Beta-Spectrum of Ne^{23} *

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Ne^{23} is known to be a negative beta-emitter, of half-life of the order of 40 sec. Pollard and Watson[1] found an end point of about 4.1 Mev for the beta-radiation by absorption in aluminum, and concluded that the spectrum was simple, because no detectable gamma-radiation of the proper half-life was found.

By use of the technique of bombarding gases in a cyclotron and transporting them to a source chamber which fits into a semicircular focusing beta-spectrometer, as previously described,[2] the beta-spectrum and half-life of Ne^{23} have been determined in this laboratory. The Ne^{23} was produced by a (d,n) reaction on Ne^{22} in the Columbia University 36-in. cyclotron. The normal mixture of neon isotopes (90.5 percent Ne^{20}, 0.3 percent Ne^{21}, 9.2 percent Ne^{22}) was used for those measurements not requiring very high intensity, while enriched neon[3] (96 percent Ne^{22}) was used for taking the beta-spectrum.

The half-life of Ne^{23} was obtained from a series of eight decay curves, an example of which is shown in Fig. 1, and found to be 40.2 ± 0.4 sec., in agreement with previous results[4] within their published precisions.

The beta-spectrum was taken with two different thicknesses of Saran window separating the source chamber from the spectrometer, and two different pressures of neon in the chamber, corresponding to total thicknesses of 2.8 and 5.7 mg/cm². The results, a typical sample of which is shown in Fig. 2, indicate that the spectrum is not dependent on the thickness in this range. The spectrum displays an end point (average for several runs, corrected for window absorption) of $\epsilon_{02}=9.24$, giving a maximum kinetic energy for the electrons of 4.21 ± 0.015 Mev. The spectrum is of the allowed shape down to about 1.2 Mev, where it deviates from linearity in the Fermi plot. On subtracting the high energy allowed spectrum, a low energy group of the allowed shape is obtained having an end point (average for several runs) of $\epsilon_{02}=3.3$, corresponding to a maximum kinetic energy of 1.18 ± 0.04 Mev. From the intercepts A_1 and A_2 of the two straight lines on the $\epsilon=1$ axis, one can calculate the relative intensities of the two groups

$$I_1/I_2=(A_1/A_2)^2[(\epsilon_{02}-1)/(\epsilon_{01}-1)]^2[f(Z,\epsilon_{01})/f(Z,\epsilon_{02})],$$

where the symbols have their usual meanings, and subscripts 1 and 2 indicate the components. The data obtained indicates that the low energy group is about seven percent as intense as the high energy group. Since $t_2/t_1=I_1/I_2$ where t_1 and t_2 are the lieftimes for the particular modes of decay, and $1/t=1/t_1+1/t_2$ (t being the observed half-life), we find $t_2=40.2$ sec., $t_1=555$ sec. The ft values are 8.78×10^4 sec. and 6050 sec. for the high and low energy groups, respectively.

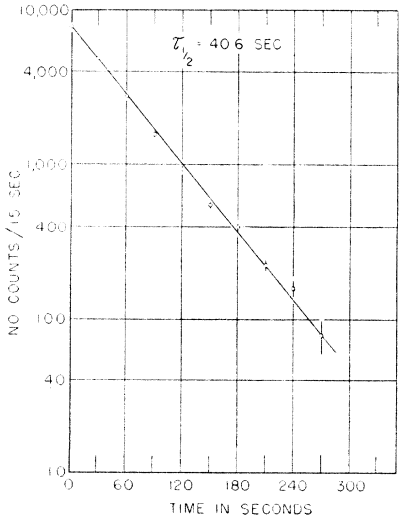

FIG. 1. Decay curve of Ne^{23}.

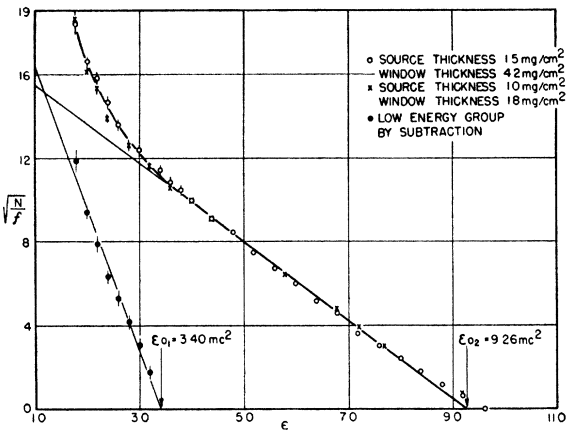

FIG. 2. Kurie plot of the negatrons from Ne^{23}. ϵ is the total energy of the electrons in units of mc^2. N is the number of electrons per unit momentum range, and f the Fermi function $p^2F(Z,\epsilon)$. $(N/f)^{\frac{1}{2}}$ is plotted in arbitrary units. The spectrum of the low energy group was obtained by subtraction and resolution (this is the explanation for the tailing-off at the high energy end).

We should like to thank Mr. P. Lindenfeld for his assistance with this experiment.

* Assisted by the AEC.
[1] E. Pollard and W. W. Watson, Phys. Rev. **58**, 12 (1940).
[2] H. Brown and V. Perez-Mendez, Phys. Rev. **75**, 1276 (1949); V. Perez-Mendez and H. Brown, Phys. Rev. **77**, 404 (1950). A paper describing the instrument in detail is now in print.
[3] Obtained from Yale University through the AEC.
[4] Huber, Lienhard, Scherrer, and Waffler, Helv. Phys. Acta **17**, 195 (1944), obtain (40.7 ± 0.8) sec.

Gamma-Radiation from Ne^{23} *

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In view of the results obtained from the beta-ray spectrum of Ne^{23}, a search was made for the gamma-ray which should accompany the low energy group of electrons discussed in the previous paper.[1] This gamma-ray would represent a transition between an excited state of Na^{23} and the ground state, and should have an energy of about 3.0 Mev.

The enriched neon was bombarded with deuterons in the cyclotron and pumped into a glass container (source chamber) which was then viewed with a counter shielded by several inches of lead except in the direction of the source chamber. Sufficient lead was placed in front of the counter to stop all beta-radiation (up to 5 Mev at least), and a decay curve was taken of the gamma rays counted. A sample curve is shown in Fig. 1, which indicates that there is a gamma-ray component of about 2 min. half-life, which is attributed to the annihilation radiation from the positrons of 120-sec. O^{15}, produced in a (d,n) reaction from a nitrogen contamination in the neon (arising from incomplete evacuation of the pumping system). There is also a short-lived component, whose lifetime is placed by an average of six such curves at (38 ± 6) sec. and which we identify with Ne^{23}. The O^{15} component would give a large comparative effect even if the contamination is less than one percent because the Ne^{23} gamma-ray would be present in only about seven percent of the Ne^{23} disintegrations and because high energy gamma-rays are detected with less efficiency. This result indicates that there is a gamma-ray associated with the decay of Ne^{23}.

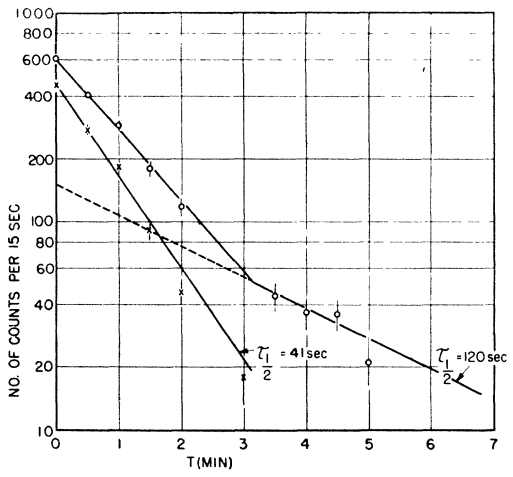

FIG. 1. Decay curve of the gamma-radiation from the neon sample bombarded with deuterons.

To determine whether the Ne^{23} gamma-ray has the energy to be expected on the basis of the beta-spectrum, an experiment was performed to determine the absorption curve for the gamma-radiation. The curve represents the ratio of the counts from the gamma-counter to the counts from a monitor counter attached to the pumping line. The result is shown in Fig. 2. Again, two

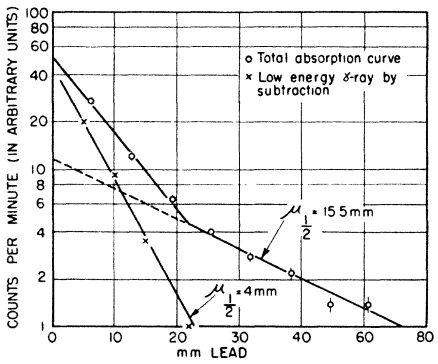

FIG. 2. Absorption curve in lead for the gamma-rays from Ne^{23} (plus O^{15} contamination).

gamma-rays are discernible. The low energy group has a half-thickness of 4 mm of lead, which corresponds to a gamma-ray energy of 500 kev, as would be expected from a positron-emitting contaminant. The high energy group has a half-thickness of 15.5 mm, corresponding to an energy of 2.8 Mev, but the absorption curve is so flat in this region that the energy might lie anywhere

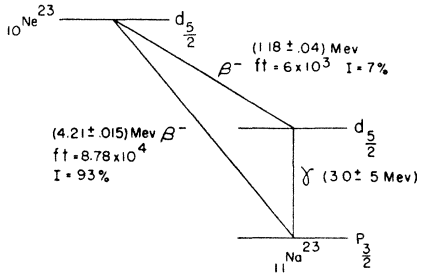

FIG. 3. Decay scheme for Ne^{23}.

from 2.5 to 3.5 Mev. This is the result to be expected if the low energy group of electrons from Ne^{23} represents a transition to an excited state of Na^{23}. The suggested level scheme is shown in Fig. 3.

The state of Ne^{23} is, according to the shell structure models,[2] $3d_{5/2}$. The ground state of Na^{23} should be, on these models, $3d_{5/2}$, but is anomalously found to exhibit a spin of $\frac{3}{2}$. This has been recently discussed by M. Mayer,[3] who suggests that it is due to a failure of pairing, so that three $3d_{5/2}$ protons combine to give a $\frac{3}{2}$ state. On this basis, one would expect that the high energy group, though allowed ($\Delta J=1$) would have a rather small matrix element, and ft value $\sim 10^5$ sec. because an extensive nucleonic rearrangement is involved. The excited state of Na^{23} may have the $d_{5/2}$ configuration predicted for the ground state. In this case the low energy group would involve a $d_{5/2}\rightarrow d_{5/2}$ transition, and its matrix element (and ft value) should be comparable to those of the mirror image nuclei, as we find to be the case. To make more certain the assignment of levels, coincidence experiments are planned.

We should like to thank Mr. P. Lindenfeld for his assistance with this experiment.

* Assisted by the AEC.

[1] H. Brown and V. Perez-Mendez, Phys. Rev. **78**, 812 (1950).
[2] M. G. Mayer, Phys. Rev. **74**, 235 (1948); E. Feenberg, Phys. Rev. **77**, 771 (1949).
[3] M. G. Mayer, Phys. Rev. **78**, 16 (1950).

Superconductivity of Isotopes of Mercury*

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THE critical field measurements on enriched isotopes of mercury reported earlier[1] have been repeated and extended. The alternating field method used for determining the susceptibility has been extensively investigated by Shoenberg.[2] All the new measurements were made at a frequency of 100 c/sec. At this frequency, the ratio of sample radius to a.c. skin depth in the normal conductor is less than 0.6, so that there is a negligible signal from the imaginary part of the susceptibility. Under these conditions, as the external magnetic field is increased through the critical value, the a.c. signal goes through a maximum. The value of the magnetic field at this maximum was taken to be the critical field.

The transition temperatures for the samples obtained by extrapolating the critical field curves are given in Table I.

TABLE I. Transition temperatures for the Hg isotopes.

Av. mass number (M)	Transition temperature (T_0)°K
199.7	4.167
200.7 (natural mercury)	4.154
202.0	4.147
203.4	4.137

The critical field measurements were extended to lower temperatures and higher fields, and it was found that the curves for the isotopes were accurately parallel down to 2.30°K.

Table II shows the product $M^{\frac{1}{2}}T_0$ for the various isotopes. This product is quite constant, and is in fact more constant than any other simple combination of these variables. The constancy

TABLE II. The product $M^{\frac{1}{2}}T_0$ for the Hg isotopes.

Av. mass number (M)	$M^{\frac{1}{2}}T_0$
199.7	58.88
200.7	58.84
202.0	58.93
203.4	58.99