Beta-Spectrum of Ne^{23} *

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April 24, 1950

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/cm^2. 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.

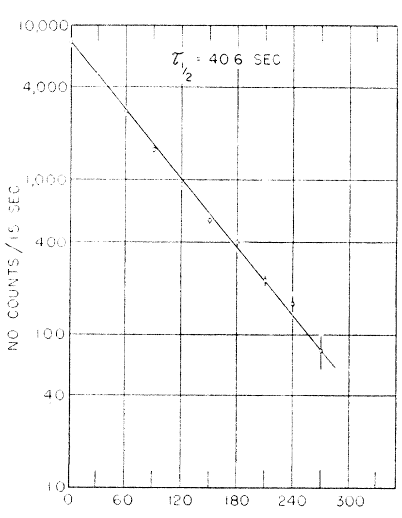

Fig. 1. Decay curve of Ne^{23}.

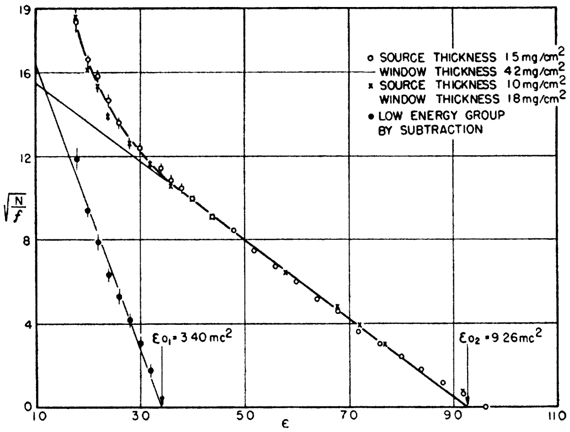

Fig. 2. Kurie plot of the negatrons from Ne^{23}. ϵ is the total energy of the electrons in units of mc^2. N is the number of electrons per unit momentum range, and f the Fermi function $p^2F(Z,\epsilon)$. $(N/f)^{\frac{1}{2}}$ is plotted in arbitrary units. The spectrum of the low energy group was obtained 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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April 24, 1950

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}.