TABLE I. Isotopic mass defects and mass differences.

Quantity	Best fit values (mMU)	Observed value (mMU)	Source
Al^{27}	-10.17 ± 0.06	-10.20 ± 0.08	Mass spectrograph[a]
Si^{28}	-14.19 ± 0.05	-14.19 ± 0.08	Mass spectrograph[b]
Si^{29}	-14.29 ± 0.05	-14.23 ± 0.14	Mass spectrograph[b]
Si^{30}	-16.97 ± 0.06	-17.10 ± 0.15	Mass spectrograph[c]
S^{32}	-17.72 ± 0.05	-17.63 ± 0.09	Mass spectrograph[d,e,f]
Si^{30}–Al^{27}	-6.79^{g}	$-6.79^{g}\pm0.01^{g}$	(d,p) and (d,α)[g]
S^{32}–Si^{29}	-3.43^{g}	$-3.44^{g}\pm0.02^{g}$	(d,p), (d,α), and (β)[g]
Si^{30}–Si^{29}	-2.68	-2.58 ± 0.10	(d,p), (n,γ), and microwave absorption[g,h,i,j]
Si^{29}–Si^{28}	-0.10^{c}	$-0.10^{c}\pm0.02$	(d,p) and (n,γ)[g,h,i,k]
Al^{28}	-9.48 ± 0.06		
P^{31}	-16.35 ± 0.05		
P^{32}	-15.89 ± 0.05		
Constants:	$n=8.971\pm0.007$		$d=14.718\pm0.006$
	$p=8.129\pm0.003$		$\alpha=3.880\pm0.032$
	1 Mev = 1.07407 mMU		

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depend on the values of n, p, d, and α, and differences in the current values of α cause a change of about 0.02 mMU in the mass defects.

The value $S^{32}=-19.11\pm0.07$ mMU given by Okuda and Ogata[2] has not been used owing to its large discrepancy with other existing mass spectrograph data. The mass defect of S^{32} given in Table I is consistent with the mass of A^{36} as found by Roberts and

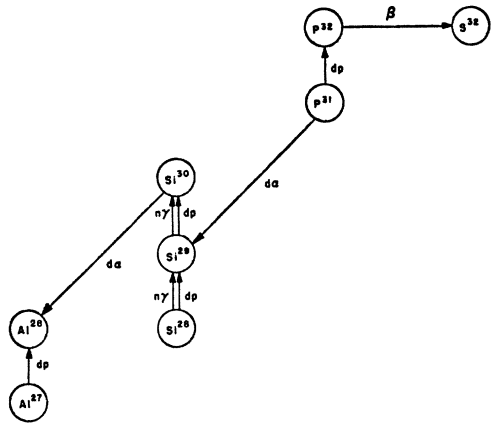

FIG. 1. *Z versus A* diagram illustrating relations of reactions used in the calculation of masses. The arrows refer to the direction of the reaction.

Nier[3] to within 0.3 mMU, which is the probable error of the mass difference value now available. The agreement of these many independent measurements greatly substantiates the recent measurements of S^{32}. Okuda and Ogata's results have been used to varying degrees in most available mass tables. Future data will require an accurate fitting of the mass defects given here with the well-known Ne^{20} and A^{36} masses, but this should cause only a slight variation of the present values. Fourteen other isotopes are linked to the Al to S chain by one or more reactions with errors of about 0.1 to 0.3 mMU. A more complete list of mass defects and source material will be published for the range $Z=10$ to $Z=20$.

* Research carried out under contract with AEC.
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Radiations of Nd^{147}

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SPECTROSCOPICALLY pure neodymium was activated with neutrons at the Oak Ridge National Laboratory, and Nd^{147} was studied with a permanent magnet spectrograph, a thick lens beta-spectrometer, and coincidence counters. Several previous investigations of the radiations of Nd^{147} have been reported in the literature, showing in part conflicting results.[1]

In the present study, internal conversion electrons were observed with the spectrograph as listed in Table I.

TABLE I. Internal conversion electrons in Nd^{147}.

Energy of electrons (kev)		Transition energy (kev)
46.0 ± 0.5	K	91.3
84.5 ± 1.0	L	91.7
89.9 ± 1.0	M	91.4
275 ± 3	K	320
315 ± 5 (weak)	L	322
489 ± 5	K	534
528 ± 5	L	535

Consistent values for the 91-kev gamma-energy were obtained from internal conversion electrons using binding energies of prometheum. Repeated runs with the same source over a period of time indicated that all three transitions decay with a half-life of about 11 days, corresponding to Nd^{147}.

A Kurie plot of the beta-spectrum, as measured with the beta-spectrometer at four percent resolution, showed a complex spectrum with three components having upper energies of 825, 600, and 380 kev. Exactness of determination of the beta-disintegration of 825 kev is estimated to be ±15 kev. A wider margin of error should be allowed for the lower energy betas, since internal conversion electrons obscure portions of the beta-spectra.

Coincidence measurements, with a resolving time of 5×10^{-7} sec, showed that the 825-kev beta-ray is in coincidence with x-rays and with internal conversion electrons of the 91-kev transition. Beta-electron coincidences were also found between the 600-kev beta-ray and internal conversion electrons of the 320-kev transition. Evidence of gamma-rays in coincidence with betas was obtained. No measurable coincidences could be detected between gamma-rays, between gamma- and x-rays, and among the 38-kev x-rays.

These results allow a tentative establishment of a decay scheme for Nd^{147} with a total energy of disintegration of ~915 kev, in which the three beta-spectra of 825, 600, and 380 kev are followed by the transitions of 91-, 320-, and 534- kev gamma-rays, respectively.

Gamma-rays of 534 kev as well as 38-kev x-rays could be observed by absorption, while the 91-kev transition appears to be largely internally converted.

A full report will be prepared on completion of the work. Grateful acknowledgment is made to The Ohio State University Development Fund for a financial grant making this research possible.

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Electron-Electron Scattering from 0.6 to 1.7 Mev*

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A MEASUREMENT has been made of the differential cross section for elastic scattering of negative beta-particles by atomic electrons, using a method whereby the two energetic elec-

trons arising from a collision are detected individually in two Geiger-Müller counters connected in coincidence.

Figure 1 (a) shows a plan view of the scattering chamber used. A uniform magnetic field is vertical. Beta-rays from the source, S,

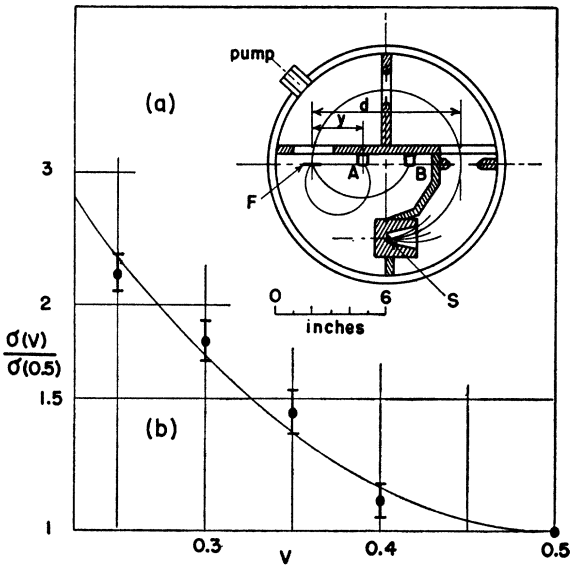

FIG. 1. (a) Plan view of scattering chamber. Shown are beta-emitter, S, scattering foil, F, two movable Geiger-Müller counters, A and B. Fractional energy transfer is given by y/d. (b) Relative differential cross section against fractional energy transfer, v, at fixed incident energy, $E=3.5\ mc^2$. A beryllium scatterer, 4.5 mg/cm², was used. The curve is taken from the Møller formula.

travel in a horizontal plane and strike a scattering foil, F. The two Geiger-Müller counters, A and B, with axes vertical, are movable from left to right in the figure. One counter is situated somewhat above the scattering foil, the other below. Momentum considerations show that to each horizontal setting of counter A, for example, there corresponds a definite horizontal setting of counter B in order for elastic collisions to be recorded. Experimentally, the scattering events appear to be practically elastic, in the sense that an inelasticity of the order of one percent in all events could have been detected. In the interest of obtaining reasonably large solid angles, the counters can be made quite long, because all elastically scattered electrons of given fractional energy transfer are focused in a vertical line at each counter. Fractional energy transfer, v, is related to counter setting by $v=y/d$, where y is the horizontal distance from scattering foil to the nearest counter, and d is the diameter of the circular path of the incident particles.

Using 10 millicuries of $Sr^{90}-Y^{90}$ as beta-emitter, and scattering foils of 0.5 mg/cm² collodion and 4.5 mg/cm² beryllium, results were obtained as follows. Figure 1 (b) shows the variation of measured differential cross section, $\sigma(v)$, with v, at a fixed incident kinetic energy, $E=3.5\ mc^2$ with a total spread of $0.4\ mc^2$. Standard statistical errors are attached. The resolution in v has a width at half-maximum of 0.04. The curve shown has been computed from the formula of Møller[1] for elastic electron-electron scattering. Similar results, not reproduced here, were found at $E=2.3\ mc^2$.

Figure 2 shows the results for absolute differential cross section at $v=0.5$, as a function of incident kinetic energy in units of mc^2. The spread in incident energy for each experimental point is that corresponding to a 12 percent incident momentum spread. The errors shown are statistical only. The experimental error is estimated to be 10 percent standard deviation. Curve A is a plot of Møller's formula. To indicate the effect of the "spin terms" in the Møller expression,[2] a plot is made with these terms arbitrarily suppressed (curve B).

The formula of Møller appears to be verified within the 10 percent experimental error. The result here is not at variance with the results of previous cloud-chamber experiments,[3,4] although for a given incident energy there is essentially no overlap in terms of fractional energy transfer investigated.

It may be of interest to note that an alternative conclusion could be drawn concerning the identity of negative beta-particles

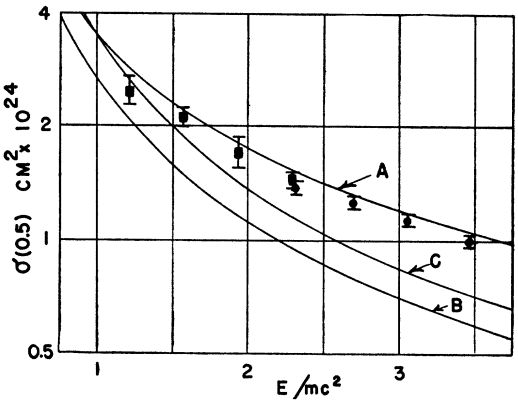

FIG. 2. Absolute differential cross section against incident kinetic energy. Observed cross section, in 10^{-24} cm² per unit fractional energy transfer, is shown as squares for 0.5-mg/cm² collodion scatterer and circles for 4.5-mg/cm² beryllium scatterer. Curve A is the Møller formula, curve B is the Møller formula less the spin terms, and curve C is the Bhabba formula less the virtual annihilation terms.

with atomic electrons.[5,6] In Fig. 2, a third formula, curve C, represents Bhabha's elastic positron-electron scattering formula[7] with the parts arising from virtual annihilation deleted. This pseudo-formula is not far from the Mott formula for coulomb scattering of fast electrons,[8] the latter being of order 10 percent smaller for these energies. The preference shown for the Møller formula would, then, imply that beta-particles are the same as electrons as far as scattering by electrons is concerned.

A detailed account of the experiment is to be published. I am indebted to Professor W. M. Woodward for suggesting the problem and for his active interest and counsel throughout the experiment.

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The Positron Activity of K^{40}

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THE nucleus K^{40} can decay to A^{40} by three processes: (a) orbital electron capture to an excited state of A^{40} with subsequent gamma-emission, (b) electron capture to the ground state of A^{40}, and (c) positron emission. Fireman[1] has calculated the ratio of process (b) to process (c) for various mass differences $K^{40}-A^{40}$. Nier and Roberts'[2] determination of the $Ca^{40}-A^{40}$ mass difference gives a mass difference for $K^{40}-A^{40}$ of $(3.35\pm0.15)\ mc^2$. With this value of the mass difference, Fireman's calculations give the ratio of process (b) to process (c) equal to (0.01, +0.02, −0.005). On the other hand, Sawyer and Wiedenbeck[3] have found the total