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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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.

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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

berkelium isotopes in a windowless gas proportional counter showed the 4.6-hour Bk^{243} previously reported[3] and a considerably longer-lived decay period corresponding to a 4.95±0.1-day half-life. Some of this same radioactivity was examined in a differential alpha-pulse analyzer,[4] which revealed alpha-particles of the following energies and abundances: 6.33±0.05 Mev (18 percent), 6.15±0.05 Mev (48 percent), and 5.90±0.05 Mev (34 percent). All three alpha-particle groups were observed to decay with a 4.95-day half-life. Initially the three alpha-particle groups belonging to the 4.6-hour Bk^{243} were also present. Consideration of the systematics of alpha-radioactivity[5] suggests that the new 4.95-day isotope is most likely Bk^{245}. The new berkelium isotope must be of mass greater than 244 or it would have been observed in bombardments of Am^{241} with alpha-particles. Furthermore, much longer half-lives than 4.95 days were predicted for Bk^{246} and Bk^{247} using methods of estimation which have been described previously.[6] Comparison of the counting rate of the 4.95-day radioactivity in the windowless counter to that in the alpha-pulse analyzer allows calculation of ~0.1 percent alpha-branching, which corresponds to a 15-year partial alpha-half-life. The alpha-particle decay of this isotope appears to be hindered by a factor of ~100 (using the conventions of reference 5) and resembles the decay of the isotope Bk^{243} in this respect.

Following the decay of the berkelium isotopes, the curium daughters resulting from electron capture decay were examined in the alpha-pulse analyzer and the characteristic alpha-particles of Cm^{243} produced by the decay of 4.6-hour Bk^{243} were observed. The amount of alpha-activity of energies expected for Cm^{245}, namely, that in the range 5.4–5.8 Mev, was such that the half-life of the latter isotope must be at least 500 years if the energy is as indicated by the alpha-decay systematics.[5] This tentative conclusion is, of course, also based on the assumption that the mass assignment of the 4.95-day berkelium isotope is correct.

Examination of the californium fraction in the alpha-pulse analyzer soon after irradiation showed only 6.75-Mev alpha-particles decaying with a 35-hour half-life (tentatively assigned previously to Cf^{246}).[7] The growth of alpha-particles of 6.08-Mev energy was observed and the amount corresponded to a half-life of approximately 160 days. This daughter is undoubtedly Cm^{242} produced by the decay of Cf^{246}, and the assignment to Cf^{246} is now regarded as certain. The decay of the Cf^{246}, followed through a decay factor of approximately 50, gave a half-life of 35.7±0.5 hours in agreement with previous measurements. The ratio of the counting rate in the windowless proportional counter to the alpha-counting rate corresponded closely to that observed for a number of "pure" alpha-emitters previously examined under similar conditions, so that Cf^{246} appears to be beta-stable as expected. No radioactivity other than Cf^{246} and its daughter Cm^{242} was observed in the californium fraction. This result is somewhat surprising since it might have been expected that Cf^{247} and possibly Cf^{245} would have half-lives long enough to allow their observation.

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The Magnetic Moment of As^{75}*

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NUCLEAR magnetic resonances of As^{75} with a natural line width at half-maxima of about eight gauss have been observed in a solution of 2 molar Na_2HAsO_4 in 3 molar NaOH in which the compound Na_3AsO_4 is presumably formed. The resonant frequency was compared to that of Na^{23} present in the above solution with the result

$$\nu(As^{75})/\nu(Na^{23}) = 0.64745 \pm 0.00015. \quad (1)$$

Using the fact that the spin of As^{75} is $\frac{3}{2}$,[1] and calculating the moment of Na^{23} by taking $\mu(H') = 2.79268 \pm 0.00006$ nuclear magnetons,[2] and $\nu(Na^{23})/\nu(H') = 0.26450 \pm 0.00003$,[3] the sign and value of the magnetic moment was found to be

$$\mu(As^{75}) = +1.4347 \pm 0.0003. \quad (2)$$

The earlier determination of $\mu(As^{75}) = 1.5 \pm 0.3$ nm by Schüler and Marketu[4] is in agreement with the more precise value of Eq. (2).

In order to avoid excessive line broadening due to the large quadrupole moment ($+0.3 \times 10^{-24}$ cm^2)[4] of arsenic, it is necessary to place the nucleus in a symmetrical molecular configuration. The solutions of the above proportions were chosen on the assumption that AsO_4^{-3} ions of tetrahedral symmetry are formed.

Arsenic signals were detected in both liquid and solid phases of the above sample with a shift of about $1/10^4$ towards higher fields for the solid state. Nuclear resonances of As^{75} were not observed in other arsenic compounds (e.g., Na_2HAsO_4). This was probably due to the fact that the line widths, resulting from quadrupole effects, were too large.

We would like to express here our gratitude to Professor Bloch for helpful participation in many consultations during the course of this work.

* Assisted by the joint program of the AEC and ONR.
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The Electrical Conductivity of Liquid Germanium*

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OBSERVATIONS of the melting of germanium have shown that the fusion process for this metal is very unusual. The entropy of fusion is 5.9 cal/deg,[1,2] about three times the value for most metals, and there is a considerable volume contraction on melting.[3] Solid germanium crystallizes in the diamond lattice, while the x-ray experiments of Hendus[4] show that the atomic arrangement in liquid germanium corresponds to a more nearly close-packed structure. These facts indicate that the binding forces of liquid germanium are of more metallic character than those of the solid, and lend interest to a measurement of the electrical conductivity of the liquid.

The difficulty of finding electrodes suitable for use with germanium at the high temperature required for this experiment necessitated measuring the effect of currents induced in a germanium core on the impedance of a surrounding coil. Unfortunately, the effects of temperature on the coil severely limit the accuracy of this technique.

The germanium was obtained from the Eagle-Picher Company and was stated to be of purity in excess of 99.9 percent. The sample container was made of quartz, and the experiment was performed in an argon atmosphere. Measurements were made at frequencies around 20 kilocycles and around 2 megacycles.