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Author
Templeton, D.H.

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by

D. H. Templeton and I. Perlman

Berkeley, California

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D. H. Templeton and I. Perlman

Radiation Laboratory and Department of Chemistry
University of California, Berkeley, California

ABSTRACT

Four new alpha-emitters of half lives 2 min., 9 min., 27 min., and 1-2 hr. have been found from the bombardment of lead with high energy deuterons. The three of longest half-life have been identified as isotopes of bismuth. It is believed that the mass numbers of all of the isotopes are less than 203.

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D. H. Templeton and I. Perlman

Radiation Laboratory and Department of Chemistry
University of California, Berkeley, California

When lead was bombarded with approximately 200-Mev deuterons in the 184-inch cyclotron a great variety of nuclear reactions were noted. Fission has been demonstrated by the identification of radioactive fission products[1] and a mixture of isotopes from Bi (element 83) to Au (element 79) have been partially identified. These were produced by reactions analogous to those reported from other irradiations with high energy particles[2].

This report has to do with some new short-lived emitters of alpha-particles produced from high energy deuterons on lead. The alpha-activity was in very low abundance compared with the Geiger counter activity and was first observed in the unseparated target material. The decay curves could be resolved into 2 min., 9 min., 27 min., and 1-2 hr. components. The longest period was too weak for accurate half-life determination. The three longest periods were chemically identified with the bismuth fraction but the chemical separation was too slow to permit observation of the 2-min. period. Lead which was bombarded with 100 Mev deuterons showed the 1-2 hr. and 27 min. periods but the shorter periods could not be detected. Therefore, the 2-min. and 9-min. activities are probably of lower mass number than the longer-lived ones. All of these isotopes of bismuth are believed to be of lower mass number than 203 since lead, enriched in Pb^{204}, did not show any alpha-activity when bombarded with 20-Mev deuterons[3].

The alpha-particle energies of the three longer periods were all in the range of 5.5 ± 0.3-Mev as measured by an alpha-particle pulse analyzer[4]. The lack of precision was caused by the high background of electrons, and by the inability to prepare extremely thin samples. Because these energies seem too low for alpha-particle half-lives of the order of minutes and since the bismuth fraction showed a great preponderance of electrons over alpha-particles it is concluded that the alpha-emission represents but a small branching in the predominantly orbital electron capture decay. For example, a 30-min. period and a 100-min. period could be resolved out of the Geiger-counter decay curve and under the assumption that these are the same as the 27-min. and 1-2 hr. alpha periods, alpha-particle to electron ratios of 7×10^{-4} and 6×10^{-5}, respectively, were calculated. The half-lives for alpha-decay for the 27-min. and 1-2 hr. activities then become about 1-month and 3-years if it is assumed that there is almost one electron emitted per orbital electron capture disintegration.

These data show that alpha-instability as reflected by the alpha-particle half-lives follows the same trend in the case of bismuth isotopes as that noted for the isotopes of polonium. In the case of polonium it has long been noted that there is a minimum half-life at ThC' (Po^{212}) and that the half-lives increase both toward lower and higher mass numbers. This curve has been extended[(5)] to show that the half-life for Po^{208} is even longer than for Po^{210} but that the partial alpha half-life then decreases again at lower mass numbers as exemplified by Po^{206}. In the case of bismuth, the earlier noted half-lives showed a decrease from heavier masses toward AcC (Bi^{211}) which has a 3-min. half-life. Recently Broda and Feather[(6)] reported that RaE(Bi^{210}) undergoes rare alpha-branching corresponding to a partial alpha half-life of about 10^4-10^5 yrs. Below RaE the half-life increases still further as shown by the failure to detect alpha-activity in Bi^{209}. However, the present studies show that very light isotopes of bismuth ($Bi^{<203}$) again have measurable alpha half-lives.

We wish to acknowledge the assistance and cooperation of Dr. John Woodyard, Dr. D. C. Sewell and all those whose operation of the 184-inch cyclotron made these irradiations possible.

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