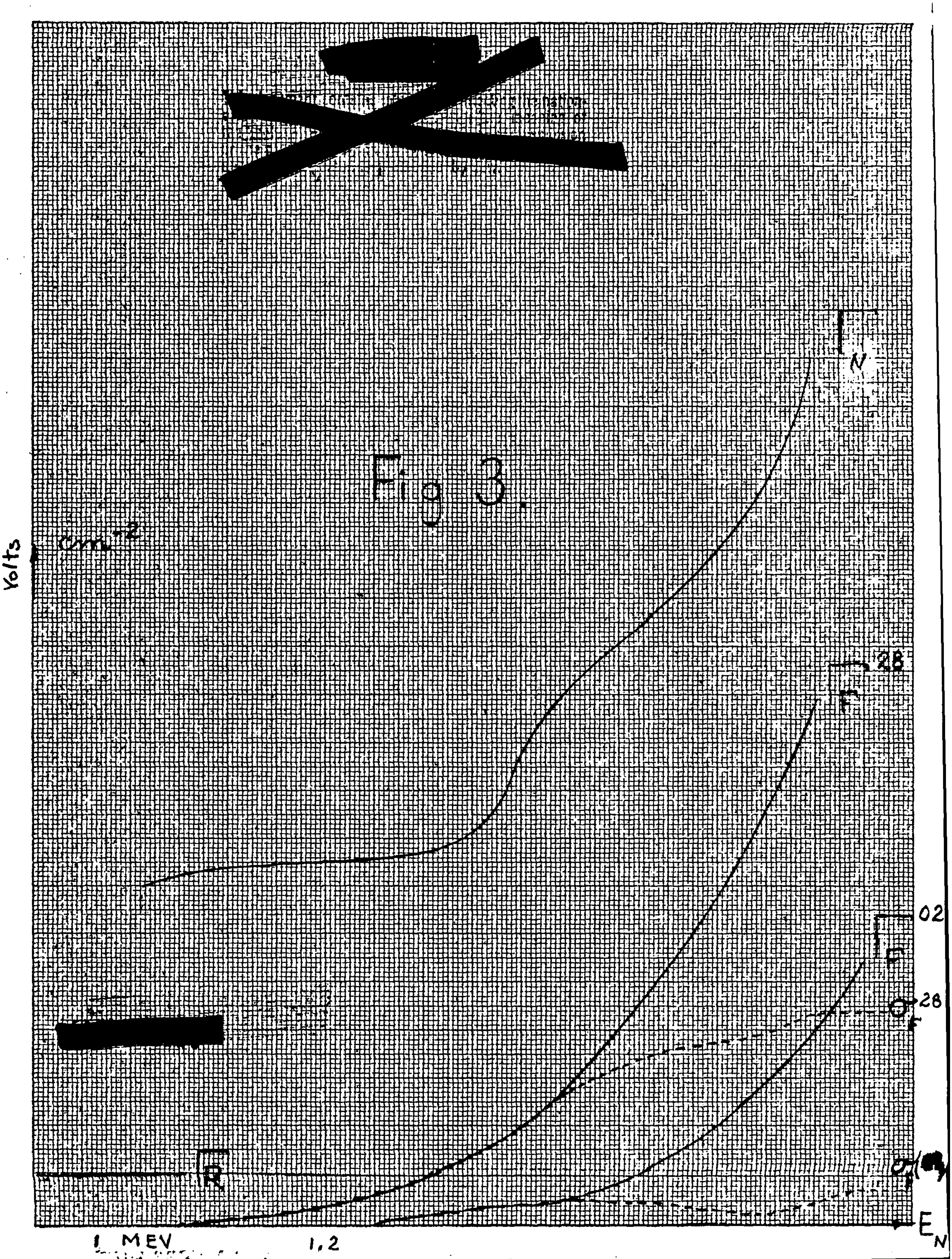
Volts cm^{-2}
Γ_N
Γ_n 28
Γ_F 02
σ_F 28
Γ_R
E_N
1 MEV
1.2

Fig 3.

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Fig 4

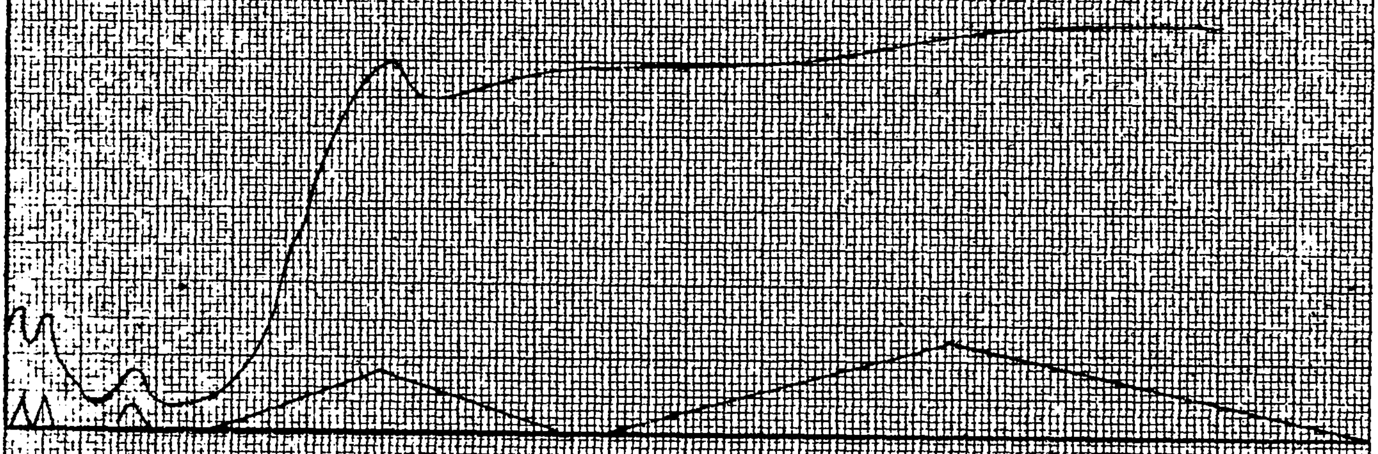

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Fig 5

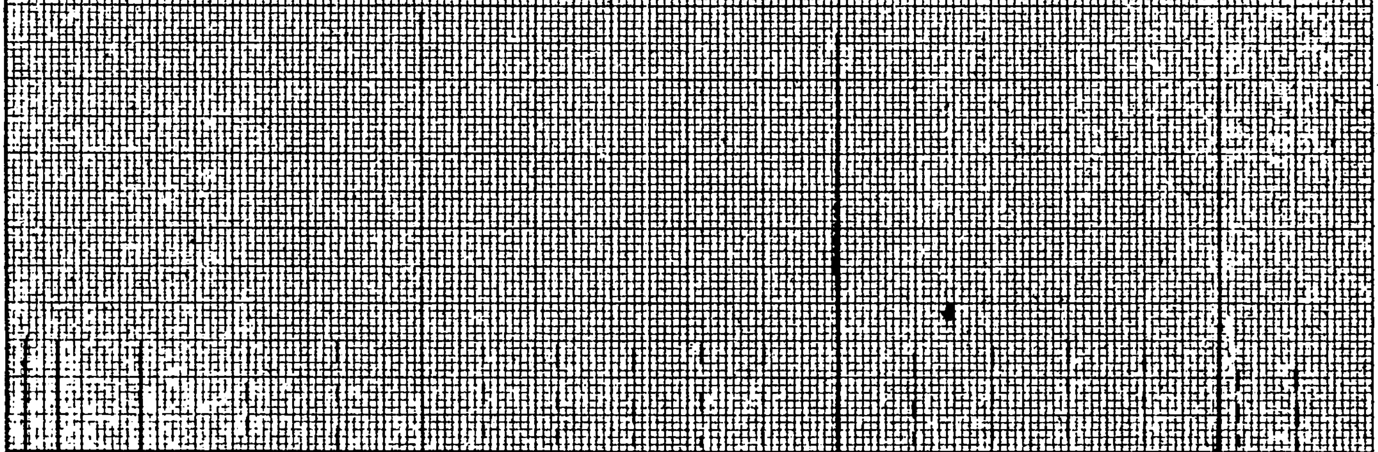

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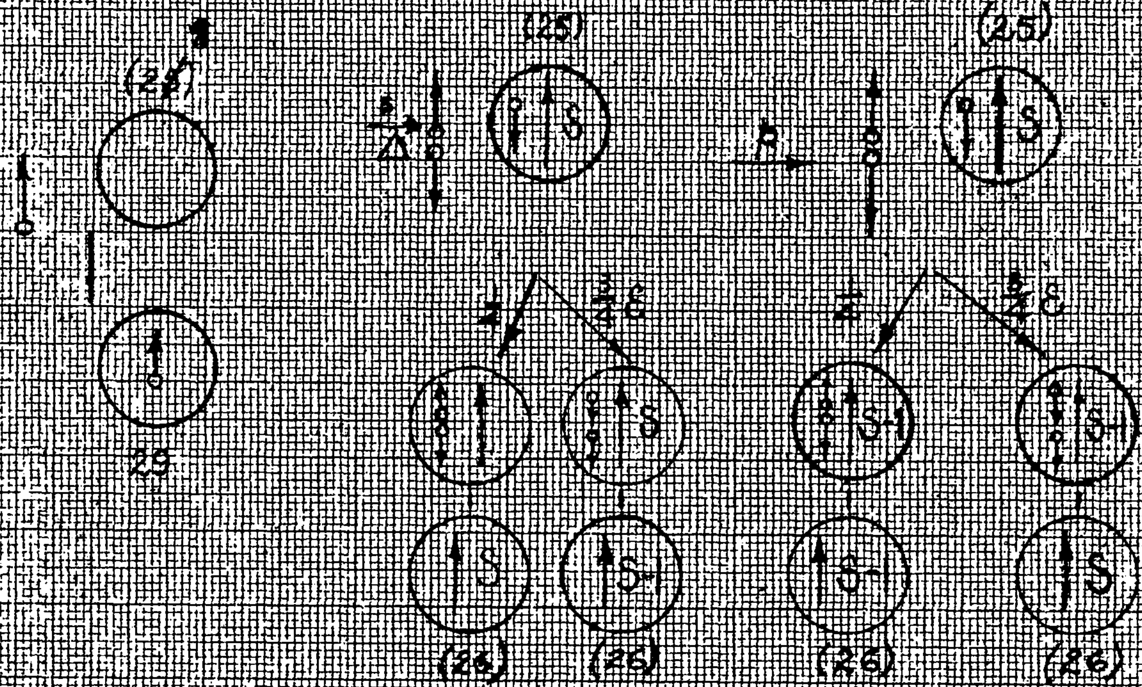
Fig 6



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