UCRL-11834

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DELAYED PROTONS IN THE DECAY OF Te^{108}

Berkeley, California

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Phys. Rev. Letters

UCRL-11834

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Contract No. W-7405-eng-48

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During the past year, a large number of delayed proton emitters has been found among the light elements.[1-5] A Russian group has also reported one nuclide in Kr or Br to be a delayed proton emitter,[6] but thus far no experimental data have been published for heavier elements, although Te has been considered as a promising case.[6]

In a recent study of the alpha activity of Te isotopes, a few counts that apparently did not belong to the alpha groups were observed.[7] In order to find out if they possibly were due to proton emission following beta decay of Te, a further study was undertaken.

The experimental apparatus was essentially the same as that used in a number of alpha decay studies at the Berkeley heavy-ion linear accelerator, and it has been described earlier.[8] In this work, reaction products, slowed down in the target chamber and carried into the adjacent vacuum chamber by He gas, were collected on a thin Ni or Al foil. The activity was deposited on a spot approximately 2 mm in diameter. Three millimeters behind the foil was a surface-barrier detector operating at a bias of 60 V, which is enough to stop 4-MeV protons. At this bias the positron pileup extends up to 1.5 MeV.

Tellurium isotopes were produced by the reaction $Ru^{96}(O^{16},xn)Te^{112-x}$. The targets were 1 to 2-mg/cm^2-thick 95% Ru^{96}, electroplated on 4.5-mg/cm^2-thick Cu. A set of Cu degrader foils was used to control the energy of the beam. Figure 1 shows the spectrum taken at 85-MeV (lab) bombarding energy. In this

case the collector foil was 2.2-mg/cm^2 Ni which is thick enough to degrade 3.3-MeV alphas of Te^{107} to energies below 1.5 MeV. Three groups are present--3.7 MeV, 3.4 MeV, and a broad distribution at 2.6 MeV. The energies refer to the kinetic energy of the emitted protons with absorption in the foil taken into account, and they are estimated to be accurate to 0.1 MeV. The same spectrum was measured through 3.7- and 6.8-mg/cm^2 Al foils, and the peaks shifted downwards an amount that can be expected of proton groups with energies given above. This activity was not present when Cu was bombarded with O^{16} ions; neither was it found in N^{14} + Ru^{96} bombardments.

The excitation function for this activity proved to be the same as that for the 3.08-MeV alpha activity reported in an earlier letter.[7] Also the half-life is the same as that of the alpha group, 5.3 ± 0.4 sec. This means that the proton activity has to be due to the same isotope, Te^{108}, which partly decays through the emission of 3.08-MeV alpha particles, and whose main decay is positron emission and electron capture to Sb^{108}. The decay curves for both protons and alpha particles are given in Fig. 2.

No proton groups that could be assigned to isotopes lighter than Te^{108} were present. In the earlier work, Te^{107} was found by measuring its alpha decay,[7] but it apparently beta decays mainly to the ground state or to low-lying excited states of Sb^{107}. The proton decay energy of these states has to be less than 2.5 MeV, otherwise they would have been seen. This indicates that the observed protons really originate from excited states of Sb^{108}, because its ground-state proton decay energy has to be less than that of Sb^{107}. The proton binding energies of Te and Sb nuclei are not known for mass numbers less than 110, so that it is not possible to find out how highly excited the proton-emitting states are. As for the absence of lighter isotopes than Te^{107}, according to mass tables[9] it is possible that their ground states are unstable against

proton (or two-proton) emission and have half-lives considerably shorter than 0.1 sec, in which case they cannot be detected by using the present method. For Te^{108}, the mass tables predict a beta-decay energy of 7 to 8 MeV, and for Sb^{108}, a proton binding energy of ~1 MeV,[9] so that the situation is favorable for delayed proton emission.

The author would like to thank Professor I. Perlman and Dr. E. K. Hyde for the opportunity of working at the Lawrence Radiation Laboratory. He would also like to thank Mr. A. Ghiorso for the use of his counting equipment and the Hilac personnel for their fine cooperation.

FOOTNOTES AND REFERENCES

*Work done under the auspices of the U. S. Atomic Energy Commission.

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FIGURE LEGENDS

Fig. 1. Delayed proton spectrum of Te^{108}.

Fig. 2. Decay curves for Te^{108}. All parts of the proton spectrum (Fig. 1) were found to decay with the same half-life.

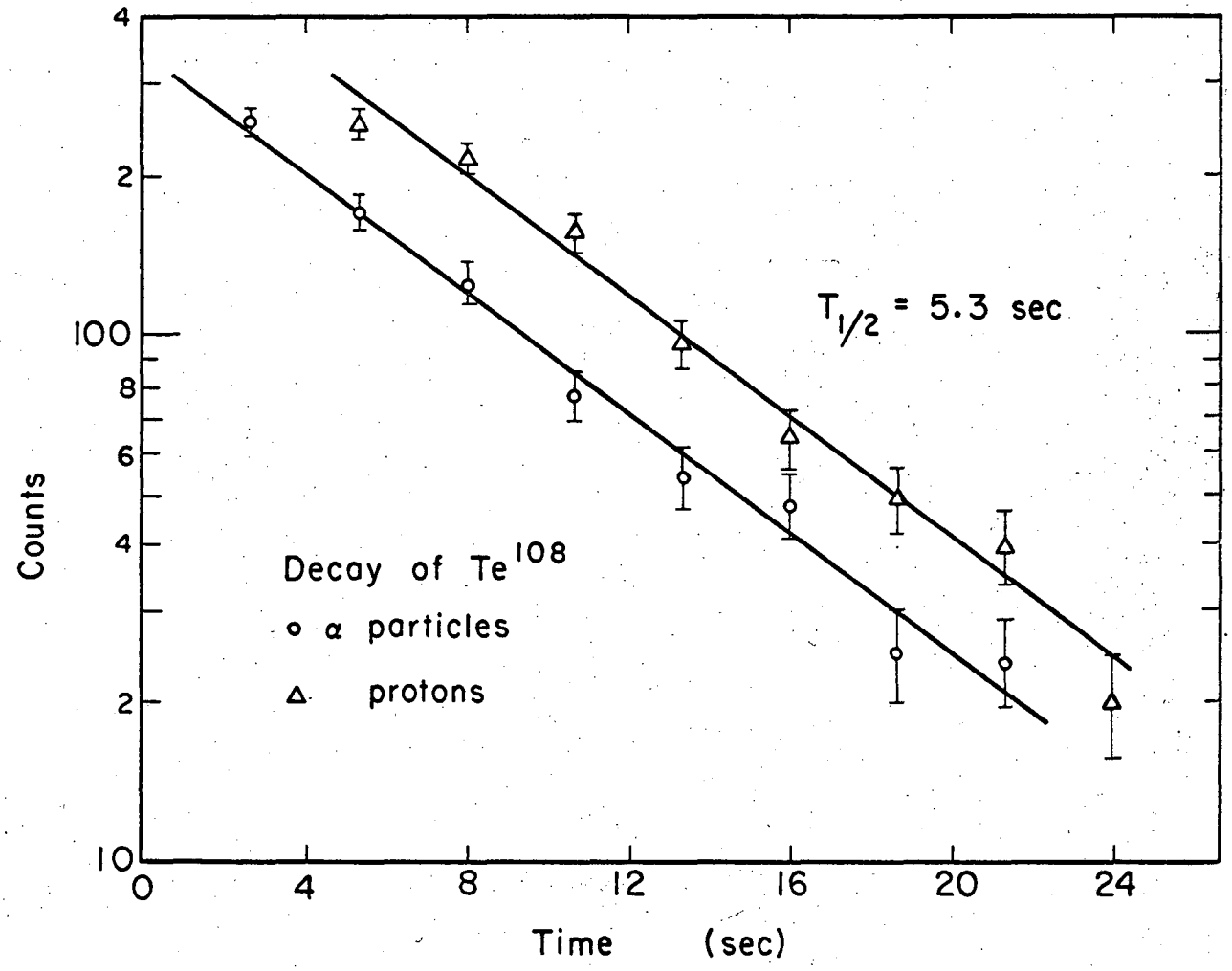

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Fig. 1

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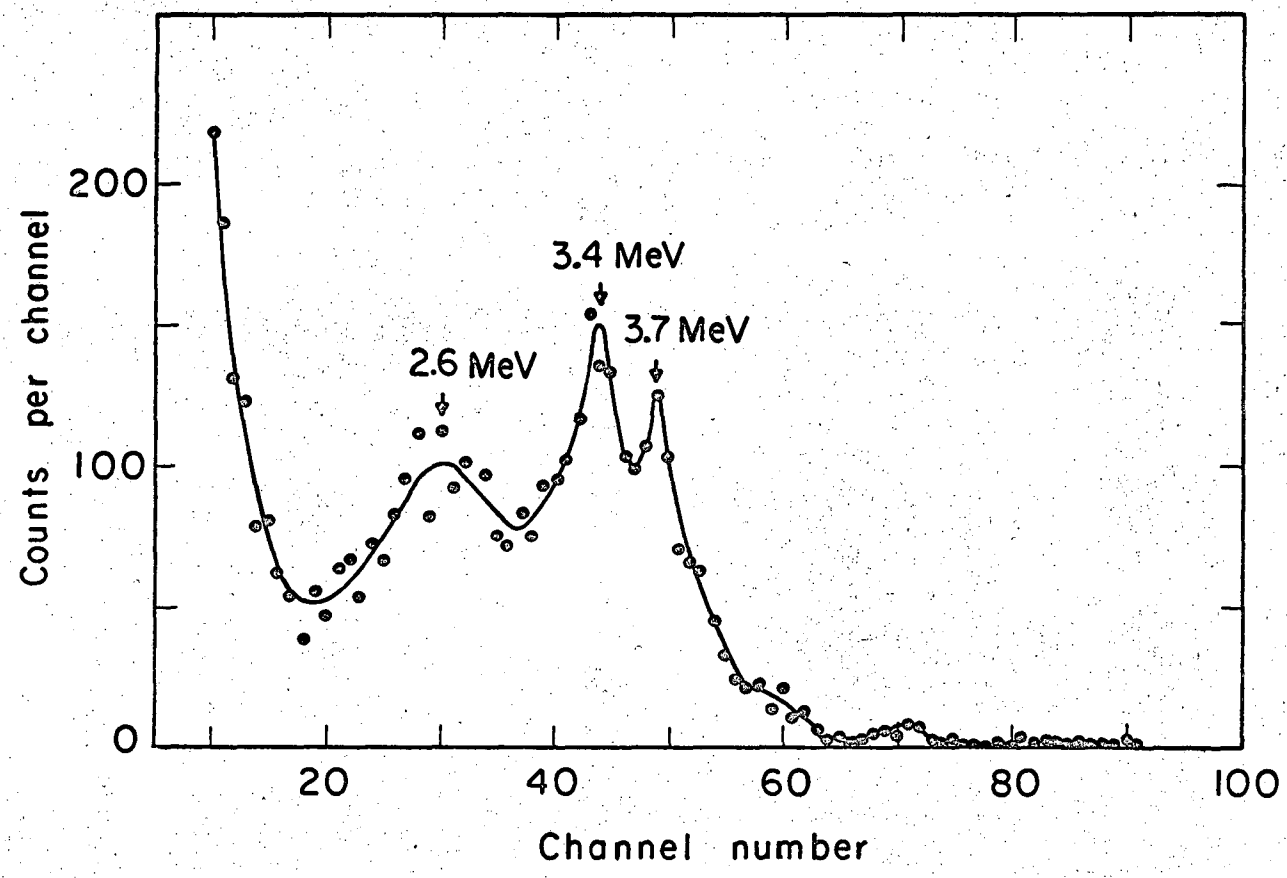

Fig. 2

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