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Author
Jones, W. Barclay.

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NEW ISOMERS OF ASTATINE-212

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NEW ISOMERS OF ASTATINE-212

W. Barclay Jones

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New Isomers of Astatine-212*

W. Barclay Jones

Lawrence Radiation Laboratory
University of California
Berkeley, California

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The $_{83}Bi^{209}$ (α, n) $_{85}At^{212}$ reaction was investigated at the Crocker Laboratory 60-inch cyclotron of the University of California. Previous work on this reaction[1-4] reports that At^{212} has a half-life of 0.20 sec, and emits alpha-particles of 7.6 or 7.88 MeV.

In this experiment, the alpha decay energies were measured with a phosphorus-diffused-junction counter having an energy resolution of 30 keV. The spectra were observed at selected intervals between cyclotron beam bursts. The spectrum taken at a bombarding energy of 24 MeV is shown in Fig. 1 (the small peaks at 5.63, 6.04, 6.28, 6.78, and 8.78 MeV are due to the calibration source, Th^{228}). The results of the experiment are summarized in Table I. The half-life associated with each of these alpha energies was measured individually by time analysis of each pulse height.

A search was made for a gamma transition between the states responsible for the 7.82- and 7.60-MeV alpha-groups by means of detecting the conversion electrons; however, no such transition was observed. Less than 1% of the alpha activity could have a gamma decay in the energy range from 100 to 600 keV; however, a ≈63-keV transition was observed with a half-life of ~0.13 sec.[5] The data indicate that the level structure might be that shown in Fig. 2.

The 4+ and 5+ assignments for Bi^{208} are from theoretical computations by C. Wahlborn,[6] and are justified by experimental work.[7] The shell-model configuration for nuclei in the region of At^{212} suggests that the neutron outside the closed shell[8] should be $2g_{9/2}$ and that the protons should be $(1h_{9/2})^3$; however, by the predictions of Pryce[9] this would lead to a ground state of 0- and an isomeric state of 9-. The 0- to 4+ transition is forbidden; so the assignment of 0- or 4+ does not appear to be justified. Alternately, as in Bi^{210}, the lower spin state for At^{212} could be 1-.

Figure 3 shows the relative excitation functions for these two isomers, as well as the absolute cross section for $Bi^{209}(\alpha, 2n)At^{211}$.[10] However, neither, the (α, n) cross sections relative to each other nor the absolute cross sections have been determined.

The hindrance factors were calculated from the empirical relation: $\log_{10} F = \log_{10} t_{1/2} - A_Z Q_{eff}^{-1/2} - B_Z$, where A_Z and B_Z are the arithmetical means of corresponding values for the two adjacent even atomic numbers.[11]

FOOTNOTES AND REFERENCES

[a] Work supported by the U. S. Atomic Energy Commission.

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Table I. Alpha-decay energies and half-lives for At^{212}.

Alpha decay energy (MeV)	Half-life (sec)	Approximate relative abundance (%)	Hindrance factor
7.60	0.305	20	6200
7.66	0.305	80	1700
7.82	0.120	80	1600
7.83	0.120	20	9500

FIGURE LEGENDS

Fig. 1. Spectrum of alpha energies for 24-MeV alpha particles on bismuth.

Fig. 2. Proposed energy-level diagram for alpha decay of At^{212}.

Fig. 3. Excitation functions for $Bi^{209}(\alpha, xn)At$. Units for the cross sections for the two isomers of At^{212} are not the same. Data for the At^{211} cross section is taken from reference 9.

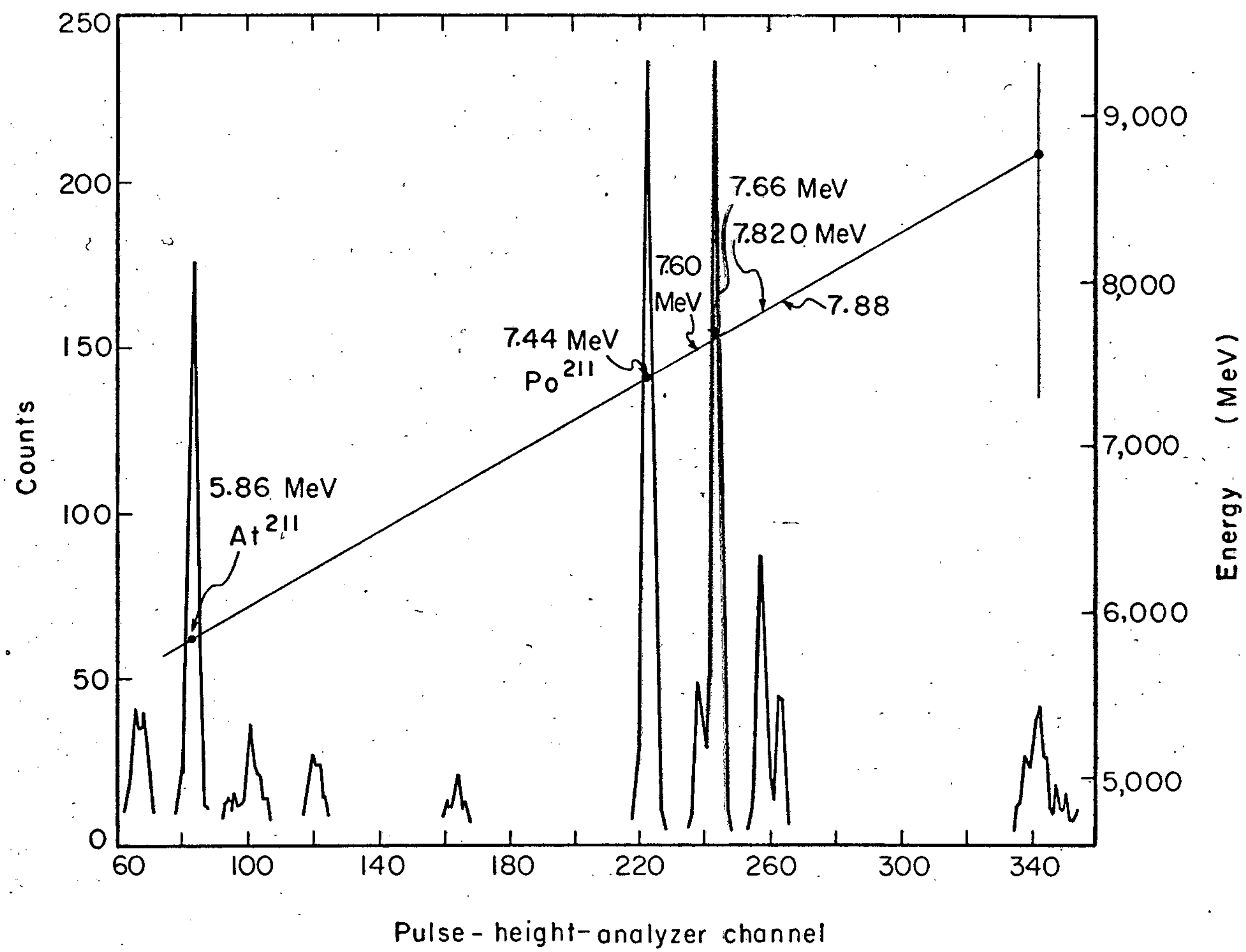

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Fig. 1.

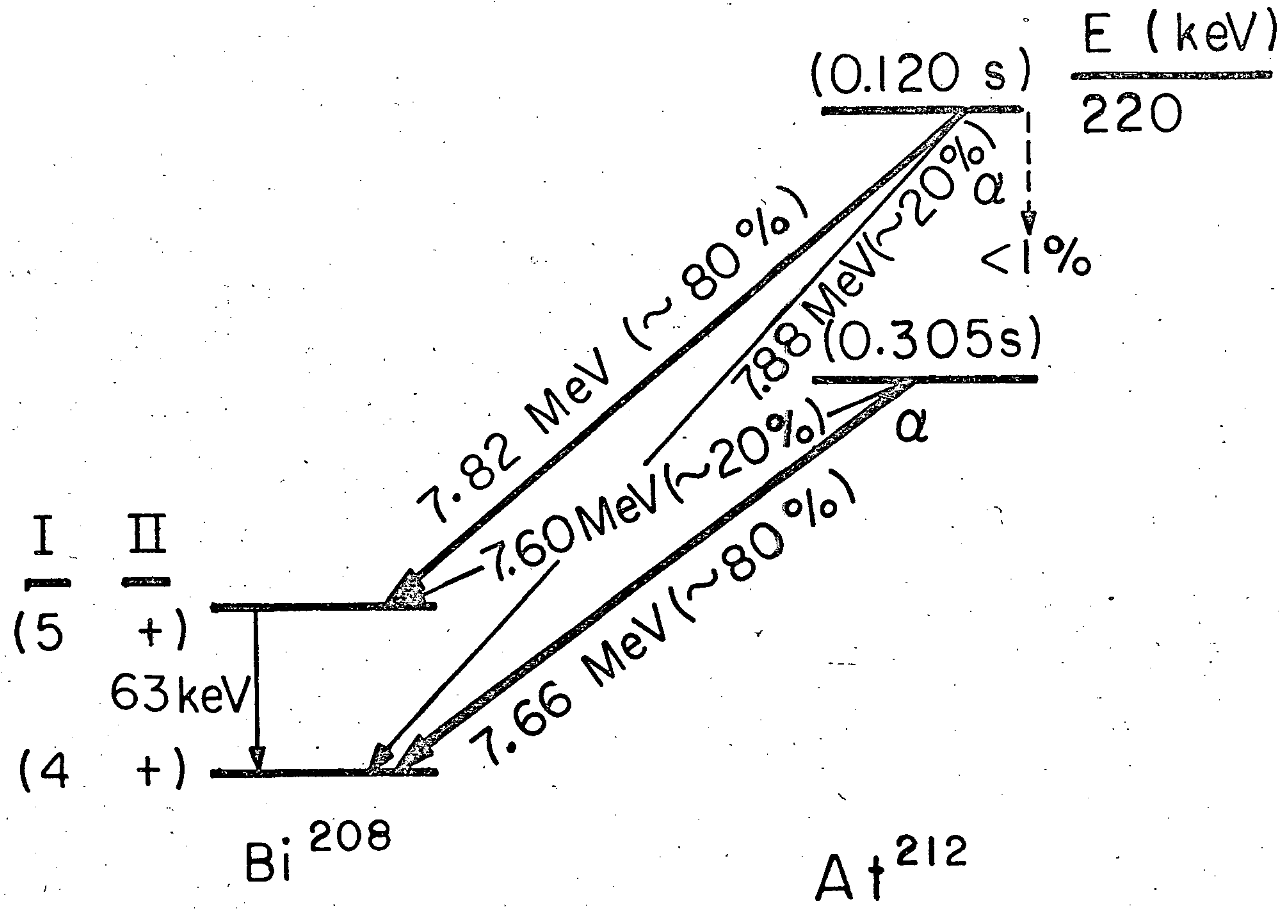

Fig. 2.

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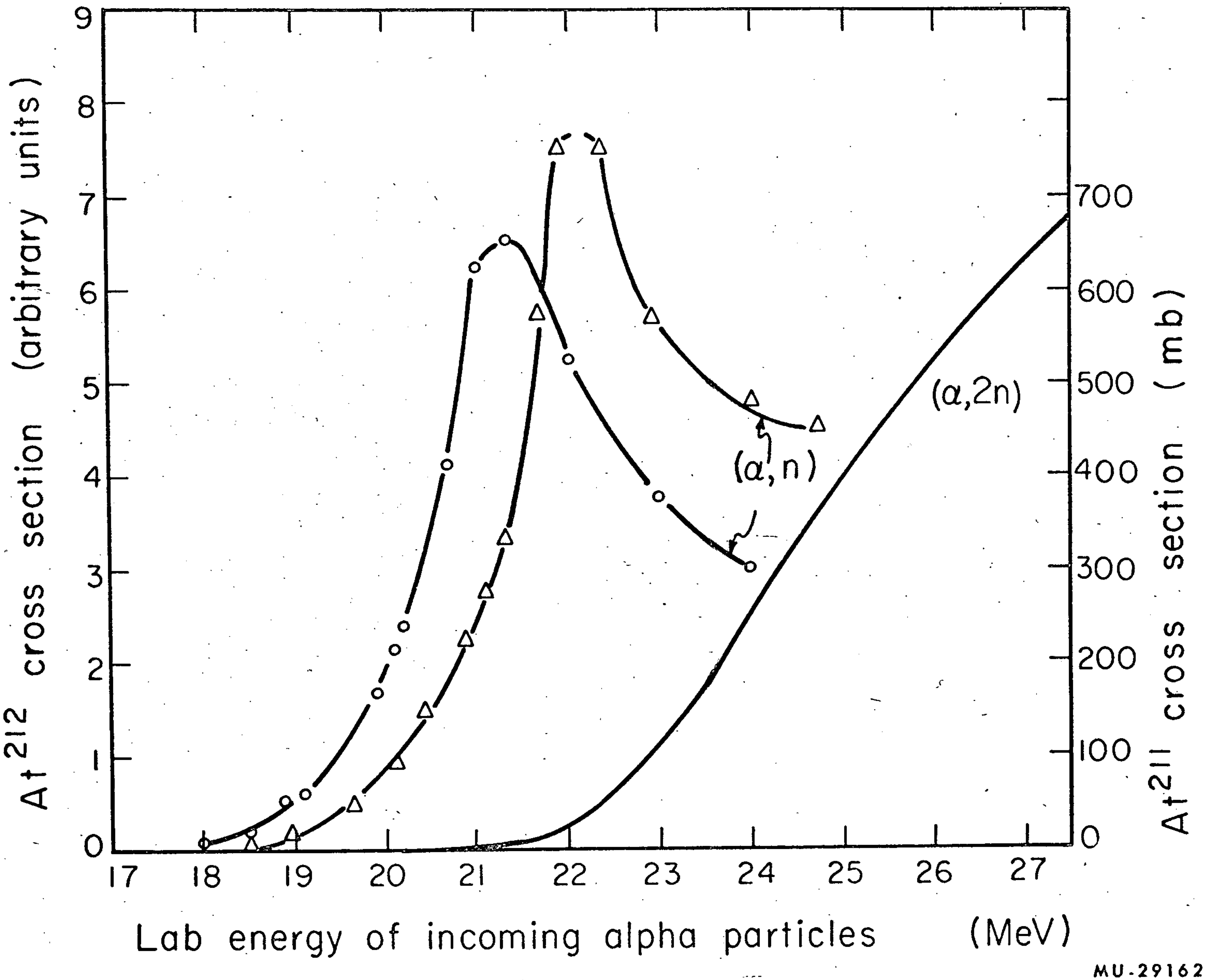
At^{212} cross section (arbitrary units)
At^{211} cross section (mb)
(α,n)
(α,2n)
Lab energy of incoming alpha particles (MeV)
MU-29162

Fig. 3.