

TABLE I.

	Counts	Duration	Rate
(AB)	765,606	26,920 min.	28.44 ± 0.03/min.
(AB-C) with 7-cm Pb absorber	26,313	13,925 min.	1.89 ± 0.01/min.
(AB-C) sans 7-cm Pb absorber	7,859	7,597 min.	1.03 ± 0.01/min.
N with 7-cm Pb absorber	116,666	15,707 min.	7.43 ± 0.02/min.
N with 1-mm Cd sheaths around N counters	6,744	5,850 min.	1.15 ± 0.01/min.
(AB-C:N) with 7-cm Pb absorber and sans Cd sheaths	61	181.33 hr.	0.34 ± 0.04/hr.
(AB-C:N) with 7-cm Pb absorber and with Cd sheaths	0	50.75 hr.	—
(AB-C:N) sans 7-cm Pb absorber and sans Cd sheaths	1	44.13 hr.	0.02 ± 0.02/hr.
(AB:N) with 7-cm Pb absorber and sans Cd sheaths	56	80.45 hr.	0.70 ± 0.09/hr.
(AB:N) with 7-cm Pb absorber and with Cd sheaths	0	46.75 hr.	—

ording to present views, there should be no neutrons from mesons stopped in paraffin.

The ratio of particles stopped in the lead to neutron coincidences is 51.6:0.34, or 152. Allowing for a 20 percent positive excess, we conclude that there is one neutron coincidence per 61 negative mesons stopped. The solid angle subtended by the neutron detecting arrangement is approximately π -steradians. If there is one neutron produced per negative meson stopped, the efficiency of the neutron detecting arrangement is 6.5 percent per incident neutron. Before any conclusion can be drawn as to the multiplicity of the neutron production, it will be necessary to determine experimentally the efficiency of the neutron detecting arrangement for incident neutrons of various energies. We are preparing to do this for Po-Be and Ra-Be neutrons. It is also not entirely impossible that the neutron coincidences are due to stopped protons, which may amount to as much as 5 percent of the number of stopped mesons.⁴ This would, however, imply an improbably high efficiency for the neutron detecting arrangement.

We are continuing our investigation of the effects reported, and are, in particular, trying to find out whether the neutrons result from capture or decay (neutral mesons producing neutrons?).

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¹ We are indebted to the Argonne National Laboratory for the loan of these counters; we understand that their efficiency for room-temperature neutrons incident at right angles to the axis is about 10 percent.

² B. Rossi, N. W. Hilberry, and J. B. Hoag, *Phys. Rev.* **57**, 464 (1940).

³ V. Tongiorgi [*Phys. Rev.* **73**, 923 (1948)], using a technique similar to ours, finds neutrons associated with extensive showers. We have recently taken data with extra anticoincidence counters of the C group, C¹, placed next to trays A and B. The (AB-C:N) rate is not significantly less than the (AB:N) rate, indicating that the doubling cannot be ascribed to showers incident on the apparatus.

⁴ B. Rossi, *Interpretation of Cosmic Ray Phenomena* (Technical Report No. 7 of the Massachusetts Institute of Technology Laboratory of Nuclear Science and Engineering, March 22, (1948).

The Isotopic Constitution of Praseodymium and Neodymium

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OUR mass spectrometric measurements of rare earth isotopic constitutions^{1,2} have been extended to include praseodymium and neodymium. Methods of analysis were similar to those discussed in the first reference.

Praseodymium was first studied by Aston,³ who reported a single isotope of mass 141. He gave no upper limits for possible existence of other stable isotopes. No other studies of this element have been reported.

For this investigation a nitric acid solution of praseodymium oxide (Hilger Laboratory No. 1533) was pipetted onto a tungsten filament and heated in air to form an adherent oxide coat. This filament was then inserted into the source of a 60° mass spectrometer. Upon heating, ion currents were obtained at masses 157, 158, and 159, corresponding to Pr¹⁴¹O¹⁶⁺, Pr¹⁴¹O¹⁷⁺, and Pr¹⁴¹O¹⁸⁺. Negligible ion currents were observed of the type Pr¹⁴¹⁺. From the ratios of the ion currents observed we can conclude that other stable praseodymium isotopes, if they exist, are present to less than the following percentages:

138	<0.002 percent	142	<0.005 percent
139	<0.003 percent	143	<0.010 percent
140	<0.005 percent	144	<0.001 percent
		145	<0.001 percent

The limits of the abundances of the isotopes at masses 142 and 143 were obtained by comparison of the observed ion currents with those predicted from the known abundances of O¹⁷ and O¹⁸ and, therefore, these limits are not as low as are the rest. Assuming a packing fraction of -3.0×10^{-4} and a conversion factor of 1.000275, the chemical atomic weight is 140.92, which is in complete agreement with the international chemical value.

Neodymium was first investigated by Aston⁴ who found isotopes at masses 143, 143, 144, 145, and 146. Later Dempster⁵ discovered rarer isotopes at masses 148 and 150. Mattauch and Hauk⁶ on the basis of photometric analysis of photographic plates gave the abundances shown in Table I.

For this investigation neodymium oxide (Hilger Laboratory No. 6783) was applied to the source in a manner similar to that used for praseodymium. The ion currents consisted principally of NdO⁺ ions with very much weaker currents of the type Nd⁺. The results tabulated in Table I are the average of 200 separate determinations in the oxide position. A typical recorder curve is shown in Fig. 1. The uncertainty quoted is not the mean deviation of these results, but is larger than this by an amount sufficient to

TABLE I. Isotopic constitution of neodymium.

Observer	142	143	144	145	146	148	150
Mattauch and Hauk	25.95	13.0	22.6	9.2	16.5	6.8	5.95
This work	27.13 ±0.2	12.20 ±0.1	23.87 ±0.2	8.30 ±0.05	17.18 ±0.2	5.72 ±0.06	5.60 ±0.06

include possible systematic errors in the mass spectrometer.¹ The actual mean deviations are about one-third of the deviations quoted in this table. The following upper limits were set for the existence of other neodymium isotopes:

138	<0.002 percent	149	<0.005 percent
139	<0.02 percent	151	<0.002 percent
140	<0.004 percent	152	<0.002 percent
141	<0.01 percent	153	<0.002 percent
147	<0.01 percent	154	<0.002 percent

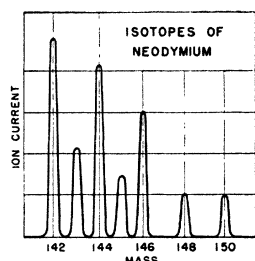


FIG. 1. A typical recorder curve for neodymium. For clarity the mass numbers shown are those of the neodymium isotopes and are sixteen units less than those of the NdO^+ ions actually recorded.

The high limits at masses 139 and 141 are due to lanthanum and praseodymium impurities in the neodymium sample. The fact that the small ion currents observed at these masses were not due to Nd isotopes was proved by the observation that the ratios of these ion currents to those of the neodymium isotopes varied with time. Assuming a packing fraction of -2.7×10^{-4} and a conversion factor of 1.000275, the chemical atomic weight is 144.25, which is in good agreement with the international chemical value of 144.27.

¹ Inghram, Hayden, and Hess, *Phys. Rev.* **72**, 967 (1947).

² Inghram, Hess, and Hayden, *Phys. Rev.* **73**, 180 (1948).

³ J. G. Aston, *Phil. Mag.* **49**, 1191 (1925).

⁴ J. G. Aston, *Nature* **132**, 930 (1933).

⁵ A. J. Dempster, *Phys. Rev.* **51**, 589 (1937).

⁶ Matthauch and Hauk, *Naturwiss.* **25**, 780 (1937).

Beta- and Gamma-Spectra of Cs^{137}

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AN investigation in this laboratory on the absorption of gamma-rays called for the use of radioactive isotopes emitting monoenergetic gamma-rays. Among those used was Cs^{137} , a fission product of high specific activity, produced by the Clinton Laboratories at Oak Ridge, Tennessee. According to the Radioactive Isotope List issued by the Atomic Energy Commission (September 1947), Cs^{137} emits two groups of beta-rays with maximum energy of 0.84 Mev (50 percent) and 0.5 Mev (50 percent), respectively, and one gamma-ray of energy 0.75 Mev. These values were determined by absorption methods. It was considered advisable to investigate the radiations

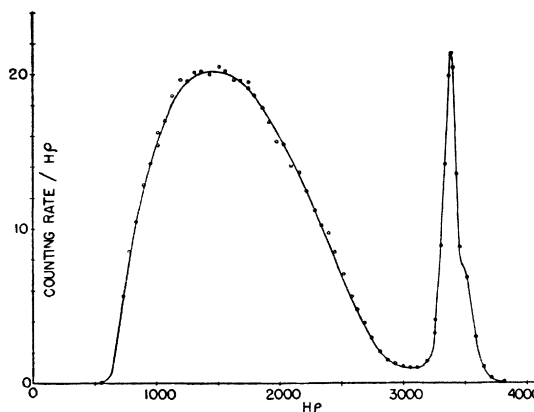


FIG. 1. Cs^{137} β -ray spectrum.

emitted by means of beta-ray spectrographs to check these results.

Two beta-ray spectrographs were used: a thin magnetic lens spectrograph and a small 180° spectrograph. The spectrographs had been previously calibrated by measurements of the spectra of ThB , P^{32} , and Cu^{64} . (In the case of the small 180° spectrograph the magnetic field was also directly measured.)

In order to remove any possible rare earth impurities from the source material, a fluoride precipitation was carried out. The beta-source was a deposit about 2 mg/cm^2 thick on a mica backing about 1 mg/cm^2 thick.

The beta-ray spectrum is shown in Fig. 1. The shape suggests a beta-spectrum of a simple type on which is superposed at the high energy end a strong internal conversion line. A Kurie plot is reproduced in Fig. 2. It indicates a maximum energy of 0.550 ± 0.005 Mev for the beta-ray spectrum. The linearity of the Kurie plot, above 0.1 Mev, indicates that we have but one beta-ray group. (The departure from linearity below 0.1 Mev is due to the fact that no great pains were taken to use very thin supports or very thin windows.) In particular, we find no indication of a beta-ray group with a maximum energy

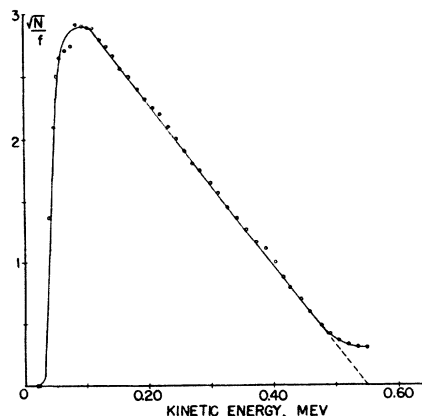


FIG. 2. Kurie plot from Fig. 1.