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LETTERS TO THE EDITORS

# Equilibrium Spectrum and Diffusion Length in Natural Uranium[1]

Neutron inelastic scattering excitation cross sections for the low-lying levels of $U^{238}$ reported by Cranberg and Levin (*1*) are at considerable variation with those inferred (*2*) by us from previously available data, but are in better agreement with what is expected on theoretical grounds. For the neutron energy groups used in (*2*) the level excitation cross sections indicated by the data of Cranberg and Levin are given in Table I.

TABLE I

| Group | E. Mev | Level excitation cross section, barns | | |
|---|---|---|---|---|
| | | 45 kev | 150 kev | 700 kev |
| 2 | 0.835–1.353 | 1.0 | 0.60 | 0.52 |
| 3 | 0.498–0.835 | 1.2 | 0.45 | |
| 4 | 0.302–0.498 | 1.4 | 0.20 | |
| 5 | 0.183–0.302 | 1.2 | | |
| 6 | 0.111–0.183 | 1.0 | | |
| 7 | 0.067–0.111 | 0.4 | | |

The corresponding inelastic scattering matrix [transfers from Group 1 are assumed to be unchanged from (*2*)] is given in Table II.

TABLE II

GROUP INELASTIC TRANSFER CROSS SECTION, BARNS

| To \ From | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| 3 | 0.50 | | | | | |
| 4 | 0.19 | 0.55 | | | | |
| 5 | 0.12 | | 0.59 | | | |
| 6 | 0.06 | | | 0.45 | | |
| 7 | | | | | 0.63 | |
| 8 | | | | | | 0.41 |

These were obtained from the level excitation cross sections by using the calculated equilibrium spectrum in natural uranium to determine group removal cross sections. A recalculation of this spectrum with the revised inelastic scattering cross sections gives the results of Table III.

[1] Work performed under the auspices of the U. S. Atomic Energy Commission.

TABLE III

| Group | Group flux |
|---|---|
| 1 | 5.63 |
| 2 | 14.67 |
| 3 | 28.05 |
| 4 | 41.70 |
| 5 | 68.56 |
| 6 | 54.20 |
| 7 | 58.77 |
| 8 | 86.83 |
| 9 | 15.92 |
| 10 | 2.35 |

Average detector cross sections now become those in Table IV.

TABLE IV

| Reaction | Calculated cross section (barns) | Measured cross section in barns (Zephyr) |
|---|---|---|
| $Pu^{239}(n, f)$ | 1.80 | 1.80 |
| $U^{235}(n, f)$ | 1.73 | $1.8 \pm 0.1$ |
| $U^{238}(n, f)$ | 0.0094 | $0.010 \pm 0.002$ |
| $Np^{237}(n, f)$ | 0.14 | $0.16 \pm 0.03$ |
| $U^{238}(n, \gamma)$ | 0.27 | $0.21 + 0.01$ |
| $Au^{197}(n, \gamma)$ | 0.64 | $0.43 \pm 0.04$ |

The comparison with the Zephyr numbers now shows an appreciable discrepancy for $U^{238}(n, \gamma)$ and $Au^{197}(n, \gamma)$. The calculated equilibrium diffusion length in natural uranium is now 8.5 cm, against the measured value of 9.6 to 10.0 cm. Assuming the correctness of the inelastic scattering data and the diffusion length measurement, a reduction of about 30% in either the average capture or average transport cross section in $U^{238}$ would be required to bring the calculated and measured diffusion lengths into agreement. The above discrepancy for $U^{238}(n, \gamma)$ suggests an error in that cross section. On the basis of radiochemical determination of the ratio of $U^{238}(n, \gamma)$ to $U^{235}(n, f)$ in various assemblies investigated with the ZPR-III facility a lowering of the $U^{238}(n, \gamma)$ cross section may be justified (*3*).

## REFERENCES

1. L. Cranberg and J. Levin, International Conference on Neutron Interaction with the Nucleus, Columbia University, September, 1957.
2. D. Meneghetti, H. H. Hummel, and W. B. Loewenstein, *Nuclear Sci. and Eng.* **3**, 151–160 (1958).
3. W. B. Loewenstein and D. Okrent (to be published).

*Argonne National Laboratory*
*Chicago, Illinois*
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D. Meneghetti
H. H. Hummel
W. B. Loewenstein