and Furry[3] in their design of a separating plant for He^3. Employing our value of α and using Jones' and Furry's theory for column performance, one would predict a 125-fold concentration rise per day as compared with the 108 actually observed. In view of the difficulty of the measurements this may be considered as satisfactory agreement.

From the work of Atkins, Bastick, and Ibbs[4] on thermal diffusion in binary mixtures of rare gases, one would predict a higher value of α in helium than we have found. With the same apparatus as was used for the helium α-determination, we have made a rough determination of the thermal diffusion effect in a helium-neon mixture and found a lower value than that given by the above investigators and in excellent agreement with the new work on binary gas mixtures by Grew.[5]

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A Random-Absorption Effect in Diffraction of X-Rays from Coarse Powders

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CONSIDERING the statistical distribution and sizes of the grains and voids in a powder sample, the x-ray absorption factor for a given path length in the sample will have a statistical distribution. The average absorption factor obtained in this manner is in general different from the absorption factor obtained by using the average absorption coefficient. The resulting modification of the diffracted x-ray intensities will be referred to as the random absorption effect.

Although it is quite simple to set up the differential equation for the intensity of diffracted radiation, an exact solution of the equation is, in general, not possible. An approximation can be readily obtained, however, as will be demonstrated presently.

Consider a powder of a single substance. This case, besides being simple to handle, is of special interest because the "micro-absorption" effect discussed in a paper by Brindley[1] is zero for this case. The path of a ray penetrating a portion of the sample will be made up of a succession of elementary lengths occurring alternately in the solid material and voids. Let the representative path length between discontinuities be designated by D. Considering diffraction from an opaque powder block as used conventionally in the Geiger-counter x-ray spectrometer, let the sample be divided up into elementary slabs of thickness $D\sin\theta$ as indicated in Fig. 1, θ being the Bragg angle. The contribution to the integrated intensity from the nth slab is given by:

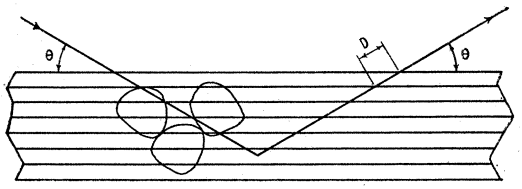

FIG. 1. Relationship of x-ray beam to sample. Several particles are sketched in to illustrate the approximate relationship of particle diameter to D and the thickness of an elementary slab.

TABLE I. Measurements on random absorption effect of x-rays.

Powder size (10^{-4} cm)	μD	(P/P_0)exp	(P/P_0)theo
10 to 20	0.43	0.94	0.91
20 to 44	0.92	0.81	0.82

P_n = (Integrated intensity due to a single slab) × (Absorption of the beam in the preceding slabs)

$$=\frac{JAv}{\sin\theta}\left\{\int^{D\sin\theta}\exp\left(\frac{-2\mu x}{\sin\theta}\right)dx\right\}\times\{v\exp(-\mu D)+v_0\}^{2(n-1)}, \quad (1)$$

where J = integrated intensity per unit volume of the solid material on basis of no absorption, A = cross section area of the x-ray beam at the sample, μ = linear absorption coefficient of the solid material, v = fraction of the volume occupied by solid material, $v_0 = 1-v$ = fraction of the volume occupied by voids.

For a solid block, the integrated intensity is $P_0 = JA/2\mu$. The value of P for the powder block is $\sum_{n=1}^{n=\infty} P_n$. Hence, one obtains

$$P/P_0 = [1+\exp(-\mu D)]/[2-v\{1-\exp(-\mu D)\}]. \quad (2)$$

An analogous expression for any number of crystalline components can be obtained in a similar manner. It is interesting to note that Eq. (2) gives the correct value of unity for $D=0$ (very fine powder) and for $v=1$ (solid block).

An experimental check was made on the random absorption effect. Three samples of iron were used: (a) solid block, (b) particles ranging from 10 to 20 microns in diameter, (c) particles ranging from 20 to 44 microns in diameter. In the theoretical evaluation of P/P_0 by Eq. (2), approximate values of D for samples (b) and (c) were taken to be 7.5 and 16 microns, respectively, and a value of 0.5 was assumed[2] for v. Radiation from an iron target was employed in a Geiger-counter x-ray spectrometer. The results are given in Table I:

These results indicate that a random absorption effect is present, and its order of magnitude is given by Eq. (2).

A more complete and detailed discussion of theoretical and experimental results is being prepared for publication.

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[2] This value is quite reasonable according to experiments on compaction of powders. See for instance, M. Muskat, *Flow of Homogeneous Fluids Through Porous Media* (McGraw-Hill Book Company, Inc., New York, 1937), p. 13.