TABLE I. Isotopes of Sb and Te formed in the irradiation of antimony with 200-Mev deuterons.

Isotope	Half-life	Decay mech.	Energy (Mev) particles	γ-rays	References
Sb	Several hours	K, e^-			2
Sb^{119}	39 hours	K	none		2
Sb	6.0 days	K, e^-, γ or IT, e^-, γ		1.1	
*Sb^{122}	2.8 days	β^-, γ, e^-			3
*Sb^{124}	60 days	β^-, γ			3
Te^{118}	6.0 days	K, no γ(?)			
Te^{119}	4.5 days	K, e^-, γ	0.2, 0.5	1.4	
*Te^{121}	140 days	IT, e^-, γ			4

* Isotope identified from properties listed in the literature but not further characterized.

The assignment of the 4.5-day tellurium—39-hour antimony isobars to mass number 119 is most reasonable in view of their production with 40-Mev deuterons on antimony, their decay characteristics, and the possibilities open. This assignment agrees with that of the 39-hour antimony by Coleman and Pool from other evidence. The most reasonable assignment of the 6.0-day tellurium—3.5-minute antimony isobars is mass number 118. They were produced with 40-Mev deuterons on antimony which would be impossible for mass number 116 and probably for mass number 117. An odd mass number (117) is also unlikely in view of observed half-life relationships. This isotopic assignment is in apparent conflict with the assignment of the 5.1-hour antimony to mass number 118.[2] However, it is possible that the 3.5-minute antimony and the 5.1-hour antimony are isomeric and that in the decay of the 6.0-day tellurium parent only the upper state (3.5-minute antimony) is formed.

If the above assignments are accepted, the 6-day antimony would have to be isomeric with a previously known activity and of these the most reasonable guess is Sb^{120}, the isomer being the 17-min. positron emitter. In order to make an assignment, a sample consisting of 95 percent isotopically pure Sn^{120} was bombarded on the Berkeley 60-inch cyclotron with 18-Mev deuterons. At this energy the cross section for the $d,3n$ reaction is known to be low as compared to the $d,2n$ reaction, so that only Sb^{120} should be formed in good yield. Three antimony activities were obtained, one the 17-minute, β^+-emitting Sb^{120}, a second the 6-day activity as anticipated, and the third the 39-hr. Sb^{119}. The K x-rays from the 6-day activity were found to be those of tin, so that the decay process is K-electron capture. The cross sections for the formation of the 6-day and 17-minute activity were roughly the same, namely 0.1×10^{-24} cm². The 6-day antimony K-capture decay is therefore assigned to Sb^{120} since the cross section is too high for any other possibilities. The Sb^{119} appeared in sixfold lower yield than the sum of the Sb^{120} isomers.

The tin fraction was found to contain a single β^--activity of 28-hour half-life. The maximum β^--energy was found from absorption in beryllium and from beta-ray spectrometer measurements to be about 0.4 Mev and no γ-radiation was present. The 26-hr. Sn of Livingood and Seaborg[5] is therefore Sn^{121}, formed in this case by the reaction $Sn^{120}(d,p)Sn^{121}$. The cross section for formation with 18-Mev deuterons is 0.02×10^{-24} cm².

The cooperation of Dr. D. C. Sewell, Mr. J. T. Vale, and all of those whose operation of the 184-inch cyclotron made these irradiations possible is gratefully acknowledged.

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The Alpha-Ray Emitting Isotope in Samarium

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IT was shown by Hevesy, Pohl, and Hosemann[1,2] in 1932–34 that samarium emits slow alpha-rays with a range in air of only 1.13 cm at the rate of 89 per second per gram. The phenomenon has been confirmed by many observers. In 1938 Wilkins and Dempster[3] reported that the alpha-ray tracks from a deposit of separated isotopes laid down on a photographic plate appeared to start from the isotope of mass 148. The experiments were interrupted by the death of Professor Wilkins and only one such deposit was made. Since that time measurements of the mass of the deposits obtained with a spark source similar to that used in the 1938 experiments showed that the amount was approximately 2×10^{-10} gram. As this quantity of samarium is not enough to have produced in three and a half months the ten tracks observed, accidental contamination must have been present. This may have been caused by the spark source itself, for in experiments on the masses of beta-active isotopes it has been observed that a spark source of ions may detach from the electrodes particles of finite size consisting of many atoms, which are reflected around inside the mass spectrograph and may settle on the plate collecting the isotopic atoms. Many more rays may thus be emitted from these specks on the plate than from the separated isotopes themselves.

It is of great interest to determine the mass of the active isotope, and in the following paragraphs some preliminary observations with much larger amounts of separated isotopes are described. Several deposits were made with the hot anode ion source developed by Dr. A. E. Shaw,[4,5]

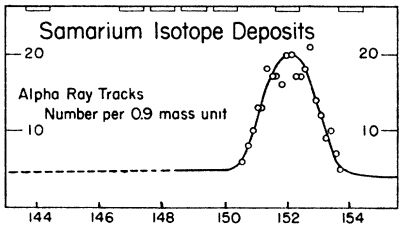

FIG. 1. Alpha-rays from separated isotopes. Ordinate points give the number of tracks within 0.45 mass unit of the abscissa mass.

where the separated isotopes are collected on metal plates coated with graphite. Alpha-ray plates were exposed for several months directly above the deposits which appeared as visible patterns of the samarium mass spectrum. One deposit which gave the distribution of tracks shown in Fig. 1 on the transfer plate was estimated from the ion current to have a total mass of 0.19 microgram. The transfer plate was exposed for 170 days, and 117 alpha-ray tracks would be expected in that time. The positions of the tracks, their lengths, and number of grains were observed, using a 95-power oil immersion objective with dark field illumination and a 10-power micrometer eyepiece. Only short tracks with lengths of 7μ or less were measured;[6] any longer tracks were ascribed to contaminations. A total of about 48 tracks that could be ascribed to samarium were found in the region between mass 150 and mass 154 as shown in Fig. 1, and no concentration was found in any other region. Each of the points through which the curve in Fig. 1 is drawn gives the number of tracks which lie in a band having its center at the mass shown and a width corresponding to 0.9 mass unit. The curve suggests that the alpha-ray emitter is the isotope at mass 152. Sputtering of part of the deposit may account for the width of the curve and the fact that the total number of tracks observed is only 40 percent of the number expected.

Other deposits were not so conclusive, and even though the unsatisfactory results with them may be attributed to loss of the deposit by sputtering, as shown by the complete removal of the graphite in some cases, the mass value 152 should be regarded as provisional for the present. Further experiments are in progress in which the isotopes are collected in small hollow chambers to avoid loss by sputtering, and more complete results may be obtained in the near future.

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A Type of Non-Linear Random Distortion (Noise) in Pulse Communication*

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WHEN the information to be transmitted in pulse communication is contained in the variation of the distance between the successive pulses, one speaks of pulse position modulation without fixed reference. In the transmission of sinusoidal signals of certain frequencies by this method, there occur, at irregular time intervals, pulse precessions, each of a short duration observable either on an oscilloscope or as audio distortion (noise). These precessions "have all the earmarks of randomness"[1] with one very puzzling property, however. For some signal frequencies, this precession, when observed on the oscilloscope, always proceeds to the right and for other frequencies always to the left, thus seemingly contradicting the argument for its random origin. Developing further the mathematical theory of pulse position modulation without fixed reference introduced elsewhere,[2] we explain this lack of symmetry and show that each such precession is triggered by the (random) pulse jitter. It appears that the afore-mentioned distortion is peculiar to the modulation scheme itself and is not a property of the circuits employed to achieve this modulation.

The discussion leading to an explanation of the above-mentioned random non-symmetric distortion may be summarized as follows. First one observes that the points at which the signal is sampled are iterated images of a one-to-one continuous transformation τ (induced by the method of sampling) of the period of our signal. Then one sees that these sampling points may be distributed periodically if and only if some power (iteration) of τ has fixed points. If τ^k is the smallest power of τ with fixed points,[3] there exists a steady-state stable equilibrium distribution of exactly k distinct sampling points which form a period containing one or more periods $1/f_s$ of the signal. If the sampling does not happen to begin at one of the above equilibrium positions there occurs a transient phenomenon, *viz.*, a rapid precession of sampling points toward these "stable equilibrium" positions which are determined completely by the ratio f_s/f_p of the signal frequency f_s to the unmodulated pulse repetition rate f_p, and by the amplitude of the signal.

Besides the k stable equilibrium positions of sampling points in the case of periodic distribution there exist k fixed sampling positions which one may call "unstable equilibrium" positions. For if sampling begins at one of these positions, then the signal will be sampled only at these fixed positions in its period. However, a small deviation, say caused by pulse jitter, will lead to a rapid precession of sampling points away from these equilibrium positions and toward the k stable equilibrium positions.

In practice, the unstable chain rarely persists long enough to be observed.

The k sampling points in a stable equilibrium distribution are separated by the k points of unstable equilibrium. For certain values of the ratio f_s/f_p each stable equilibrium position of sampling has in its proximity an unstable sampling position. If, as a result of random pulse jitter, there occurs a small deviation in the direction of the unstable equilibrium position and if this deviation exceeds the distance between the stable and its neighboring unstable positions, there occurs a precession (referred to in the first paragraph) of pulses (sampling positions) toward the next and relatively distant equilibrium position. The relative positions of the adjacent stable and unstable equilibrium positions determine the direction of such a pulse precession.

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