in the ammonium salt This applies to both the undiluted and the diluted salts. The splitting $\delta=0.13$ cm^{-1} for the undilute potassium salt ($\delta=0.091$ for the diluted salt) is somewhat less than the value quoted above for the corresponding ammonium salt. Bagguley and Griffiths[5] report a value of $\delta=0.12$ cm^{-1} for chrome alum. The general appearance of their curves indicates that they refer to the potassium salt. Halliday and Wheatley[6] obtained values of 0.12 cm^{-1} for potassium chrome alum and 0.13 cm^{-1} for ammonium chrome alum. The difference between their values and ours for the undiluted salts appears to be greater than the experimental error in measuring the peak positions. It appears that the interference effects mentioned above shift the positions of the maxima in a different way than do the interference effects in the method used by Halliday[6] and by Griffiths.[5]

A detailed report of this investigation will be given in a forthcoming paper.

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Violet Asymmetry of Potassium Resonance Lines under High Rubidium Vapor Pressure

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IT is not surprising at all to conceive that alkali vapors of higher vapor pressure can be used as perturbing atoms, as foreign gases do, on the absorption lines of other alkalis of relatively lower vapor pressure. Because of experimental difficulties, however, experimental research has very seldom been accomplished.

The chief difficulty lies first in the fact that before the discovery of the corrosion-resistant optical windows, it was impossible to get an absorption tube of an alkali vapor in high pressure. Secondly, when the alkali vapor pressure is high, not only its own absorption lines will be extensively broadened but also its molecular absorption bands will be added to the spectrum. Thus the spectral lines of the alkali to be studied will be badly obscured. Füchtbauer and Heimann[1] studied the effects of caesium vapor on the high series lines of sodium by mixing Cs in the discharge lamp of Na. Their pressure was very, very low.

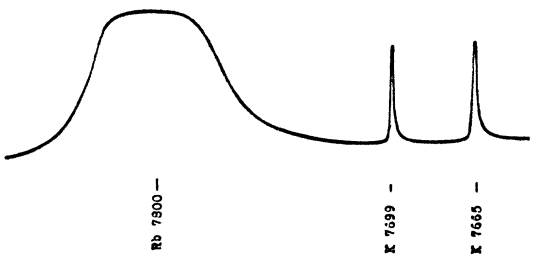

FIG. 1. K resonance lines and the λ7800 of Rb at 426 C. (Rb vapor pressure 19.86 mm; tube length 2 mm.)

If the corrosion resistant MgO windows[2] are used to construct an absorption tube of only 2-mm length,[3] the width of the absorption lines can be considerably narrowed. When the absorption tube of Rb with a trace of K is heated to temperatures as high as 556 C the resonance lines of Rb, λλ7800.29 and 7947.64, with a separation of 147A, are so much broadened that, even when the 2-mm tube is used, they begin to overlap. The pressure of Rb vapor under that temperature would be not less than 150 mm if one extrapolated from the empirical formula of temperature *vs.* Rb vapor density.[4] Fortunately, the region for the λλ7664.94, 7699.01 lines of potassium presented as impurity in the Rb metal are not yet masked, rendering observations feasible.

The microphotometer curve shown in Fig. 1 shows clearly the violet asymmetry of the K lines and the broadened Rb 7800.29. The asymmetry becomes appreciable when the vapor pressure of Rb amounts to about 15 mm or up for the 2-mm tube. When the tube length is increased to 7.5 cm, the asymmetry appears at a Rb vapor pressure of about 2 mm. It is also to be noted that the K impurity lines are narrower than they ought to be if the absorption lines of pure potassium[5] are taken. There is no measurable shift.

This sort of research not only can give more extended data on the investigation of the pressure effects on spectral lines, but also suggests a way to investigate quantitatively the variation of the vapor pressure and the line intensities of one element in the presence of other element or elements. By the measurement of the area under the line contour in terms of the absolute absorption coefficients, it should be possible to estimate the concentration of the absorbing atoms in the absorption column.

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Production of New Tc Activities from Separated Mo Isotopes*

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April 30, 1948

DURING the past 10 months, a series of 35 bombardments with 15–20 Mev deuterons on the different enriched Mo isotopes has yielded several new Tc activities (element 43). In addition, data on previously uncertain activities have been obtained. In each case the Tc was separated chemically from the bombarded Mo isotopes by means of a highly efficient volatility separation method developed in our chemical studies on the element, and where necessary, the Tc was prepared as a thin sample for counting by co-precipitation with platinum sulfide. All counting was done with mica end-window, bell-type

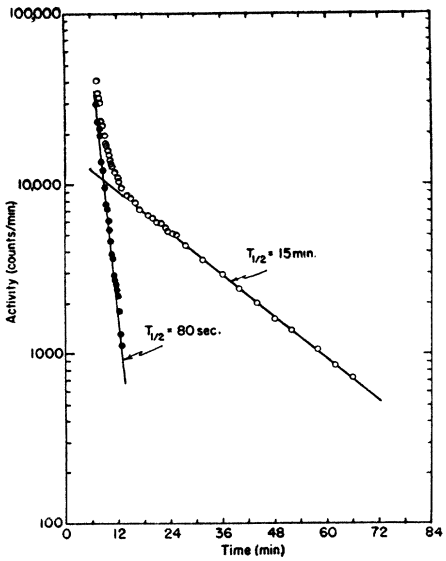

FIG. 1. Decay curve of the 80-second Tc activity produced by the deuteron bombardment of Mo enriched in Mo^{100}.

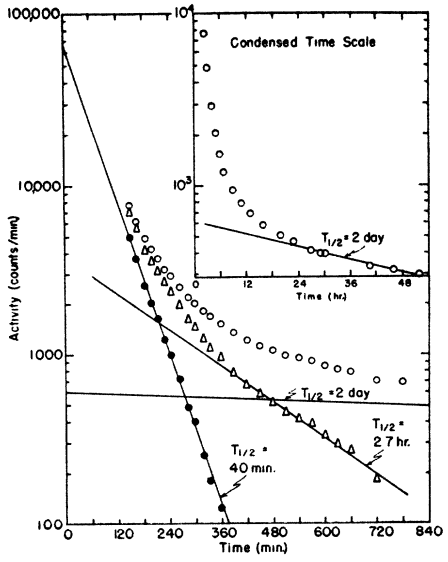

FIG. 3. Decay curve of the 40-min. Tc activity produced by the deuteron bombardment of Mo enriched in Mo^{92}, and of Mo enriched in Mo^{98}.

Geiger-Müller tubes. A preliminary series of deuteron bombardments was carried out in order to see what new activities might be present. This was followed then by a second series using bombardment periods and measuring techniques which served to emphasize the desired radioactivity. Whenever several activities were present together, aluminum and lead absorption curves for the particular Tc activity being studied were obtained by the method of isochrons, i.e. by taking decay curves through each of a set of selected absorbers.

80-second Tc. Short deuteron bombardments on Mo^{100} produced a new short-lived Tc activity which decayed with a half-life of 80±10 seconds (Fig. 1) and which emitted charged particles having an energy of 2.3±0.5 Mev. A gamma-ray of 0.6±0.1-Mev energy was also found associated with this period. The decay curve also shows the previously known[1] 14–15 min. Tc^{101} period as a longer lived component. The new activity is probably Tc^{100} or Tc^{101} produced by $(d,2n)$ or (d,n) reactions, respectively. If it is the latter, it represents an independent isomer of Tc^{101}, of which the 15-min. activity may be the ground state.

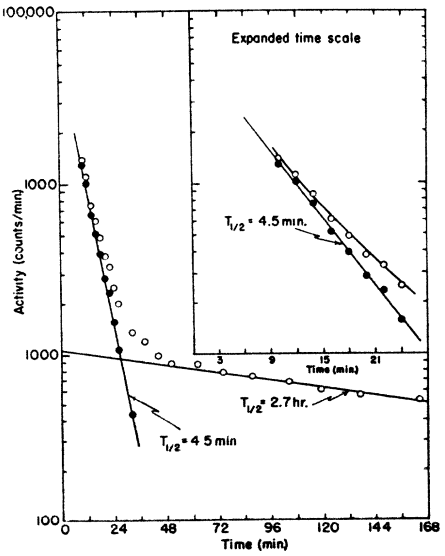

FIG. 2. Decay curve of the 4.5-min. Tc activity produced by the deuteron bombardment of Mo enriched in Mo^{92}.

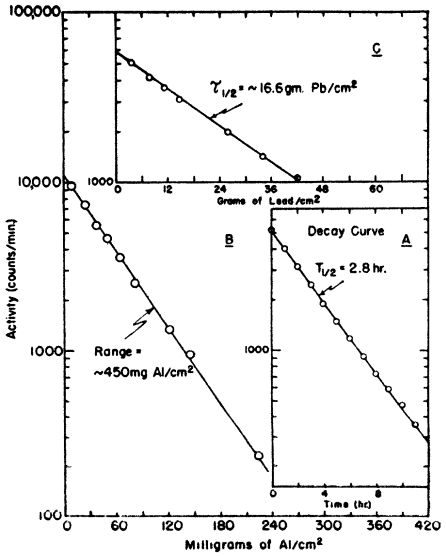

FIG. 4. *A*. Decay curve of the 2.8-hr. Tc activity produced by the deuteron bombardment of Mo enriched in Mo^{92}. *B*. Aluminum absorption curve for the 2.8-hr. Tc. *C*. Lead absorption curve for the 2.8-hr. Tc.

4.5-minute Tc. Five-minute deuteron bombardments of Mo^{92} gave rise to a new positron emitter with a half-life of 4.5±0.5 min. and a positron energy of 4.3±0.5 Mev. A gamma-ray of 1.3±0.3 Mev energy was also present. The decay curve (Fig. 2) showed a longer lived period with a 2.7-hr. half-life, the existence of which has already been indicated.[2] As a result of its mode of production, this 4.5-min. Tc activity is probably Tc^{92} or Tc^{93}.

40-minute Tc. Bombardment of Mo^{97} and Mo^{98} gave rise to a 40±5 min. Tc radioactivity (Fig. 3) emitting charged particles having an energy of 2.0±0.5 Mev. The decay curves show the presence of the previously known 2.7 hr. and ~2 day Tc activities.[3]

2.8-hour Tc. Although a 2.7-hr. activity had been previously observed in a Mo target,[2] no work had been done on the character and energies of its radiations or on its unambiguous chemical identification. Bombardments of Mo^{92} gave good yields of a 2.7±0.1-hr. Tc which was shown to be a positron emitter by magnetic deflection. A positron energy of 1.2±0.2 Mev, and a hard gamma-ray of 2.4±0.5 Mev were determined by absorption measurements. This activity is probably Tc^{92} or Tc^{93}.

This note reports only a part of the results from a general program for the characterization and assignment of the various radioactivities of element 43 produced by deuteron bombardments with the enriched Mo isotopes. The complete data and discussion will appear in a forthcoming article.

* This document is based on work performed under Contract Number W-7405 eng 26 for the Atomic Energy Project at Oak Ridge National Laboratory.

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Identification of Beta-Rays with Atomic Electrons

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THE old question whether beta-rays are identical with atomic electrons was recently reviewed by Crane.[1] When this problem was much discussed about ten years ago, experiments by Zahn and Spees[2] set doubts at rest by showing that the value of e/m for beta-rays does not differ from the value found for atomic electrons by more than 1.5 percent. While this and other indirect evidence support the assumption that beta-rays and atomic electrons are identical, the question remains ". . . whether or not experiments can exclude the possibility that, for example, the spin of the beta-particle is different from one-half unit, with only a slight effect upon the mass. This kind of question should be answered as precisely as possible for the record. . . ."[3]

As long as experiments show only that a particular property of beta-rays has the same value, within the attainable experimental error, as the corresponding property of atomic electrons, some doubts whether beta-rays and atomic electrons are identical might persist. We have carried out an experiment which is based on the well-founded assumption that Pauli's exclusion principle would not hold for a pair of particles if they differed in any property whatsoever. In this way we have been able to answer the question raised with a degree of certainty which could not be attained by determining the value of any single property of beta-rays and electrons.

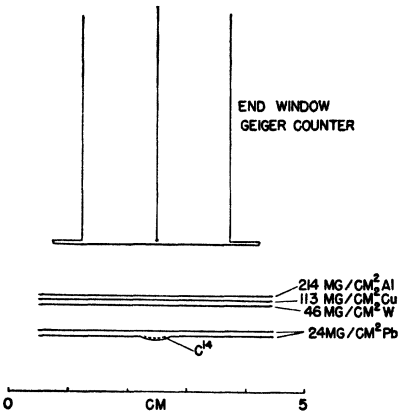

FIG. 1. Arrangement used in search for photons from beta-rays stopped in lead.

The experiment is based on the following consideration: when beta-rays are stopped in matter, their final fate will depend on whether or not they are identical with atomic electrons. If they were not identical with atomic electrons, they would not obey Pauli's exclusion principle and could therefore be captured into bound orbits "filled" with atomic electrons. Their transition to the lowest orbit would take place within an extremely short time and would be accompanied by K x-rays, slightly longer in wavelength than the K x-rays characteristic of the capturing atom, because of the additional screening. A test for the absence or presence of these x-rays can thus decide whether or not beta-rays are identical with electrons.

To carry out the experiment, it is convenient to use a source which emits soft beta-rays and no gamma-rays It is also desirable that the source have high specific activity and that the beta-rays be stopped in a heavy element. We have used as a source of beta-rays C^{14} in the form of $BaCO_3$, with 3–5 percent of the carbon consisting of C^{14}. This source emits beta-rays of 155 kev maximum energy and no gamma-rays.[4] The experimental arrangement is shown in Fig. 1. The C^{14} source was deposited on lead. The bare source emitted "in the direction" of the Geiger counter approximately 5×10^5 beta-rays per min. This was estimated by measuring the counting rate with 7.55 mg/cm² Al absorbing the beta-rays. This absorber was found to reduce the intensity of a weak C^{14} source to 15 percent. Corrections for absorption in the air and the mica window (~3 mg/cm²) were also made. To search for x-rays the source was covered by a lead foil (24.0 mg/cm²) which absorbed practically all beta-rays. When soft photons and secondary electrons were filtered out by 113 mg/cm² of Cu and 214 mg/cm² of Al, approximately 10 counts per minute above background were detected.