and a log ft value of 7.8. This suggests a first forbidden transition with $\Delta I=0$ or ±1, "yes" for the 680-kev group. The first excited state of Sr^{86} is tentatively assigned as a 2+ state because of the probable $E2$ assignment[36] to the 1.080-Mev gamma ray. This is consistent with the beta-gamma polarization correlations made by Hamilton, Lemonick, and Pipkin.[35] A consistent decay scheme is then obtained by assigning the lower-energy beta group as a $\Delta I=0$, "yes" transition. This decay scheme is indicated in Fig. 16.

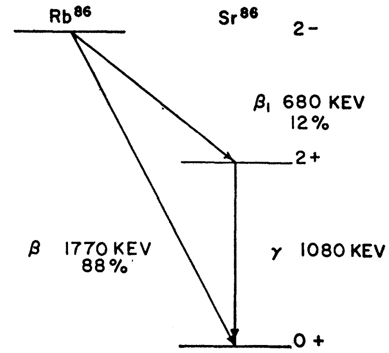

FIG. 16. Rb^{86} decay scheme.

DISCUSSION

The correction for the effect of the finite DeBroglie[45] wavelength was applied to the spectrum of Rb^{86}. This correction made no significant difference in the end points or shape of the subtraction or total spectra.

The Kurie plots of the 680-kev beta group of Rb^{86} and the 886-kev beta group of Tm^{170} were examined for deviation from a straight line. Limits on the value of the quantity ϕ defined by Mahmoud and Konopinski[46] for the Fierz interference effect were determined. For the 680-kev group of Rb^{86}, ϕ was -0.05 ± 0.10. For the 886-kev group of Tm^{170}, ϕ was 0.05 ± 0.08. The error given is the probable error determined by the statistics. The quantity 2ϕ is equal to r as defined by Davidson and Peaslee.[47] Within experimental error, there appears to be no deviation from a straight line.

It was found in general that the maximum energies obtained by coincidence methods are in better agreement with the energy differences between high-energy beta end points and gamma-ray energies than those obtained from subtraction spectra.

[45] Rose, Perry, and Dismuke, Oak Ridge National Laboratory ORNL-1459, 1953 (unpublished).
[46] H. M. Mahmoud and E. J. Konopinski, Phys. Rev. **88**, 1266 (1952).
[47] J. P. Davidson and D. C. Peaslee, Phys. Rev. **91**, 1232 (1953).

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$A^{40}(\gamma,n)$ Threshold and the Mass of A^{39}†

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The $A^{40}(\gamma,n)A^{39}$ reaction is found to have a threshold at 9.85 ± 0.15 Mev. Using the most recent mass spectrograph measurements for the mass of A^{40}, the mass of A^{39} is calculated to have a value of 38.97681 ± 0.00020. The relationship of this measurement to other reaction energy data is discussed.

INTRODUCTION

THE recent modification of the neutron detection apparatus used in this laboratory for the study of photonuclear reactions to accommodate gaseous targets[1] has permitted a determination of the $A^{40}(\gamma,n)$ threshold. Using the accurate mass spectrographic data for the mass of A^{40}, the measurement yields a precise value for the mass of A^{39} and an important check on nuclear transmutation data in this region of mass number.

EXPERIMENT

The apparatus is identical to that previously reported[1] for the study of the properties of the giant (γ,n) dipole resonances in gaseous targets, and the entire operational procedure is identical except that neutron yields in the vicinity of threshold are taken with greater statistical precision and are more closely spaced in betatron energy.

† Supported in part by the U. S. Air Research and Development Command and the joint program of the U. S. Office of Naval Research and the U. S. Atomic Energy Commission.
[1] Ferguson, Halpern, Nathans, and Yergin, Phys. Rev. **95**, 659 (1954).

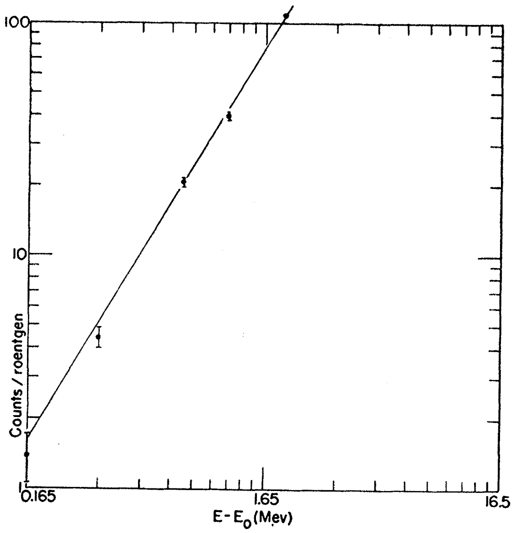

FIG. 1. Log-log plot of argon yield near threshold as a function of $E-E_0$. The assumed value of the threshold E_0 is 9.85 Mev.

The data appear in the form of neutron yields per roentgen for varying betatron energies and extrapolation to threshold is achieved in the manner previously used[2] for the measurement of photoneutron thresholds.

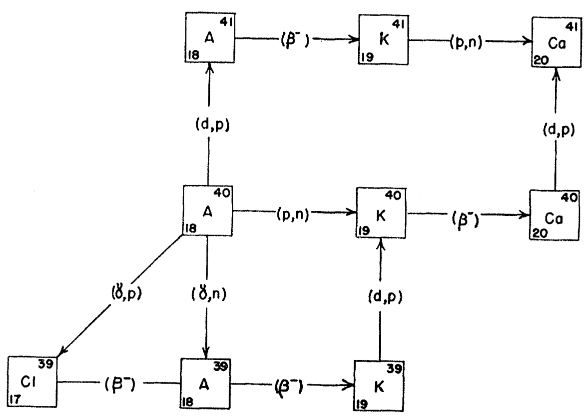

FIG. 2. Transmutations connecting the mass of A^{39} with the masses of neighboring isotopes.

[2] Sher, Halpern, and Mann, Phys. Rev. **84**, 387 (1951).

The data are assumed to be represented by the relation $Y=(E-E_0)^m$, where Y is the yield, E is the maximum bremsstrahlung energy, m is a constant for a given isotope, and E_0 is taken to be the threshold energy. E_0 and m are determined graphically by trial as shown by the log-log plot of Fig. 1 representing the data of this paper for an argon target at 100 atmosphere pressure. E_0 is found to be 9.85 Mev, and if a value of E_0 differing from this by 0.1 Mev is chosen the plot deviates strongly from a straight line. The absolute scale of energy of the betatron is calibrated in terms of the known (γ,n) thresholds of Bi, Mn, and C^{12}, and the over-all error in the threshold determination is estimated to be 0.15 Mev. Taking the value 39.97524 ± 3 for the mass of A^{40} as given by Nier,[3] this yields for the mass of A^{39} the value 38.97681 ± 0.00020.

DISCUSSION

Figure 2 shows the connection between the mass of A^{39} and neighboring isotopes as determined by available transmutation data. As can be seen, there are other reactions, though less direct than the $A^{40}(\gamma,n)A^{39}$ threshold, for deriving the mass of A^{39} from that of A^{40}. The $A^{40}(\gamma,p)Cl^{39}$ threshold coupled with the β-ray decay scheme of Cl^{39} to A^{39} is a simple chain. Haslam *et al.*,[4] report a total disintegration energy of 3.3 Mev for the decay of Cl^{39}, which in turn was produced from A^{40} by a (γ,p) reaction with a measured threshold of 14.2 ± 0.2 Mev. This would lead to an A^{39} mass of 38.97877 Mev in contradiction to the results of this paper. Wilkinson and Carver,[5] on the other hand, quote the $A^{40}(\gamma,p)$ threshold at 10.8 ± 0.1 Mev which, with the above disintegration energy of Cl^{39}, leads to an A^{39} mass of 38.97512.

Using data pertaining to the other chains[6] illustrated in Fig. 2, i.e., A^{40} to K^{40} to K^{39} to A^{39}, one arrives at a value of 38.97686 ± 0.00030 for the mass of A^{39}, in excellent agreement with our data.

[3] A. O. Nier, Phys. Rev. **81**, 624 (1952).
[4] Haslam, Katz, Moody, and Skarsgard, Phys. Rev. **80**, 318 (1950).
[5] D. H. Wilkinson and J. H. Carver, Phys. Rev. **83**, 466 (1951).
[6] See W. Low and C. H. Townes, Phys. Rev. **80**, 608 (1950) for a complete list of references.