Letters to the Editor

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The Parities of the Ground States of N^{14} and C^{14}†

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IN view of the well-known difficulty in reconciling the apparently allowed shape and second forbidden lifetime of the C^{14}, N^{14} beta-decay with theory, we considered that it would be of interest to determine whether or not a parity change exists. We have carried out experiments based on the stripping theory of Butler[1] to determine the relative parities of N^{14} and C^{14}.

Using 4-Mev deuterons from the Rochester 26-inch cyclotron we have examined the angular distribution of the neutrons from the $C^{13}(d, n)N^{14}$ reaction and the distribution of the protons from the $C^{13}(d, p)C^{14}$ reaction. The neutrons were detected by use of a cylindrical ionization chamber filled with helium at 20-atmospheres pressure, and the protons were detected by use of a sodium iodide crystal with a 1P21 photomultiplier. At each angle the amplified detector outputs were analyzed by a 30-channel pulse-height discriminator to give pulse-height spectra.

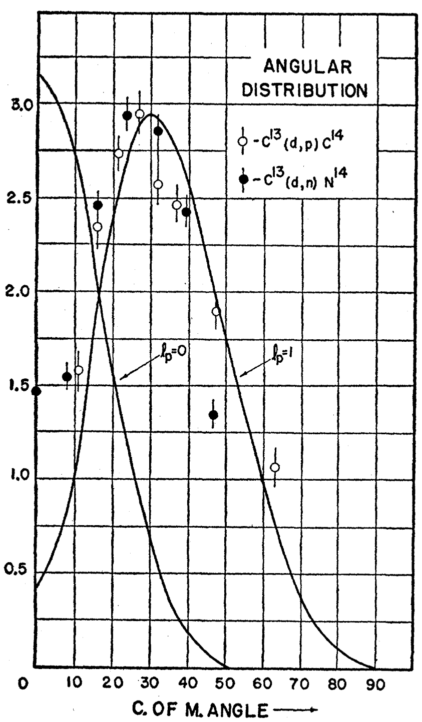

FIG. 1. The angular distribution of the neutrons from the $C^{13}(d, n)N^{14}$ reaction and the angular distribution of the protons from the $C^{13}(d, p)C^{14}$ reaction. The curves are the angular distributions predicted by the Butler theory corresponding to a deuteron energy of 4 Mev. l_p is the angular momentum transferred to the target nucleus by the absorbed nucleon. The angular distribution corresponding to $l_p=2$ has a maximum at about 60°; conservation of spin and parity forbids this value for both of the above reactions.

Figure 1 shows that the angular distributions of the protons and neutrons are almost identical. There are minima at 0° and maxima at about 28° in the center-of-mass system. These are in very good agreement with the curve, corresponding to our energy, calculated from the Butler theory for a transition in which the absorbed nucleon transfers one unit of angular momentum to the target nucleus. This shows conclusively that the parities of the N^{14} and C^{14} ground states are the same. Hence, it is no longer possible to invoke a parity change in the explanation of the C^{14}, N^{14} beta-decay.

We have confirmed the previous measurement[2] of the relative parities of the C^{12} and C^{13} ground states using the $C^{12}(d, p)C^{13}$ reaction. Consequently, we have shown that the parities of the ground states of N^{14} and C^{14} are the same as that of the C^{12} ground state, which we assume to be even.

A detailed description of the work will be submitted for publication at a later date. We are indebted to Professor H. W. Fulbright for suggesting the problem and for his continued interest and suggestions.

† This work assisted by the AEC.
[1] S. T. Butler, Proc. Roy. Soc. (London) **A208**, 559 (1951).
[2] J. Rotblat *et al.* as quoted in reference 1.

Rotational Temperatures of Vegard-Kaplan Auroral Bands*

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CONFLICTING data exist regarding one of the more important physical properties of the earth's upper atmosphere, namely, the temperature. The particle density at the 220-km level indicates that the temperature is of the order of 1000°K, whereas the numerous investigations by Vegard of the rotational structure of auroral N_2^+ bands yield temperatures of around 350°K at perhaps the 200-km level. Recent summaries of the temperature problem have been given by Bates[1] and Gerson.[2]

Although the N_2^+ bands arise from permitted transitions, there is no apparent reason why the rotational structure should not yield a true temperature. Nevertheless, bands from forbidden transitions should give a more reliable value for the temperature of the region from which the emissions arise. A number of $^1\Sigma_g{}^+-{}^3\Sigma_u{}^+$ Vegard-Kaplan N_2 bands have been photographed in the spectra of several intense auroral displays. The grating spectrograph was used in the third order, giving a dispersion of 28 A/mm. These bands have considerable widths; for example, the (1, 11) and (2, 12) bands with heads at λλ3683, 3767 are each about 25 angstroms wide. The rotational structure can be seen, and it is possible to estimate the position of the strongest line on the P branch.

The intensity of a rotational line may be written as $I=c\nu^4S\times\exp[-B_{v'}K'(K'+1)hc/kT]$. Since the P and ^PQ lines overlap, the "line strength" factor S in the above equation must be the sum of the two branches. According to Schlapp[3] the value of S is $(K+3/2)$, K referring to the lower $^1\Sigma$ state. If we form the derivative dI/dK', equate to zero, and solve for the K' value at which I is a maximum, then $T=1.44B_{v'}(2K'+1)(K'+5/2)$. The formula for the lines of the P branch of the (1, 11) band is $\nu-\nu_0=-3.228K-0.374K^2$. The writer judges that the distance from the zero gap to the maximum of the P branch is 14 angstroms, or 103 cm⁻¹. From the above formula the corresponding K value is 13; hence $K'=12$. Substituting in the temperature formula yields a value of approximately 750°K. The mean temperature derived from five V-K bands in the wavelength range λλ3400–3800 is 850°K.