It is possible, even likely on theoretical grounds, that nucleons do not generate electrons or photons directly, but rather through the production and subsequent almost immediate decay of neutral mesons. It also appears possible, in view of the recent experiments with photographic emulsions,[3] that the primary products of nuclear collisions are heavy mesons, which then disintegrate into neutral mesons and ordinary mesons. It is hoped that a more complete analysis of existing data as well as the results of new experiments now in progress will throw some light on the exact mechanism of production of electrons and photons by nucleons. The research described in this letter was supported partially by Contract N5 ORI-78, U. S. Navy Department, Office of Naval Research.

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[1] H. Bridge, B. Rossi, and R. W. Williams, Phys. Rev. 72, 257 (1947).
[2] See, for instance, J. Daudin, Comptes Rendus (May 1944); G. D. Rochester, Proc. Roy. Soc. A187, 464 (1946); W. B. Fretter, Phys. Rev. 71, 462 (1947).
[3] C. M. G. Lattes, G. P. S. Occhialini, and C. F. Powell, Nature 160 453 (1947).

Isotopic Composition of Samarium

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DURING the last three years several measurements of the abundance of the samarium isotopes were made at the Metallurgical Laboratory. The only previous measurements were those of Aston,[1] which were made from incompletely resolved spectra and were admittedly not very accurate. The observation of the neutron absorption by the isotope at mass 149 by Lapp, Van Horn, and Dempster[2,3] required a new measurement. For their measurements mass spectra were made on Eastman III-O ultraviolet sensitive spectroscopic plates with a double focusing instrument in which the ion source was a vacuum spark between nickel tubes packed with the oxide of samarium. The gadolinium abundances as measured by Wahl[4] were used as intensity standards. There is, however, some question as to the slope of the density curve used by Wahl in determining the gadolinium abundances, since the intensity standards were printed by x-rays.

A second measurement was a photometric comparison of samarium with the neodymium isotopes by Wilfrid Rall and A. J. Dempster,[5] using the abundances given by J. Mattauch and V. Hank[6] for the latter element as standards. In their determination of the neodymium standards these authors fixed the slope of the photographic density curve by means of exposures with different exposure times on the same plate, assuming constancy of discharge. These values are given in the third row of Table I.

TABLE I. Abundance of samarium isotopes.

144	147	148	149	150	152	154	Obs.
3	17	14	15	5	26	20	Aston[1]
3	14.2	9.5	12.7	5.0	31.9	23.7	L,VH,D[2,3]
2.7	15.2	10.8	14.1	7.7	27.1	22.4	R,D[5]
3.16 ±.10	15.07 ±.15	11.27 ±.11	13.84 ±.14	7.47 ±.07	26.63 ±.26	22.53 ±.22	I,H,H

Our own measurements were made using electrometric recording of the ion currents. This eliminates the difficulties in determining the density curves so that the isotopic abundances determined are independent of any other measurements. The analysis was made with a 60°, six-inch radius of curvature single focusing mass spectrometer in the same manner as our previously reported measurements of lanthanum and cerium.[7] The ions were produced by heating the oxide of samarium on a tungsten filament. Ion currents were measured with a vibrating reed electrometer connected to a Brown Electronik Strip Chart Recorder. No source magnet was used, and the ion beams were swept across the final collector by changing the analyzer magnetic field. Thus all discriminations are believed to be below 1 percent.[7] The results are tabulated in the fourth row of Table I. Except in the case of mass 144 the errors tabulated are larger than the mean deviations by amounts sufficient to include possible systematic errors in the mass spectrometer. The actual mean deviations are about three times smaller than the deviations quoted in the table.

Calculations of the chemical atomic weight from these abundances, assuming a packing fraction for samarium of -2.4×10^{-4} and the factor 1.000275 in converting from the physical to the chemical atomic weight scales, gives a value of 150.35 as compared with the chemically determined value of 150.37.

The following upper limits for possible samarium isotopes of neighboring masses were obtained: 140, 141, 142, less than 0.001 percent; 143, 145, and 146, less than 0.002 percent; 151, less than 0.02 percent; 153 and 155, less than 0.01 percent; 156, 157, and 158, less than 0.002 percent.

These limits are of special interest in connection with the alpha-activity of samarium which corresponds to a half-life for all the nuclei of 10^{12} years. Because the location of this activity is still uncertain, and because the isotope of mass 146 has been assumed to be undetected because it is alpha-active, it is of interest to consider this isotope as the source of the activity. Since if it is present, it is present to less than 0.002 percent, the upper limit on the half-life of the isotope is 2×10^{7} years. This is too short a half-life from geological considerations to explain the present activity, so this activity must still be located in one of the known isotopes. Thus, if the 146 is absent because of alpha-activity, it is a different activity from the alpha-activity now existing in samarium.

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[3] R. E. Lapp, J. R. Van Horn, and A. J. Dempster, Phys. Rev. 71, 745 (1947).
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