ARMOUR RESEARCH FOUNDATION OF ILLINOIS INSTITUTE OF TECHNOLOGY

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On June 1, 1963, the name of Armour Research Foundation of Illinois Institute of Technology will be changed to IIT Research Institute.

June 5, 1963

U. S. Atomic Energy Commission
Chicago Operations Office
9800 South Cass Avenue
Argonne, Illinois

Attention: Fred C. Mattmueller, Director
Contracts Division

Subject: ARF Report A6027-2 (Contract No. AT(11-1)-578,
Project Agreement No. 24) entitled "Studies of the
Resonance Integrals of Re and Tm," covering the
period May 1, 1963 through May 31, 1963.

Gentlemen:

During this reporting period efforts were expended on
resonance integral activation and reactivity measurements.

To obtain the number of activated Tm atoms by determining
the number of 84 keV Yb¹⁷⁰ gamma rays, it is necessary to know the
branching ratio for the beta decay of Tm¹⁷⁰ and the internal conver-
sion coefficient for Yb¹⁷⁰. It is well established* that in 22 percent of
the decays the first excited state (84 keV) of Yb¹⁷⁰ is populated. This

* A. V. Pohm, W. E. Lewis, J. H. Talboy, Jr., E. N. Jensen,
Phys. Rev. 95, 1523 (1954); T. D. Nainan, H. G. Deware, A. Mukerji,
Proc. Indian Acad. Sci. 44A, 111 (1956).

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figure probably has an uncertainty of less than ± 2 percent. The uncertainty is difficult to estimate because the experimenters did not discuss the errors in their measurements.

The theoretical values for α_K and α_L internal conversion coefficients for the K and L shells respectively, have been tabulated by Rose and Sliv. The contribution from the other electronic shells is usually taken to be 0.315 times the L shell contribution. Although it is well known that these calculations may be somewhat inaccurate due to the neglect of dynamic nuclear effects, it was not expected that these effects are of importance in a highly enhanced transition, such as the one under consideration. However, there is increasing evidence that even for highly enhanced transitions there is a discrepancy between theory and experiment. It is important to note also that disagreement between theory and experiment is known to exist for α_K/α_L as well as for α_K and the total coefficient, α_{total} .

The theoretical internal conversion coefficient for Yb^{170} is 6.34. One can take the measured α_K and obtain a total "measured" internal conversion coefficient by assuming that the ratio $\frac{\alpha_K}{\alpha_L + \alpha_M + \dots}$ is given correctly by theory. Using the results of Jansen et al. for α_K , this gives a value of $7.27^{+.45}_{-.70}$. However in view of the fact that the K/L ratio determined experimentally disagrees with the theoretical result, this is a somewhat questionable procedure. A better procedure

is to combine lifetime measurements ($T_{1/2}$) with the reduced transition probability (B) in order to compute the internal conversion coefficient by using the formula

$$1 + \alpha_{\text{total}} = \frac{282}{E^5 T_{1/2} B(E2, 0 \rightarrow 2)}$$

where $E = 84.229 \pm 0.041$ keV.

Using the best available values of $T_{1/2}$ and B we calculate $\alpha_{\text{total}} = 6.6 \pm 0.5$. There are more recent pertinent measurements which may permit the uncertainty to be somewhat reduced. Although these results are not yet published, we expect to obtain them during the next reporting period.

In summary the Tm^{170} beta decay branching ratio is 0.22 with an uncertainty of 2 percent, which is sufficiently accurate for our purpose. The internal conversion coefficient is not so well known, but more experimental work is being done and it is hoped that the uncertainty will be reduced. In any case our final results will use the best value available at that time and further improvements can easily be incorporated later as they become available.

Preliminary investigation of the danger coefficient technique for measuring resonance integrals in the Armour Research Reactor (ARR) is proceeding. The objective of this part of the program is to measure the sensitivity of the ARR. If sensitivity permits, the infinitely dilute resonance integral of thulium will then be measured.

Several aspects of the reactivity measurements are receiving attention. (1) A range of suitable reactor power levels will be defined by the requirements that the non-fission source contribution to the neutron density be negligible but that the random fluctuations in reactivity contributed by radiolytic decomposition of H_2O or other power dependent effects are also negligible. (2) The relative coarseness of reactivity control noted in experiments conducted prior to initiation of this program is being examined. Available measurements indicate that the difficulty may be due to large rod speeds (inches per second) rather than large rod worth (reactivity per inch). It may be possible to reduce the speed of the standard control rod drive either electrically or by insertion of a special gear box. Greater precision in locating the actual position of the rod in the reactor can be achieved by observing position indicators at the drive mechanism rather than at the console register. The possibility of installing a special shim in the reflector for low worth, high positioning precision remains open.

(3) To permit flexibility in location and the introduction of a buckling voltage into the signal, a new neutron chamber is being selected for purchase. Present indications are that a compensated ion chamber will be most suitable. A power supply and vibrating reed electrometer are available at ARF for use with the chamber. (4) An efficient procedure for sample handling is being considered, which consists of lucite push rods to insert samples into a cadmium liner

bolted into position in the glory hole. Advantages are that the reactor need not be shut down when changing samples, and that a simple means is provided for filling the glory hole with a moderating material. This latter is expected to reduce the scattering effect of the sample, an effect requiring significant corrections in measurements made at other sites where a much larger, unfilled space surrounds the sample.

In June, we will review the special techniques required for counting Tm foils and continue the search to obtain the best value of the internal conversion coefficient. The preparation of the detailed plan for the reactivity measurements will continue.

Respectfully submitted,

ARMOUR RESEARCH FOUNDATION
of Illinois Institute of Technology

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for
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