Artificial Radioactive Isotopes of Polonium, Bismuth and Lead*

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March 8, 1947

THROUGH use of cyclotron beams of 20-Mev deuterons and 40-Mev helium ions and of an intense neutron source, new artificial radioactive isotopes have been produced and identified to varying degrees of certainty as shown in Table I.

As a result of the new experiments, definite mass numbers have been assigned to some previously known radioactive isotopes as shown in Table II.

The mass assignments of the polonium isotopes were made on the basis of their relative yields when lead of different isotopic composition was bombarded with 40-Mev helium ions.[1]

The 9-day Po^{206} was found to decay into the 6.4-day bismuth activity assigned to Bi^{206} or Bi^{207} by Fajans and Voigt.[2] The assignment to Bi^{206} is in agreement with the observation of Corson, MacKenzie, and Segrè[3] that this activity is not produced by the alpha-decay of ${}_{85}At^{211}$.

The 5.7-hour Po^{207} cannot be Po^{208} because it was not made by bombardment of Bi^{209} with 20-Mev deuterons, for which a high $(d, 3n)$ cross section is expected.

The alpha-activity attributed to Po^{208} may be a mixture of Po^{208} and Po^{209} with similar α-particle ranges, but on the basis of yield arguments most of this activity must be Po^{208}.

The high yield of the 12-hour bismuth from deuterons on Pb^{204} limits the assignment to Bi^{203} or Bi^{204}, and the high yield from helium ions on thallium sets 204 as the lowest possible mass. Therefore the isotope is Bi^{204}. It decays into the 68-minute lead[2,4] which assigns this lead to an excited state of Pb^{204}. Only 4 percent as many counts of 68-minute Pb are observed as of 12-hr. Bi^{204}. Unless the counting efficiencies are different by 25-fold, some of the Bi^{204} decays directly to stable Pb^{204}.

A long-lived activity (negative electrons and γ-rays) was found in bismuth which had been subjected to a very high neutron flux for several months. The long-lived activity followed the bismuth through several chemical separations from added Ag, Sb, Sn, Tl, Hg, and Pb. It is assumed to be Bi^{208}, which may decay either by β^- emission or by electron capture, since both Pb^{208} and Po^{208} appear to be stable with respect to such decay.

The 52-hr. lead isotope has been produced previously by deuterons on thallium[2,5] and by fast neutrons on lead[4] and was assigned to either 203 or 205. Since it failed to appear as a result of the reaction $Pb^{204}(d, p)Pb^{205}$, it is now assigned as Pb^{203}. Maurer and Ramm[4] made the same assignment on the basis of experiments which seemed to show that the activity was produced from Pb^{204} but not from Pb^{206} by fast neutrons. We have confirmed this result by bombarding Pb^{204} and Pb^{206} in the Argonne pile.

Detailed accounts of the experiments leading to these results will appear in forthcoming papers.

TABLE I.

Isotope	Mode of Decay	Half-life	Method of Production
Po^{206}	K (~90%), α (~10%, 5.2 Mev), γ	9 day	$Pb^{204}(\alpha, 2n)$
Po^{207}	K (~100%), α (~0.01%, 5.1 Mev), γ	5.7 hr.	$Pb^{206}(\alpha, 3n)$
Po^{208}	α (5.14 Mev)	~3 yr.	$Pb^{207}(\alpha, 3n)$
Bi^{204}	K (e^-, γ)	12 hr.	$Pb^{204}(d, 2n)$ $Tl(\alpha, 3n)$
Bi^{208}?	? (e^-, γ)	long-lived	$Bi(n, 2n)$?

TABLE II.

Isotope	Mode of Decay	Half-life
Bi^{206}	K, e^-, γ	6.4 day
Pb^{204*}	$I.T., e^-, \gamma$	68 min.
Pb^{203}	K, e^-, γ	52 hr.

* This report is based on work performed under Contract No. W-7405-eng-48 with the Manhattan Project at the Radiation Laboratory, University of California.

[1] We are indebted to Dr. B. J. Moyer, Dr. C. M. Van Atta and members of the isotope separation staff for making available the separated lead isotopes, to Dr. E. H. Huffman, Mr. R. C. Lilly, and Miss Dorothy Bockhop for their purification, and to Mr. T. J. Vale for his mass spectrometric assay. The bombardments were made possible through the cooperation of Dr. J. G. Hamilton, Mr. T. Putnam and other members of the group that operates the 60-inch cyclotron.

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Auger Showers and the Comets

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March 20, 1947

KLEIN has conjectured that the Auger extensive cosmic-ray showers are produced by fragments of hypothetical matter having negative atomic nuclei.[1] The writer has conjectured that the comets consist of this type of matter.[2] Now, if both these conjectures should be correct, then, in the absence of adverse variations of barometric pressure, the frequency of Auger showers in any locality would be expected to increase during a cometary meteor shower overhead. Therefore, even at the risk of engaging in what might perhaps be loosely described as a wild-goose chase, it should be of interest to schedule experiments on Auger showers so as to determine whether or not such increases actually occur. By combining these experiments with visual observations—or with radio-echo or radar observations, so as not to be dependent on darkness and a clear sky—one could also attempt to determine whether or not the passage of an individual cometary meteor near the zenith is accompanied by Auger showers.

One of the meteor showers to which a parent comet has been assigned is the Perseid shower in August.

I am indebted to Professor Niels Arley for calling my attention to Klein's paper.

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