UCRL-17568
cy. 2

University of California

Ernest O. Lawrence Radiation Laboratory

NUCLEAR SPECTROSCOPY FOLLOWING ^{40}Ar, xn REACTIONS

F. S. Stephens, David Ward, and J. O. Newton

June 1967

UCRL-17568
Preprint

UNIVERSITY OF CALIFORNIA

Lawrence Radiation Laboratory
Berkeley, California

AEC Contract No. W-7405-eng-48

NUCLEAR SPECTROSCOPY FOLLOWING ^{40}Ar,xn REACTIONS

F. S. Stephens, David Ward, and J. O. Newton

June 1967

Nuclear Spectroscopy Following ^{40}Ar,xn Reactions*

F. S. Stephens, David Ward, and J. O. Newton†
Lawrence Radiation Laboratory, University of California
Berkeley, California

We have studied the gamma rays emitted as the final step in the deexcitation of ^{40}Ar,xn reaction products. Previous studies of this type have used projectiles ranging from protons to ^{19}F ions.[1-3] The advantages of using very heavy projectiles are: (1) considerably greater linear and angular momentum are imparted to the compound system; (2) accessibility is provided to regions of the periodic table that cannot easily be reached with lighter ions, and (3) the very neutron-deficient compound systems can usually be produced with lower excitation energy, resulting in greater product specificity.

That it is feasible to make spectroscopic measurements following ^{40}Ar,xn reactions is shown in Fig. 1 where spectra resulting from ^{124,122,120}Sn(^{40}Ar,4n)^{160,158,156}Er reactions are shown. We have also made the 88, 90, and 92 neutron Yb isotopes by bombarding separated Te targets, and the rotational transitions thus identified are shown in Table I. It is reasonably clear that the sharp discontinuity between 88 and 90 neutrons is smearing out as the proton number increases.

The peak cross sections (at ~160 MeV) for the ^{40}Ar,4n reactions were measured on the assumption that the 4+→2+ transition represents the entire cross section for producing the 4n product. This seems very likely as there is essentially no drop in the rotational transition intensities until much higher in the bands. Our preliminary estimate is that the ^{40}Ar,4n cross sections peak around 250 mb, and adding an empirical correction for the 3n and 5n reactions we obtain ^{40}Ar,xn cross sections of ~450 mb. This means that angular momenta up to about 50ℏ are contributing to the xn reactions. This implies that the upper limit to the observed ground-band rotational spectra depends on the nuclear energy levels rather than being a limitation imposed by the available angular momentum.

We also have an estimate of the cross section for evaporated alpha particles from ^{40}Ar reactions on ^{124}Sn and ^{130}Te at 160 MeV, and find them to be around 100 mb. Thus it appears that most of the total reaction cross section for ^{40}Ar on Sn and Te targets at this energy still goes into compound nucleus formation and subsequently into neutron emission. Even if a considerably smaller fraction of the total reaction cross section goes into these reactions, it seems likely that spectroscopic studies will be possible following xn reactions with considerably heavier ions.

Table I

Rotational Transition Energies

	N = 92		N = 90		N = 88	
	^{160}Er	^{162}Yb	^{158}Er	^{160}Yb	^{156}Er	^{158}Yb
2→0	126.2	166.5	192.7	243.0	344.4	357.9
4→2	264.3	320.2	335.7	395.3	452.9	476.0
6→4	376.3	436.2	443.8	508.8	543.2	548.3
8→6	464.6	521.2	523.8	588.7	618.2	
10→8	532.1	569.4	579.7	~636	~675	
12→10	579.4		608.7			

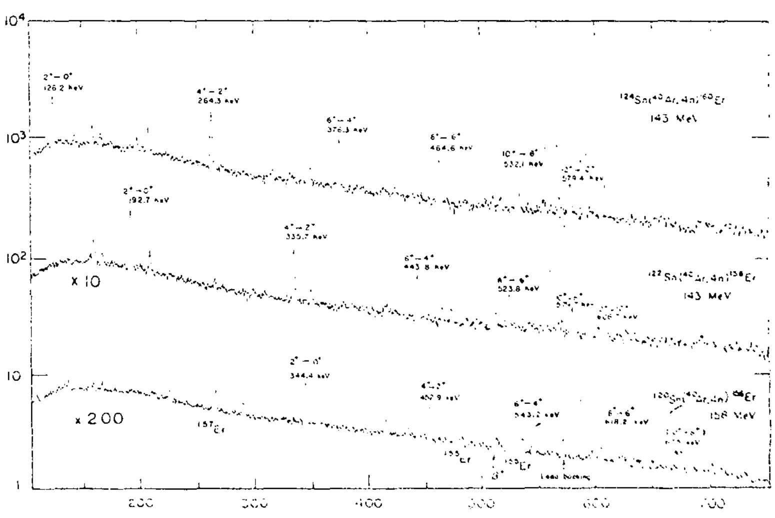

Fig. 1. Gamma-ray spectra following ^{40}Ar,4n reactions, taken with a 6 cm^2×0.8 cm deep Ge(Li) detector.

Footnotes and references:

*This work was performed under the auspices of the U.S. Atomic Energy Commision.
†Department of Physics, University of Manchester, Manchester 13, England.

1) H. Morinaga and P. E. Gugelot, Nucl. Phys. 46 (1963) 210.

2) G. B. Hansen, B. Elbek, K. A. Hagemann, and W. F. Hornyak, Nucl. Phys. 47 (1963) 529.

3) F. S. Stephens, N. L. Lark, and R. M. Diamond, Nucl. Phys. 63 (1965) 82.