TABLE I. *Summary of the identifications of fine products of uranium bombarded by fast neutrons.*

ELEMENT	HALF-PERIOD	ISOTOPE	RADIATION	MAXIMUM ENERGY (MEV)
Pd	26 min.			
	17 hr.	112	electrons	
Ag	7.5 day	111	electrons	0.8
	3.5 hr.	112	electrons	2.0
Cd	56 hr.	115		
	3 hr.	117		
	50 min.			
In	4.5 hr.	115*	γ-rays	0.31–0.35
			conversion electrons	0.28
	2 hr.	117	electrons	1.8

* Radioactive isomer of stable nucleus.

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[1] Y. Nishina, T. Yasaki, H. Ezoe, K. Kimura and M. Ikawa, Nature, n press (1940).

On the Temperature Assignments of Experimental Thermal Diffusion Coefficients

When one calculates coefficients of thermal diffusion from viscosity data on the basis of a particular molecular model, the isothermal nature of viscosity measurements enables one to evaluate theoretically the coefficients at definite temperatures. The thermal diffusion coefficient can only be directly measured, however, when a temperature gradient exists. Comparison of theory with experiment then becomes rather difficult, because the measured value is essentially the "effective" value of the coefficient over a temperature range that is usually quite large. The problem then arises as to what definite temperature to assign an experimentally determined value.

The fundamental equation of thermal diffusion is

$$\text{grad } c_1 = -(K_T/T) \text{ grad } T, \tag{1}$$

where c_1, is the concentration (mol-fraction) of one of the constituents, T is the absolute temperature, and K_T is a quantity that for isotopes reduces to the form

$$K_T = \frac{105}{118}\frac{M_2-M_1}{M_2+M_1} R_T c_1 c_2, \tag{2}$$

the M's being the molecular weights and R_T being the ratio of the thermal diffusion coefficient for the given gas to that for rigid elastic spheres.

Assuming R_T independent of temperature, we then have from Eqs. (1) and (2)

$$\frac{118}{105}\frac{M_2+M_1}{M_2-M_1}\ln\frac{(c_1/c_2)_1}{(c_1/c_2)_2} = R_T \ln\frac{T_2}{T_1}. \tag{3}$$

If one then measures the concentrations of the constituents in the hot and cold sides of the apparatus, the value of R_T that one calculates from Eq. (3) will be an "effective" value of R_T over the temperature range T_1 to T_2, that we shall hereafter designate as R_e to distinguish it from the true value of R_T at a given temperature.

Let us now take into consideration the fact that R_T varies with temperature by assuming that the variation can be described approximately by an equation of the form

$$R_T = R_\infty - B/T. \tag{4}$$

R_∞ is the value approached by R_T as T increases, and B is a constant for a given gas. We see that if $R_\infty = 1$ we have the equation derivable from Sutherland's model neglecting terms of higher order in ϵ/KT.[1] R_∞ is used in this case instead of unity in order to make our result more general.

We have from Eqs. (1), (2), and (4)

$$\frac{118}{105}\frac{M_2+M_1}{M_2-M_1}\ln\frac{(c_1/c_2)_1}{(c_1/c_2)_2} = R_\infty \ln\frac{T_2}{T_1} - B\frac{T_2-T_1}{T_1T_2}. \tag{5}$$

We now want to find the temperature T_r at which our measured value, R_e becomes equal to the true value R_T. From Eqs. (3), (4) and (5), we find this to be

$$T_r = \frac{T_1T_2}{T_2-T_1}\ln\frac{T_2}{T_1}. \tag{6}$$

Actually one should use instead of Eq. (4) the equation derived from the particular model that one is comparing. However, Eq. (4) has two advantages. First, having two adjustable parameters, it can be made to represent with sufficient accuracy for our purpose the variation of R_T with temperature. Second, as we see from Eq. (6), the final result comes out independent of our constants R_∞ and B. For example, if one were to use the equation for the Sutherland model derived recently by Jones,[2] the final result, besides being much more complicated is dependent on the Sutherland constant, while at the same time values of T_r calculated in this manner differ but slightly from those calculated from Eq. (6).

In comparing the values for methane and neon measured by Nier[3, 4] with those calculated from viscosity, Brown[5] and Jones[1] have taken the measured value R_e to be roughly the value at the mean temperature $T_m = \frac{1}{2}(T_1+T_2)$. However, inspection of Eq. (6) shows that T_r is often considerably smaller than T_m, and if R_T falls at all rapidly with the temperature, serious error can result.

Nier[4] has measured R_e for neon over three temperature ranges. Jones calculates from Eq. (54) of his paper values of R_T at the mean temperature of the above temperature ranges, that are in rough agreement with experiment. For comparison, corresponding values of R_T calculated from Jones' equation at temperatures T_r as well as T_m are shown in Table I. We see that they are in somewhat better agree-

TABLE I. *Experimental values of R_e for neon and R_T values calculated from the Sutherland model.*

Temperature Range	T_m	T_r	R_e(Nier)	R_T at T_m	R_T at T_r
283°–617°K	450°K	407°K	0.71±0.02	0.77	0.75
90°–294°K	192°K	153°K	0.44±0.01	0.54	0.45
90°–195°K	142°K	129°K	0.39±0.03	0.42	0.38

ment with experiment, although this should not be taken too seriously at the present time, for as Jones points out, many difficulties still face the Sutherland model. The important point is that using values calculated at T_m instead of at T_r can lead one to errors of as much as 25 percent.

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[2] Reference 1, Eq. (54).
[3] A. O. Nier, Phys. Rev. **56**, 1009 (1939).
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On the Fine Structure Pattern of Cosmic Rays at Mexico City

In August, 1940, a preliminary survey of directional cosmic-ray intensity was carried out at Mexico City, in search of a fine structure pattern analogous to that found at St. Louis, Missouri, by Ribner[1] and at Columbia, Missouri, by Cooper.[2] As in the Missouri experiments, the procedure here was to explore repeatedly a succession of zenith angles z at a given azimuth φ, and in this manner to determine the zenith angle intensity distribution $I(z, \varphi)$ for a predetermined set of azimuthal orientations φ. In the experiment described here, the four principal azimuths $\varphi=0°$, 90°, 180°, 270° (N, E, S, W) were explored in the zenith angle range $0°\leqq z\leqq 54°$ at angular intervals of 6°. The cosmic-ray telescope employed has been briefly described elsewhere.[3]

Before proceeding to our results, it should first be remarked that the fine structure pattern found in Missouri, $\lambda=50°$N, $h_0=10.6$ meters,[4] may be represented throughout the sky by an intensity surface $I(z, \varphi)$ possessing loci of prominences of very nearly circular form, concentric about the zenith.[2] There appear to be at least three such loci, at zenith angles $z=7°$, 20°, 35°. The possibility had been contemplated by one of us[5] that a pattern of this simple form might arise from the absorption of lines or bands inherent in the cosmic-ray spectra at infinity, provided that such spectral lines or bands were unaffected by the earth's magnetic field. This simple explanation has not been substantiated thus far by direct absorption measurements,[6] and so the possibility remains that the phenomena may have a geomagnetic or other origin. This peculiar circumstance added further incentive to undertake the present experiment at a lower geomagnetic latitude.

Our present results at Mexico City, $\lambda=29°$N, $h_0=7.5$ meters,[4] are summarized in Fig. 1, where we have plotted $I(z, \varphi)$ directly,[7] in two curves. The top curve shows the variation of $I(z, \varphi)$ (that is, the total number of counts normalized to unity at the zenith) in the western and eastern azimuths; and the bottom curve shows the variation of $I(z, \varphi)$ in the southern and northern azimuths. It may be noted, in passing, that the top curve shows a marked west-east excess and the bottom curve an almost equally pronounced south-north excess, both agreeing well with those established by Johnson[8] at the same locality. The features of the curves which are of primary interest to us are the two prominences in each of the three azimuths E, S, W and the prominence (possibly two) in the N azimuth. Their positions are summarized in Table I. These results suggest, as the simplest hypothesis, that there are two oval loci of prominences, enclosing the zenith but slightly eccentric with respect to it. Whether or not this is the proper connectivity of the prominences remains to be decided by further exploration at smaller intervals of both azimuth and zenith angle. Such further exploration is now being undertaken with this object in view.

TABLE I. *Inner and outer prominences z_1 and z_2 (in degrees) for different azimuths φ.*

φ	z_1	z_2
N	(18)	42
E	18	42
S	12	48
W	12	42

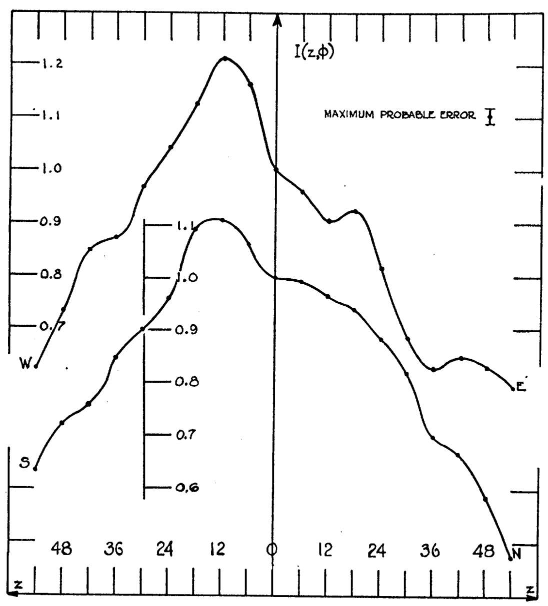

FIG. 1. Normalized directional cosmic-ray intensity $I(z, \varphi)$ at Mexico City, as a function of zenith angle z, for the four azimuths W, E (top curve) and S, N (bottom curve). The maximum probable error is about 1.5 percent, and the average probable error about 1.0 percent, of the zenith intensity.