were used. In carrying out the calculations, they had overlooked one factor which is of importance to this comparison. When this is considered, their results are in good agreement with the corrections calculated by M. E. Rose[6] for negatrons which are indeed negligible. However, the corrections for positrons turn out to be considerably larger than those for negatrons. These small corrections do not account for all the deviations observed in the low energy region where the true distribution of electrons is susceptible to distortion due to the finite source thickness and backing. Nevertheless these corrections improve the over-all agreements. In Fig. 1, we have replotted the Kurie plots of Cu^{64} negatron and positron spectra. In the upper right corner of Fig. 1 is an insert of the revised screening and relativistic corrections for Cu^{64}. With these corrections, the negatron curve now starts to deviate from the straight line in the Kurie plot around 130 kev, and the positron curve begins to deviate around 140 kev. Even at 50 kev the deviation from the Kurie plot for negatrons is less than 6 percent, for positrons not more than 8 percent. In Fig. 2, the logarithm of the ratio of the positrons to negatrons is plotted against x. The theoretical curve is drawn according to the approximation formula where $Z_{Ni}=Z_{Zn}=Z_{Cu}$. If the exact equation is used, the theoretical curve will be rotated upward approximately one degree in Fig. 2. This figure illustrates that even without screening and relativistic corrections, the experimental value of the ratio of positrons to negatrons is less than twice the theoretical value at 18 kev. However, when the corrections are applied, the agreement between the experimental and theoretical values is excellent. The dotted curve in Fig. 2 shows the data of Backus[2] and Cook and Langer[3] adjusted to our data in the high energy region.

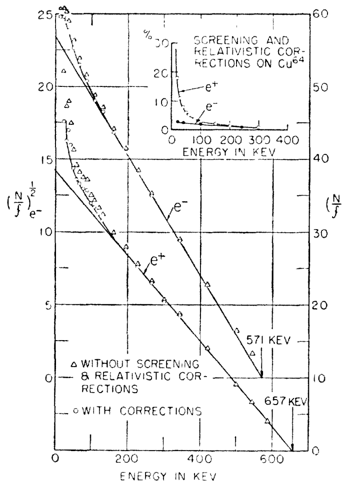

FIG. 1. Kurie plots of Cu^{64} negatron and positron spectra.

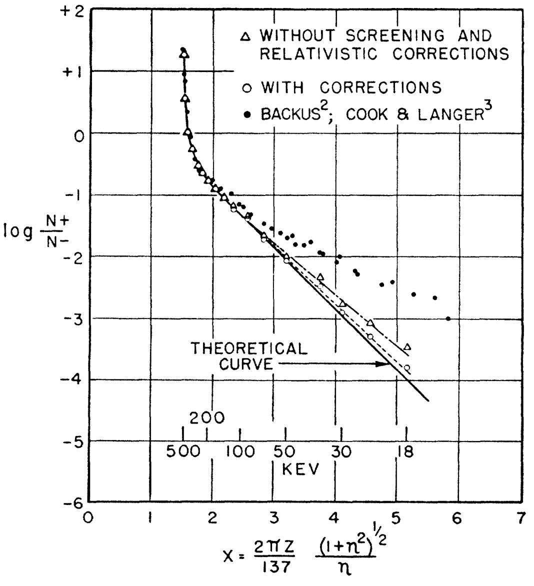

FIG. 2. The ratio of the number of positrons to the number of negatrons as a function of energy.

If there is distortion due to elastic backscattering or change of detector efficiency with energy, this should affect the electron and positron curves equally, and thus the ratio $N+/N-$ should remain unaffected. On the other hand, the inelastic scattering effects must be small here. Otherwise, they would tend to affect the positrons more than the electrons at low energies due to the sharper low energy "cut-off" of the positron momentum distribution curve and, thus, increase the $N+/N-$ ratio at low energies.

The good agreement between the theoretical and experimental curves in Fig. 2 indicates that the Fermi theory probably does approximate the true distributions for negatrons and positrons at low energies. In any event, any remaining true deviations must be much smaller than has been previously suggested.[2,3]

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The Fundamental Band of Carbon Monoxide at 4.7μ in the Solar Spectrum*

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DURING 1948 high dispersion spectrograms of the sun were obtained in Columbus, Ohio using a prism-grating infra-red spectrograph designed by Dr. R. Noble under the direction of Professor H. H. Nielsen (instrument of the Pfund type, focal length of the parabolic mirrors: 100 cm, aperture: f/5). The installation was equipped with a rapid response Perkin-Elmer thermopile, an electronic amplifier of the same firm, and a Brown recorder. In particular, the region extending from 2250 cm^{-1} (4.44μ) to 1990 cm^{-1} (5.02μ) was mapped with an echelette grating ruled with 7200 lines per inch. Spectral lines 0.5 cm^{-1} apart are clearly separated.

The new solar spectrograms have been compared with measurements published in 1947 on the fundamental bands of $C^{12}O^{16}$ and $C^{13}O^{16}$ situated in the 4.7μ region.[1] In this publication the wave numbers of 51 rotational lines are given for the fundamental band of $C^{12}O^{16}$. It is stated that the positions of the lines are reliable to about ± 0.07 cm^{-1}.

In the solar spectrum part of the CO band (from R_{15} to R_{28}) falls in a region of stong absorption due to the 4.5μ band of N_2O^2 and to the 4.3μ band of CO_2. Of the 38 remaining lines, twenty correspond within ± 0.10 cm^{-1} to sharp lines observed in the solar spectrum while the eighteen others are masked by stronger lines or may be found in the wings of such lines. The distribution of intensities also corresponds to that observed in the laboratory. Hence, it may be stated that the fundamental band of $C^{12}O^{16}$ is present on the observed solar spectrograms. Because of the complexity of these spectrograms it has not been possible to decide with certainty about the identification of the fundamental band due to $C^{13}O^{16}$.

A striking change in intensity was observed for the band identified as CO when the solar spectrum was observed on different days. On April 25, May 26, and May 31, 1948 this band was intense; for example, the line noted R_3 by Lagemann, Nielsen, and Dickey[1] had a central absorption of about 50 percent on a spectrogram taken at 4 P.M. on May 31. On records obtained on June 16 and 17, 1948 the CO band was weak; for example, the central absorption of R_3 was observed to be about 15 percent on a spectrogram taken at 9 A.M. on June 16. For the same days an intensity change of the same order was also noted, in the same spectral region for several lines due to CO_2, while no appreciable change was observed for the 4.5μ band of N_2O. Hence, it may be concluded that the absorption by CO and CO_2 was enhanced in the atmosphere of Columbus, Ohio during April and May, 1948. CO may also be expected in the solar atmosphere. However, it is believed that the solar contribution to the band observed at 4.7μ is negligible.

Details on our observations of the solar spectrum will be published in the Astrophysical Journal.

* This work was carried out, in part, under contract between the Air Materiel Command Wright Patterson Air Force Base and the Ohio State University Research Foundation.

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Shape of the Beta-Spectrum of the Forbidden Transition of Yttrium 91

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THE momentum distribution of the negatrons emitted in the 57-day disintegration of $_{39}Y^{91}$ has been determined as being different from the spectrum expected for an allowed transition. The exact shape of the spectrum gives confirmation for the shell structure model of the nucleus and for the validity of Gamow-Teller selection rules.

The measurements were made in the large, high resolution, magnetic spectrometer.[1] The activity, obtained carrier-free from Oak Ridge, was further separated from the alkaline earths. The source had a thickness of about 0.15 mg/cm^2 and was uniformly deposited on a plastic (LC-600) backing of 0.02 mg/cm^2 and held at ground potential. Both mica and thin Zapon window counters were used in appropriate and overlapping energy regions, and the data were adjusted to the same intensity level at one point.

Figure 1 shows a conventional Fermi plot of the data. The Coulomb function, F_B was evaluated by means of Bethe's approximation,[2] which was found to be in very good agreement with that calculated by expanding the complex Γ-function. It is obvious from Fig. 1 that the Fermi plot is not the straight line which is characteristic of allowed transitions and which has also been found for many presumably forbidden transitions.[3] It is instead, definitely curved, being convex toward the energy axis near the end point.[4] The maximum energy release is 1.53 Mev.

According to its "comparative lifetime" ($f=4.7\times 10^8$), this transition would be empirically classified as twice-forbidden. However, Feenberg and Hammack's[5] analysis of the shell structure in nuclei leads to the prediction of a spin change of 2 units, together with a parity change. Such a transition is theoretically classified as once-forbidden under Gamow-Teller selection rules. According to the theory of forbidden spectra,[6] it also has the special property that only one type of nuclear matrix element fails to vanish for it. This means that a unique energy dependence is predicted, differing from the allowed shape by the factor

$$a\sim[(W^2-1)+(W_0-W)^2],$$

where W is the electron's energy in mc^2 units, and $W_0=4.01$ is the end point.

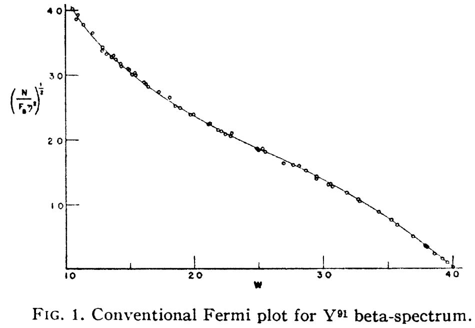

FIG. 1. Conventional Fermi plot for Y^{91} beta-spectrum.

When the ordinates of the curve in Fig. 1 are divided by a, a straight line should be obtained if the above outlined theory is correct. The actual result is shown in Fig. 2. The striking agreement with the theoretical expectations furnishes good evidence for the reliability of the shell model. It also provides the first piece of evidence for the validity of the Gamow-Teller rules based on a spectrum shape.

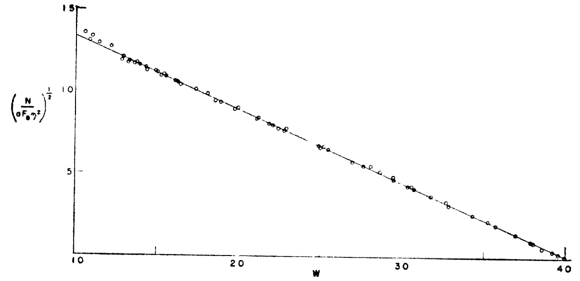

FIG. 2. Forbidden Fermi plot for Y^{91} beta-spectrum. Here the ordinates are divided by the additional factor,

$$a^{\frac{1}{2}}\sim[(W^2-1)+(W_0-W)^2]^{\frac{1}{2}}.$$

This work has been assisted by a grant from the Frederick Gardner Cottrell Fund of the Research Corporation and by the joint program of the ONR and AEC.

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Threshold Energy for Meson Production

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THE threshold energy for the production of mesons by colliding systems of elementary particles can be calculated by a simple relativistic extension of the principles employed in deducing the "Q" and the threshold beam energy for ordinary nuclear reactions. This calculation does not re-