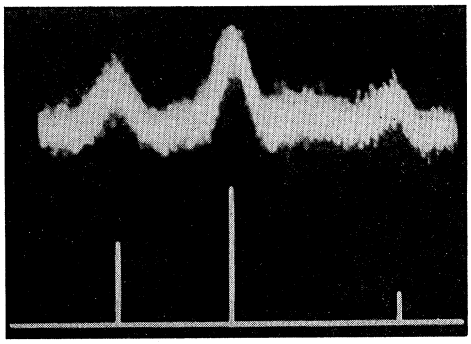

FIG. 1. Theoretical and observed hyperfine structure in the $J=0$ to $J=1$ rotational transition of CH_3CN occurring at 18,400 Mc. Observed spacing of lines are 1.40 Mc/sec. and 2.10 Mc/sec. from central line.

mined is 4.67 ± 0.10 Mc. This differs somewhat from that given by Townes and his co-workers[2] for the nitrogen coupling in ClCN, 3.66 ± 0.15 Mc. This difference is significantly greater than that allowed by the probable experimental errors and must be attributed to differences in the electronic structures of the molecules. An even greater difference is shown for CH_3NC, for which the hyperfine structure could not be resolved. This indicates that the absolute value of the coupling factor $eQ(\partial^2V/\partial z^2)$ must be less than about one megacycle and implies a rather symmetric distribution of electronic charge about the nitrogen nucleus.

In calculating the hyperfine structure, the formula,

$$T_F=\left(eQ\frac{\partial^2V}{\partial z^2}\right)\left(\frac{3K^2}{J(J+1)}-1\right)\frac{\frac{3}{4}C(C+1)-I(I+1)J(J+1)}{2I(2I-1)(2J-1)(2J+3)},$$

where

$$C=F(F+1)-I(I+1)-J(J+1)$$

was used. This formula differs slightly from that given by Coles and Good[3] and that used in previous papers[4] from this laboratory. Though both formulas give correct positions of the lines, they yield different coupling coefficients except when $I=\frac{3}{2}$. The different formulas apparently arise from different definitions of quadrupole coupling existing in the literature. The above formula is used so that the coupling coefficient may be compared with the results of Townes and his associates.

Molecular Properties. The structure of the second rotational line of CH_3CN ($J=1$ to $J=2$ transition), observed at 36,800 Mc, reveals a purely symmetric top configuration for this molecule. The moment of inertia, I_B, determined from the present measurements is 90.9×10^{-40} g cm^2, compared with 92.8×10^{-40} g cm^2, computed from the dimensions determined by electron diffraction.[5] For the $J=0$ to $J=1$ transition of CH_3NC a single line was observed at 1.488-cm wave-length. However, in the region of the second rotational transition, about 7.45-mm wave-length, a group of eight lines was observed, dispersed over a region of 330 Mc. These are too widely spaced to represent hyperfine structure caused by the nitrogen nucleus. An attempt is being made to interpret the spectrum on the basis that the molecule is a very slightly asymmetric top, i.e., that the CNC group is not quite linear. Because the compound is rather unstable some of the lines may be due to impurities. We are attempting to determine whether this is true, or if any of the lines arise from molecules in excited vibrational states. Assuming the symmetric top configuration, the moment of inertia is 83.2×10^{-40} g cm^2, in satisfactory agreement with the most recent electron-diffraction data,[6] from which the moment of inertia, I_B, is determined as 84.8×10^{-40} g cm^2.

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** Frederick Gardner Cottrell Fellow.

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Sea Level Latitude Effect of Cosmic Radiation*

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ON a recent voyage from Rio de Janeiro to Boston the vertical intensity of the total and hard components of the cosmic radiation were measured with a Geiger counter telescope apparatus. The hard component was measured both through 8 cm and 16 cm of lead.

The apparatus consisted of two identical units each with five trays of nine Geiger counters in parallel. The individual counting rates of the counters, their dead times, and the resolving time of the circuits were sufficiently small to preclude their contributing to any spurious effects on the coincident rates of the telescopes.

While the vertical intensity of the total and hard components of the radiation are measured directly, the intensity of the soft component must be arrived at by the difference between the other measured quantities. Such a method gives rise to considerably larger probable errors in the determination of the latitude effect, and the method has been criticized for this reason. Certain observers have made an effort to circumvent this difficulty by measuring the radiation underneath from 1 to 2 cm of lead to determine the latitude effect of the soft component. In any event,

TABLE I. Percentage diminution in the vertical intensity.

Telescope	Total radiation No lead	Hard component 8 cm	Hard component 16 cm	Soft component 8-cm diff.	Soft component 16-cm diff.
1 and 2	5.05±0.55	5.26±1.27	5.36±1.33	4.3±4.6	4.5±4.3
1	5.34±0.77	4.96±0.92	6.20±0.97	6.0±2.8	3.7±2.9
2	4.76±0.75	5.56±0.88	4.51±0.91	2.6±3.7	5.3±3.2
Combined		5.32±0.46		4.46±0.61	

previous determinations have been somewhat ambiguous, as is evidenced by the fact that Auger's[1] data have been interpreted to give a ten percent latitude effect for the soft component by Heisenberg[2] and a zero percent latitude effect by Heitler.[3]

We have paid particular attention to the estimates of probable errors in our calculations, based on the individual probable errors of the individual intensities of the components as measured in the high latitudes and at the equator. The probable errors of the intensities are estimated in the usual manner from the total number of counts obtained for a given condition. The probable errors are derived for the determination of the latitude effects using standard statistical concepts.

In Table I we have summarized the results for the separate telescopes and for the combined results. It is interesting to note that the latitude effects for the total radiation and the hard component are smaller than have been reported previously. (Arley[4] summarizes previous results as indicating a sea level latitude effect of from 10 to 20 percent.) Of greater interest, however, is the fact that our data strongly indicate the existence of a sea level latitude effect for the soft component whose magnitude is of the same order as that for the hard and total radiation.

If the soft component is defined as that radiation which is absorbed in 10 cm of lead, the radiation is largely restricted, except for Auger showers, to that which is formed below one kilometer from the earth's surface, by mesotron decay and knock-on processes from the mesotron component existing near sea level, rather than pair formation having to do with primary electrons or with electrons produced near the top of the atmosphere. It is not surprising to us, therefore, to find the latitude effects of the hard and soft components of comparable magnitude.

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Total Cross Sections of Nuclei for 90-Mev Neutrons

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GOOD geometry neutron attenuation measurements have been made, using the 184-inch cyclotron as a neutron source and carbon disks as detectors. The line-up of equipment was as follows:

1. Source: This was a $\frac{1}{2}$-in. Be target inside the cyclotron traversed by 190-Mev deuterons, giving neutrons of 90-Mev mean energy and an energy distribution having a width of about 27 Mev between points of half-maximum intensity.[1,2]

2. Neutron window in tank wall in line of neutron beam: This window is of spun aluminum, $\frac{1}{8}$ in. thick×32-in. diameter, and its purpose is to reduce the amount of scattering material in the path of the beam.

3. Detector: A carbon disk $\frac{1}{8}$ in. thick×$1\frac{11}{16}$-in. diameter was placed 17 feet from the source. This had the 20.5-min. C^{11} induced in it by the $(n, 2n)$ reaction; the activity was of the order of a few thousand counts per minute after a 1.5-minute exposure.

4. Scattering blocks: These were $2\frac{1}{2}$ in. in diameter and of various lengths and were placed about midway between source and detector.

5. Monitor: A carbon disk similar to the detector was placed between the source and the scattering block.

Source, monitor, scatterer, and detector were lined up accurately with the aid of a cathetometer. Each measurement consisted of a determination of the ratio (detector activity/monitor activity) with G-M counters. This was done with no scatterer (blank), with a very long copper scatterer (background), and with the scatterer whose attenuation was being measured. The background, arising from scattering in the window, sample supports, and other surrounding material, was 6 percent of the blank. Absorption curves were run on paraffin, carbon, aluminum, and copper, and these were exponential as far as they could be followed accurately in the presence of the background (to about 1/20 of the initial intensity). The most accurate cross-section measurements were made with scatterers about one mean free path long, on which repeated measurements were made to improve the statistics. The spread found in these individual measurements was what was expected from the number of counts taken.

Li, Be, C, Mg, Al, Cu, Zn, Sn, Pb, and U were done as the elements. H was done by taking the difference between carbon and paraffin blocks having about the same attenuation, the readings being taken alternately on the two blocks. The difference $D-H$ was found by a similar direct comparison of heavy and light water contained in thin-walled aluminum cells. O, N, and Cl were computed from the attenuations in water, melamine, and carbon tetrachloride. The statistical mean errors in the direct measurements are 1 percent, and greater than this in the difference measurements; the quoted mean errors include an additional 1 percent added to allow for other possible sources of error. A computed correction has been made for the error caused

TABLE I.

Substance	Total cross section (barns) (10^{-24} cm^2)
H	0.083 ±0.004
*D	0.117 ±0.005
Li	0.314 ±0.006
Be	0.431 ±0.008
C	0.550 ±0.011
N	0.656 ±0.021
O	0.765 ±0.020
Mg	1.03 ±0.02
Al	1.12 ±0.02
Cl	1.38 ±0.03
Cu	2.22 ±0.04
Zn	2.21 ±0.04
Sn	3.28 ±0.06
Pb	4.53 ±0.09
U	5.03 ±0.10

* The difference $D-H$, which may be interpreted roughly as the $n-n$ cross section, is good to ±0.003.