Title
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Publication Date
1964-11-01

UCRL-11765

University of California

Ernest O. Lawrence Radiation Laboratory

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Berkeley, California

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Submitted to Phys. Rev. Letters UCRL-11765

UNIVERSITY OF CALIFORNIA

Lawrence Radiation Laboratory
Berkeley, California

AEC Contract No. W-7405-eng-48

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November 1964

A NEW REGION OF ALPHA RADIOACTIVITY*

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Alpha radioactivity is a mode of decay commonly associated with the heavier elements. In this paper we report on a discovery of alpha decay from nuclides in the region of mass 100.

It has long been recognized from atomic mass data that an enhancement of the alpha decay energies of the tellurium isotopes is present due to the effect of the 50-proton closed shell. The enhancement, however, is not large enough to produce a detectable instability toward alpha particle emission among the tellurium isotopes presently known. Some unsuccessful attempts to produce neutron-deficient tellurium alpha emitters by high energy proton spallation have been previously reported[1,2]. We have obtained results on the alpha radioactivity of the very light tellurium isotopes whose alpha decay energies are additionally enhanced by the N = 50 closed shell.

We bombarded a 90% enriched Ru^{96} target with high energy O^{16} ions from the Berkeley heavy-ion linear accelerator (Hilac), and obtained alpha particle spectra of the products using techniques described in an earlier paper[3]. Two weak alpha groups (established by dE/dx experiments) were observed at 3.28 MeV and 3.08 MeV which decayed with half-lives of 2.2 sec and 5.3 sec. respectively. An alpha particle spectrum of these activities is shown in Fig. 1. We established that these activities were due to isotopes of tellurium when we observed that they could not be produced in $Ru^{96} + N^{14}$ bombardments.

We obtained mass assignments for these activities from excitation function measurements using the results of Black on heavy-ion reactions in this mass region to interpret our data[5]. As shown in Fig. 2, the peak cross section for the production of the 3.28 MeV alpha activity falls at a bombarding energy of 104 MeV. This energy compares most favourably with that expected for the reaction $Ru^{96}(O^{16},5n)Te^{107}$. The excitation function for the 3.08 MeV group peaks at a bombarding energy of 87 MeV which is close to the value expected for the reaction $Ru^{96}(O^{16},4n)Te^{108}$. The results are summarized in Table 1.

Table 1

Summary of Results

Nuclide	E_α (MeV)	$t_{1/2}$ (sec)
Te^{107}	3.28 ± 0.03	2.2 ± 0.2
Te^{108}	3.08 ± 0.03	5.3 ± 0.4

These nuclides represent the first opportunity to study alpha decay from nuclei where the valence neutrons and protons are in the same single particle level, in this case, the $1g_{7/2}$ level. This may give rise to a kind of "super-allowed" alpha decay resulting in large reduced alpha widths. At present, we cannot give any estimates of the alpha reduced widths for Te^{107} and Te^{108} because the alpha branching ratios are not known.

The most alpha labile tellurium isotope is expected to be Te^{104} since it can alpha decay to the double closed shell nuclide Sn^{100}. Our first experiments were directed toward producing this nuclide by the reaction $Ru^{96}(O^{16},8n)Te^{104}$. Apparently, however, the peak cross section for this reaction as well as for the O^{16},7n and O^{16},6n reactions is extremely small due to the high neutron binding energies in this region.

We expect that it will also be possible to observe alpha decay from

the very neutron-deficient isotopes of iodine and xenon.

We would like to thank Professor I. Perlman, Professor J. O. Rasmussen, Dr. E. K. Hyde, and A. Ghiorso for their interest in this work. One of us (R.D.M.) would like to express his appreciation to the Chemistry Division of the Lawrence Radiation Laboratory for their kind hospitality.

* Research performed under the auspices of the U.S. Atomic Energy Commission.

1. J. O. Rasmussen, S. G. Thompson, and A. Ghiorso, Phys. Rev. 89, 33 (1953).
2. M. Karras, G. Andersson, and M. J. Nurmia, Arkiv Fysik 23, 57 (1962).
3. R. D. Macfarlane and R. D. Griffioen, Nucl. Instr. Methods 24, 461 (1963).
4. R. P. Black, "Heavy Ion Reactions in the Medium Mass Region" (thesis) Massachusetts Institute of Technology, (1964).

Figure Captions

Figure 1. Alpha particle spectrum of the products of the reaction $Ru^{96} + O^{16}$ at a bombarding energy of 95 MeV (lab).

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Figure 2. Excitation functions for the production of the new Te alpha emitters.

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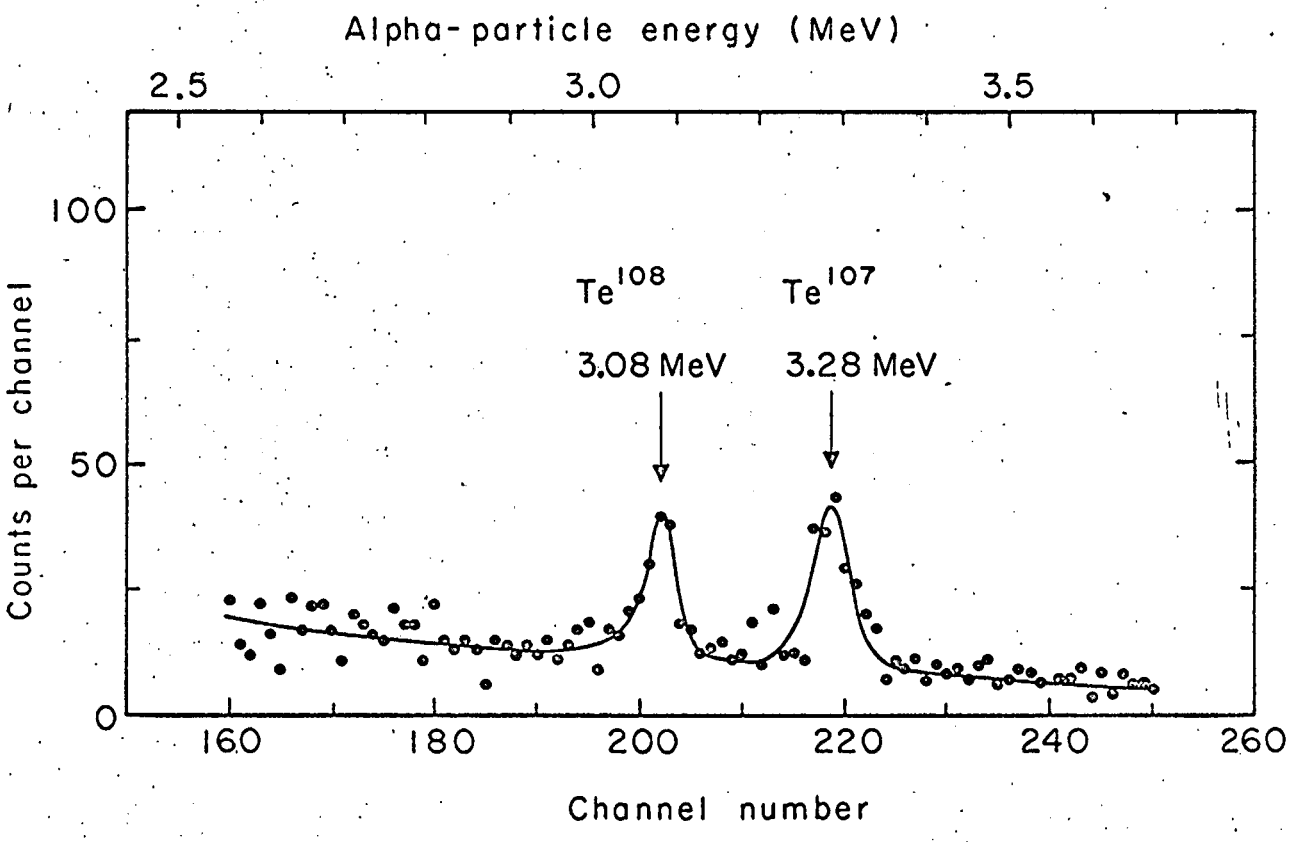
Alpha-particle energy (MeV)
2.5
3.0
3.5
100
50
0
Counts per channel
Te108
3.08 MeV
Te107
3.28 MeV
160
180
200
220
240
260
Channel number
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Fig. 1

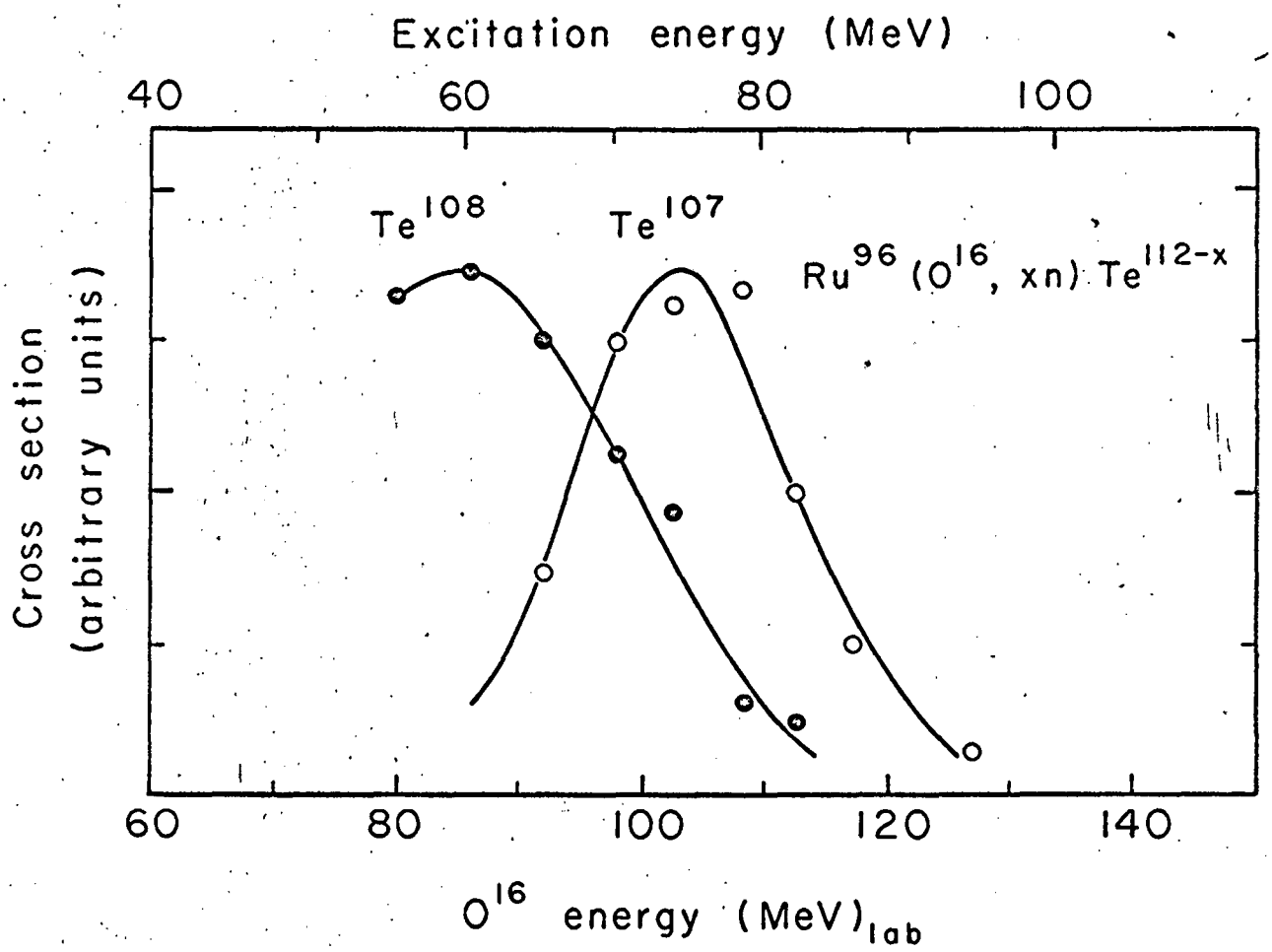

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Fig. 2