A 2.8 Hour Rhenium Isotope

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With 2 figures. (Received December 27, 1961)

Summary A rhenium isotope of 2.8 hours is produced by irradiating iridium or osmium with fast neutrons. Arguments are given for assigning this activity to the mass number 190.

Zusammenfassung Ein Rheniumisotop mit 2,8 Stunden Halbwertszeit ist durch Bestrahlung von Iridium und von Osmium mit schnellen Neutronen hergestellt worden. Es werden Gründe dafür angegeben, diese Aktivität der Massenzahl 190 zuzuordnen.

Résumé Un isotope de rhenium avec une demi-période de 2,8 heures a été produite par irradiation de l'iridium et de l'osmium avec des neutrons rapides. Des arguments sont donnés pour attribuer cette activité au nombre de masse 190.

A rhenium isotope with a half-life of about one hour has been reported by several authors. Chu[1] observed its presence in the rhenium fraction of osmium irradiated with 19 MeV deuterons. Aten and De Feyffer[2] could not confirm this with 28 MeV deuterons but observed a 1 to 2 hours half-life in the rhenium fraction of osmium irradiated with fast neutrons. Haldar and Wiig[3] also mention a one hour rhenium isotope produced by protons on rhenium and tungsten, for which they consider mass numbers 184 to 186.

We have been able to produce a rhenium isotope with a half-life of this order of magnitude in the course of fast neutron reactions on iridium and osmium. By irradiating iridium oxide with fast neutrons (produced by bombarding beryllium with 28 MeV deuterons in the Buenos Aires synchro-cyclotron) and isolating the rhenium fraction, half-lives of about 2.8 hours, 17 hours and several days were observed (Fig. 1). In fast separations the 3 min. ^{190}Re is also seen, which confirms its mass number. The chemical procedure was the following: the irradiated iridium oxide was treated with hot concentrated ammonia containing a few drops of a concentrated H_2O_2 solution. The iridium oxide decomposes the H_2O_2 catalytically and during this process part of the rhenium goes into solution in a way similar to that described for the Ru-Tc system[4]. The mixture was filtered at this stage and Re carrier added to the filtrate. After an iron scavenging step, the solution was brought nearly to dryness, nitric acid added and Os repeatedly distilled off with help of carrier. Rhenium was then precipitated from a dilute hydrochloric acid solution with nitron or tetraphenyl-arsonium chloride. The process takes about ten minutes. The 2.8 hours half-life was also observed when the rhenium fraction was further purified by distillation.

With fast neutron irradiations of natural osmium, the 2.8 hour half-life was again observed when the rhenium fraction was counted through a 50 mg/cm^2 aluminium absorber (Fig. 2). An enriched ^{189}Os sample (origin: Oak Ridge. Composition: 1.7% ^{188}Os, 87.3% ^{189}Os,

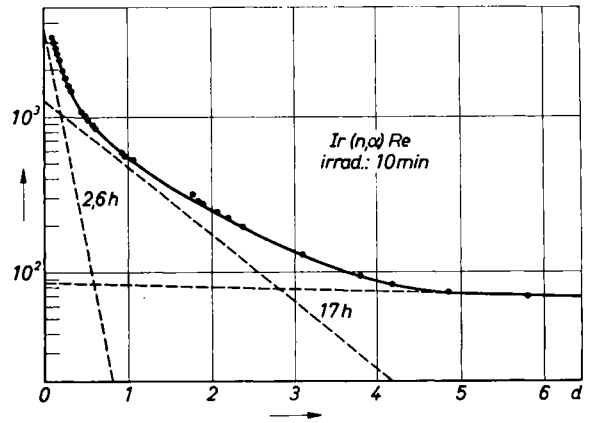

Fig. 1. Decay curve of the rhenium produced by irradiating iridium with fast neutrons

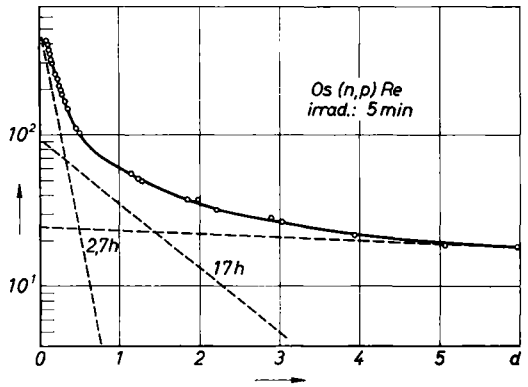

Fig. 2. Decay curve of the rhenium produced by irradiating natural osmium with fast neutrons

[1] T. C. Chu, Physic. Rev. **79**, 582 (1950).
[2] A. H. W. Aten jr. and G. D. De Feyffer, Physica **21**, 543 (1955).
[3] B. C. Haldar and E. O. Wiig, Physic. Rev. **105**, 1285 (1957).
[4] J. Flegenheimer, Proc. Int. Conf. Peaceful Uses Atomic Energy, Geneva **7**, 191 (1956).

8.5% ^{190}Os and 2.5% ^{192}Os) irradiated for the same length of time and counted in the same way without chemical separations, also showed the 2.8 hour half-life, but with a yield about five times lower (using the 17 hours ^{188}Re as monitor). (The ratio of about 5 between the 2.7 : 17 hours Re activities obtained in natural Os : enriched ^{189}Os can be explained by the fact that a contribution to the activation by the (n, np) process cannot be neglected.)
Absorption measurements carried out with aluminium foils on the Ir (n, α) sample only showed the presence of a β-radiation with a maximum energy of about 1.7 MeV. At this time about equal activities of 17 hours and 2.8 hours rhenium were present. In all cases the total yield of the 2.8 hours rhenium was lower than that of 17 hours ^{188}Re.
The fast neutron reaction on iridium supports a mass number of 188 or 190 for the 2.8 hour rhenium isotope, since other nuclear reactions than (n, α) are unlikely with our neutron energies. The lower yield with the enriched ^{189}Os sample as compared to natural osmium suggests that the mass number 190 is probable for this isotope.

Acknowledgement

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Note added in proof:

In connection with our experiments the discovery of ^{189}Re with a half-life of 23 hours (B. CRASEMANN, G. T. EMERY and W. R. KANE, Bull. Amer. Physic. Soc. II. 7, 353, April 23, 1962) is of great interest. (In the mean time this nuclide had also been observed in our laboratory by prolonged irradiation of enriched ^{189}Os with fast neutrons.) Evidently, the long period which we assumed to be the 17-hours ^{188}Re, was mainly ^{189}Re in the fast neutron irradiation of enriched ^{189}Os. This invalidates our detailed discussion of the activity ratios of the 2.7 hours and 17 hours activities. We may add that irradiation of 98.7% enriched ^{192}Os with 28 MeV deutons produced a rhenium fraction in which the only periods we observed were 2.8 hours, due to the (d, α) reaction, and 24 hours, due to the $(d, \alpha n)$ reaction.

Über die Herstellung von Si^{32} durch einen (t,p)-Prozeß

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Mit 4 Abbildungen. (Eingegangen am 15. März 1962)

Zusammenfassung Mit Tritonen aus dem $Li^6(n, t)He^4$-Prozeß wurde über die Reaktion $Si^{30}(t, p)Si^{32}$ das bisher wenig bekannte langlebige Nuklid Si^{32} hergestellt. Die Identität des Nuklids konnte mittels der Abtrennung und Identifizierung der Tochter P^{32} und durch den Tochteranstieg im radiochemisch gereinigten Si^{32}-Präparat nachgewiesen werden. Durch Vergleich der Bildungswahrscheinlichkeiten für die Reaktionen $Mg^{26}(t, p)Mg^{28}$ und $Si^{30}(t, p)Si^{32}$ wurde die Halbwertszeit des Si^{32} zu 650 Jahren bestimmt.

Summary Tritons produced by the process Li^6 (n, t) He^4 were used to obtain the long-lived Si^{32} by means of the reaction Si^{30} (t, p) Si^{32}. The identity of the nuclide was proved by means of separation and identification of the daughter P^{32} and by the growth of the daughter activity in the Si^{32} sample following a silicon-phosphorus separation. A comparison of the probabilities of the reactions Mg^{26} (t, p) Mg^{28} and Si^{30} (t, p) Si^{32} led to a value of 650 years for the half-life of Si^{32}.

Résumé Des tritons produits par le processus Li^6 (n, t) He^4 ont été utilisés pour la préparation du Si^{32} – isotope peu connu, à longue période – au moyen de la réaction Si^{30} (t, p) Si^{32}. L'identité de cette nuclide a été démontrée par l'isolation et l'identification du P^{32} produit par la transformation du Si^{32} ainsi que par l'accroissement de cette nuclide dans une préparation purifiée du Si^{32}. Une comparaison de la probabilité des réactions Mg^{26} (t, p) Mg^{28} et Si^{30} (t, p) Si^{32} donne une demi-période de 650 ans pour le Si^{32}.

Einführung

Auf der Suche nach langlebigen Isotopen des Siliziums entdeckte M. LINDNER 1953[1,2] bei der Kernzersplitterung von Cl^{37} mit 340 MeV Protonen ein β-aktives Silizium-Isotop, dem er die Massenzahl 32 zuschreiben konnte, da es ihm gelang, P^{32} als Tochterprodukt nachzuweisen. Die Analyse der Absorptionskurve ergab, daß das Si^{32} ein Negatronenstrahler von ca. 100 KeV β-Maximalenergie ist, entsprechend einer Reichweite von ungefähr 15 mg Al/cm². γ-Strahlen wurden nicht festgestellt. Das Si^{32} ist so langlebig, daß innerhalb der mehrmonatigen Versuchszeit keine Aktivitätsabnahme zu beobachten war. Die Halbwertszeit wurde daher aus der Bildungswahrscheinlichkeit der Si^{32}-Kerne bei der Kernzersplitterung des Cl^{37} errechnet, wobei die Wirkungsquerschnitte für die Reaktio-

[1] M. LINDNER, Heavy Isotopes of Magnesium and Silicon. Physic. Rev. 89, 1150 (1953).
[2] M. LINDNER, New Nuclides Produced in Chlorine Spallation. Physic. Rev. 91, 642–44 (1953).