3×10^{-7} sec). The maximum beta-energy is estimated from aluminum absorption curves to be at 1 Mev. From scintillation counter spectrometer studies, the gamma-energies are estimated at 0.90±0.05 and approximately 0.4 Mev; these figures have been checked by lead absorption curves.

A 10-min activity also appears in the decay of Sb grown from fission product Sn. The half-life of the Sn parent of this activity is estimated at less than 1 hr. Since the only periods found in Sb that has been grown from fission product Sn are 10 min, 9 hr, and 93 hr, it is probable that the reported genetic relationship of a 60-min Sb to a 70-min Sn is in error.[3-5] It is possible that the "70-min Sn" was a mixture which consisted, at least in part, of the 50-min Sn^{126} and 1.5-hr Sn^{127} described herein. In one $\gamma-\gamma$ coincidence decay curve run on Sb directly from fission a 40-min period was observed, but it has not been further investigated.

A period of ~30 days occurs in the decay of fission product Sb. The fission yield of this activity relative to 93-hr Sb^{127} is higher for 14-Mev fission than for thermal fission, and, hence, this activity probably belongs to a mass chain lower than 127. Grummitt and Wilkinson once reported a 28-day Sb,[6] but it has not been reported on the Plutonium Project.

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[1] R. W. Spence, Brookhaven Conference Report BNL-C-9, p. 43, July, 1949.
[2] Unpublished work at Los Alamos Scientific Laboratory by Cowan, Ford, Barnes, Minkkinen, Gilmore, and Pollock.
[3] Nishina, Kimura, Yasaki, and Ikawa, Z. Physik **119**, 195 (1942).
[4] O. Hahn and F. Strassman, Naturwiss. **31**, 499 (1943).
[5] J. A. Seiler, Paper 129, *Radiochemical Studies:* The Fission Products, National Nuclear Energy Series, Vol. IV, 9 (McGraw-Hill Book Company, Inc., New York, 1951).
[6] W. E. Grummitt and G. Wilkinson, Nature **158**, 163 (1946).

Tantalum Activities Produced by Photonuclear Reactions on Tungsten*

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THE irradiation of tungsten in a synchrotron-produced beam of x-rays with a maximum energy of 68 Mev yielded the three tantalum activities with appreciable intensities listed in Table I.

In this work spectroscopically examined samples of

$$Na_2WO_4\cdot 2H_2O$$

were irradiated at maximum energies of 30 and 68 Mev for periods from one to four hours. The activities were identified as tantalum by a chemical procedure based on that of Meinke,[1] which separates the rare earths, zirconium (hafnium), and tungsten from tantalum. To decrease the chemical separation time and to get a sample containing much less carrier, a fraction of the tantalum activity was adsorbed from a basic solution of Na_2WO_4 on insoluble sodium tantalate.[2] Duffield *et al.*[3] identified the 48-min activity as Ta^{185} from its preparation by a (γ, p) reaction on separated W^{186} isotope, confirming Butement's tentative assignment.[4]

Coincidence counting experiments showed that the soft and hard electron components of approximately equal intensity were not emitted within a delay period of less than 10 μsec. The soft electrons may be associated with a 1.85-min isomeric transition in W^{185} as proposed by Duffield *et al.*; however branching beta-decay is not excluded.

Characteristics of the 8.0-hr activity were similar to those given for Ta^{180} by Wilkinson.[5] Identification was confirmed by the high yield of 8.0-hr activity from x-rays on enriched W^{182} obtained on loan from the Isotopes Division of the AEC.

The 6.0-day period apparently corresponded to Butement's[4] 4.8-day activity. A longer decay period was probably associated with Ta^{182} and W^{185}; intensities were too low for identification.

TABLE I. Tantalum activities produced by x-rays on tungsten.

Half-life	Radiation	Electron energy (by absorption)	Relative yield at 68 Mev $\left(\frac{\text{atoms Ta}^A}{\text{atoms W}}\right)\Big/\left(\frac{\text{atoms N}^{13}}{\text{atoms N}^{14}}\right)$	Yield (arbitrary units) 68 Mev	Yield (arbitrary units) 30 Mev
48 min	β^- and e^-?	1.6, 0.15	0.41[a]	1[a]	1[a]
6.0 day	β^-	0.6	1.4	3.3	3.2
8.0 hr	β^-, x-rays	0.7	1.8[b]	4.3	1.2

[a] Based only on 1.6-Mev betas. [b] Based on decay scheme of reference 5.

Yields of activities were compared to the yield of C^{11} induced simultaneously in an organic compound. Absorption, self-scattering, and back-scattering corrections were applied.[6] Results in Table I were in terms of the $N^{12}(\gamma, p)N^{13}$ yield, for comparison with the results of Perlman and Friedlander.[7,8] Ta^{185} could form only by $W^{186}(\gamma, p)$. Ta^{180} could form by $W^{182}(\gamma, pn)$ or by a heavier isotope losing more neutrons. The variation in the yield with energy of Ta^{180} compared to Ta^{185} would result from the higher binding energy of two particles. The yield ratio of the 6.0-day activity to Ta^{185} did not change appreciably with energy suggesting that both are produced primarily by similar processes, (γ, p), and supports Butement's tentative assignment to Ta^{183}.

(γ, p) yields were similar in magnitude to those reported by Perlman and Friedlander. The approximate equality of the (γ, pn) and (γ, p) yields resembled their $Ge^{70}(\gamma, pn)Ga^{68}$ result.

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Experimental details of this work are described more fully in the AEC report ISC-158.

* Work performed in the Ames Laboratory of the AEC.

[1] W. W. Meinke, AECD-2738 (1949).
[2] Powell, Schoeller, and John, Analyst **60**, 506 (1935).
[3] Duffield, Hsiao, and Sloth, Phys. Rev. **79**, 1011 (1950).
[4] F. D. S. Butement, Proc. Roy. Soc. (London) **A64**, 395 (1951).
[5] G. Wilkinson, Phys. Rev. **80**, 495 (1950).
[6] Engelkemeir, Seiler, Steinberg, and Winsberg, National Nuclear Energy Series **9**, Paper 4 (1950).
[7] M. L. Perlman and G. Friedlander, Phys. Rev. **74**, 442 (1948).
[8] M. L. Perlman, Phys. Rev. **75**, 988 (1949).

New Isotopes of Berkelium and Californium

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IN the course of work on transplutonium isotopes at Berkeley, it has been possible to prepare mixtures of Cm^{242}, Cm^{243}, and Cm^{244} by intensive neutron irradiation of samples[1,2] originally consisting of the isotope Am^{241}. The heaviest curium isotopes are useful sources for the preparation of berkelium and californium isotopes heavier than have been previously observed from helium ion and deuteron bombardments of the isotopes Am^{241} and Cm^{242}. The properties of such new isotopes are of intrinsic interest and also contribute to the extension of the systematics of radioactivity. This letter outlines some of the experimental work which has been done in this connection.

A target containing approximately 100 μg of Cm^{242}, ~5 μg Cm^{243}, and ~2 μg of Cm^{244}, was bombarded with 35-Mev helium ions and 16-Mev deuterons using the same target technique mentioned previously.[3] The resulting californium and berkelium isotopes were chemically separated from each other, from the target materials, and from fission products using the same combinations of precipitation and ion exchange methods as have been reported previously.[3] The final chemical separations were completed approximately 9 hours after the end of the bombardment.

Examination of the radiations associated with the decay of the