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REMARKS ON THE FISSION-CAPTURE RATIO OF 25

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The capture-fission ratio & = Ccapture/C fission messured at thermal energies but this measurement cannot be extended to emergies occurring in the fission spectrum. Therefore theoretical conriderations to estimate the energy dependence of of are relevant.

The ratio & is given by

$$\propto = \frac{T_r}{T_r}$$

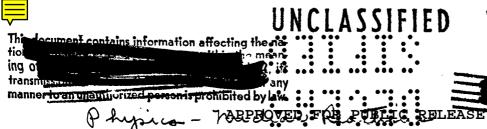
to fission respectively. We are interested in the ratio K of the values of of at low energies to the values around 1 MeV:

$$\mathbf{R} = \frac{(\mathbf{r_r})_{1 \text{ MeV}}}{(\mathbf{r_r})_{1 \text{ eV}}} \qquad \frac{(\mathbf{r_r})_{1 \text{ eV}}}{(\mathbf{r_r})_{1 \text{ MeV}}} \tag{1}$$

The expression for G at 1 MeV is given by:

$$\sigma_{f} = \begin{cases} \sigma_{o} & \frac{\Gamma_{f}}{\Gamma_{e} + \Gamma_{n} + \Gamma_{r}} \end{cases}$$
 (2)

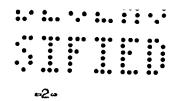
o is taken as TR2 (R nuclear radius), which defines the sticking probability 5. Since for 1 MeV: R/X = 2.3, } won't be



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larger than unity. Γ_n is the neutron width, which consists of several terms: $\Gamma_n = \Gamma_{no} + \Gamma_{n1} + \Gamma_{n2} + \ldots$, corresponding to the elastic remission (Γ_{no}) and to the inelastic emissions Γ_{n1} . If R > X, the following relation holds: 1)

$$r_{no} = \begin{cases} \sum_{\ell=0}^{L} (2\ell + 1) \frac{D_{\ell}}{\pi} \end{cases}$$

L is the maximum ℓ which can get into the nucleus (L=R/X) and D_{ℓ} is the average distance between the states which can be formed by neutrons with the angular momentum ℓ , by collision with a nucleus in a state with definite quantum numbers. Let us call Δ the distance between degenerate levels of given angular momentum, J, and assume Δ independent of J, we get $D_{\ell} = \frac{\Delta}{2(2\ell+1)}$, the factor 2 coming from the spin. One then gets

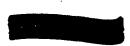
$$\Gamma_{no} = \begin{cases} \frac{L+1}{\pi} & \frac{\Delta}{2} \end{cases}$$

We may neglect Γ_{r} in (2) for 1 MeV and get for Γ_{r} :

$$r_{f} = \frac{r_{n}}{\frac{\sigma_{o}}{\sigma_{f}} - 1}$$

We then write: $\Gamma_n = N \Gamma_{no}$ where $N \gg 1$ is related to the number of levels which can be reached via inelastic scattering of 1 MeV neutrons. It is somewhat smaller than this number because Γ_{ni} is

¹⁾ See Bohr and Wheeler Phys. Rev. 56, 426 (1939) and also LA-24 (33 and 34) page 8, formula 17.





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smaller than r_{no} . We then get for r_f :

$$i_{f}^{*} = \left[\left\{ N \middle/ \left(\frac{\sigma_{o}}{\sigma_{f}} \right\} - 1 \right) \right] \frac{L+1}{\pi} \frac{\Delta}{2}$$

After inserting $L = R/\lambda = 2.2$ and $\sigma_0/\sigma_{f} = 2$ on the basis 6f the experimental value $G_f = 1.6 \text{ tarns}^2$ and $G_o = \pi R^2 = 3 \text{ tarns}$, one obtains:

$$T_{f} = \frac{H_{1}^{2}}{2(-1)} \frac{\Delta}{2}$$

 Δ can be estimated in the following way: At thermal energies $\Delta/2$ is just equal to the level distance D between the levels observed by McDaniel. 2) (The factor two comes from the fact that the neutrons excite levels with two values of J.) The decrease of the level distance from thermal energies to 1 MeV can be estimated by using a dependence $e^{-\sqrt{aE}}$ for the level distance (E is the excitation of the compound nucleus) and by adjusting the constant a so that the level distance decreases from 100 - 300 kilovolts at E = 0, to 2 eV at E = 6 MeV. We then obtain a = 22 (MeV)² and a decrease of \triangle by a factor of 2.5 if B is raised from 6 to 7 MeV.

In order to get a lower limit on T_f , we put $\{=1, N=2,$ $\Delta/2 = 1/3 D_0$, and $D_0 = 1 \text{ eV}$. This gives:

$$r_{r} > 0.66 \text{ eV}.$$

2) LA Report in preparation.



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¹⁾ A. O. Hanson, CF-618

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The most plausible value for T_f may be obtained by putting N=2, $\frac{1}{2}=0.75$, $D_0=2$:

$$(\Gamma_{f})_{1 \text{ MeV}} \sim 2 \text{ eV}.$$

We used Γ_{Γ} at low energies in order to estimate K which is defined in (1). $(\Gamma_{\Gamma})_{low}$ is smaller or equal to the total width Γ of the levels observed by McDaniel. According to his curves one may put:

One obtains for the fission width at low energies:

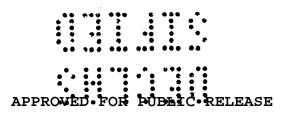
$$\Gamma_{\ell} = \frac{\Gamma}{1+\alpha}$$

which gives 0.2 eV with a value of 0.25. Thus the ratio K obeys the relation:

$$k \ge 2.6 (1+\alpha)$$

with the most probable value of $T_{\mathbf{f}}$, we obtain





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