and $Se^{78}(n, \alpha)Ge^{75}$, respectively. Absorption measurements show the maximum energy of the beta-particles from the 89-minute activity to be 1.2 ± 0.1 Mev, in agreement with Sagane's value of 1.1 Mev for his 81-minute period.[3] Gamma-rays are present but their intensity relative to the beta-particles is rather low.

Ge^{77}: 12 hours.—Sagane[1] reported a negative beta-emitter of 8 hours' half-life from slow neutron and deuteron bombardments of germanium and assigned it to Ge^{77}, because fast neutrons had produced very little of this activity. Our experiments confirm this assignment but show the half-life to be about 12 hours. This period, chemically identified as due to germanium, was produced by the d, p reaction in the bombardment of germanium with 16-Mev deuterons and by the n, α reaction in the fast neutron bombardment of selenium. These results, combined with the fact that the 12-hour period did not appear in fast neutron bombardments of either germanium or arsenic, make its assignment to Ge^{77} certain. The growth of As^{77} (90 days)[7] from this activity has not yet been investigated.

Ge^{69}.—In addition to the periods discussed, Sagane[1] reported a positron-emitting 29-minute activity which he obtained from fast neutrons on germanium only and therefore assigned to Ge^{69}. We failed to observe this period from the reactions $Ge^{70}(n, 2n)Ge^{69}$ and $Ga^{69}(d, 2n)Ge^{69}$ and Mann[2] did not find it from the reaction $Zn^{66}(\alpha, n)Ge^{69}$. These facts lead us to reject Sagane's assignment. The 195-day period reported by Mann[2] may be due to Ge^{69}.

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Radioactive Isotope of Protoactinium

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Hahn and Strassmann[1] have recently pointed out that the radioactivity of 25 days half-life assigned[2] to $_{91}Pa^{233}$, originally reported by Meitner, Strassmann and Hahn[2] to be the daughter of the 26-minute $_{90}Th^{233}$ produced by neutron capture in thorium, might actually be due to an isotope of zirconium. There is a 26-day zirconium[1] formed in the fission of uranium by neutrons, and hence probably also in the fission of thorium by neutrons. Since Meitner, Strassmann and Hahn[2] used zirconium as the carrier material for their radioactive substance, the question arises as to whether their 25-day radioactivity from thorium plus neutrons might be due to an isotope of zirconium rather than protoactinium.

We have investigated this point and our experiments definitely show that, in agreement with the original conclusions of Meitner, Strassmann and Hahn,[2] slow neutron bombardment of thorium produces a protoactinium of approximately 25 days half-life.[3] About 10 g of thorium nitrate, encased in a large paraffin block, was exposed for an hour to the neutrons produced during the bombardment of phosphorus with 100 microamperes of deuterons in the 60-inch cyclotron. The thorium was dissolved and precipitated from acid solution as the iodate, after the addition of appropriate carriers for the fission products, and then, after redissolving the thorium iodate in concentrated hydrochloric acid, successive precipitations of zirconium phosphate were performed. This showed that a 25-day period was growing from a parent of approximately 26 minutes half-life, presumably $_{90}Th^{233}$. The cross section for the production of the 25-day activity was very much greater than that of any of the fission products (e.g., antimony, tellurium, iodine, etc.). The absence in the zirconium phosphate fractions of the 17-hour zirconium, known[4] to be produced in the fission of uranium by neutrons, suggests that the amount of radioactive zirconium formed from fission in this experiment was negligible.

Final proof that the 25-day activity is an isotope of protoactinium, and not of zirconium, was obtained by separating protoactinium and zirconium by fractional crystallization[5] of zirconium oxychloride from hydrochloric acid solution. A sample of greater intensity was prepared, zirconium carrier was added and the sample was purified carefully and converted to zirconium oxychloride. The fractional crystallizations showed that the specific activities (activity per milligram ZrO_2) of the first fractions were of the order of 5 percent of the specific activity of the over-all sample, showing an accumulation of the activity in the mother liquor as should be the case for protoactinium. A sample of 17-hour zirconium was prepared (from uranium plus neutrons) and subjected to a similar series of fractional crystallizations; in this case the specific activities of all the fractions were the same as that of the over-all sample, as was to be expected.

Absorption measurements show the presence of a gamma-ray, and an upper limit for the beta-rays of about 0.4 Mev.

A search for $_{92}U^{233}$ activity from the decay of $_{91}Pa^{233}$ was made by chemically separating uranium. This uranium fraction was inactive with respect to beta-particle emission. The question of alpha-radioactivity is being investigated. $_{90}Th^{233}$ and $_{91}Pa^{233}$ are members of the $4n+1$ series of radioactive elements (the series which is missing among the natural radioactivities).

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