The Fermi gas and liquid-drop models lead to considerably higher energies (500 MeV. or more) for $\bar{T} = 5$ MeV.

It is interesting to note that in the pure Bohr type of process the particles should be emitted under arbitrary angles; however, the angular distribution of tracks in a number of the stars show marked deviations from spherical symmetry, and probably these disintegrations are characterized by the fact that thermal equilibrium is never fully attained. Fig. 3 shows an extreme example of such a star. The probability that all four tracks were ejected under arbitrary angles is calculated as less than 1 in 10^5 . However, since the recoil nucleus shows considerable momentum, and the ejected particles are of relatively low energy (20 or 30 MeV.), it is doubtful if this process is of the pure Heisenberg type, as observed in cloud chambers³.

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¹ Weisskopf, *Phys. Rev.*, **52**, 295 (1937).

² Lattes, Muirhead, Occhialini and Powell, *Nature*, **159**, 694 (1947).

³ Hazen, *Phys. Rev.*, **65**, 67 (1944).

Adsorption Isotherms from Chromatographic Measurements

It has been shown¹ that adsorption isotherms can be calculated with good accuracy from chromatographic data, utilizing the measured concentrations (c_r) of eluted solute after developing the original band with v c.c. of pure solvent. Use is made of the equation

$$q = f(c) = (\mu_c + v.c_r)/x_t - \alpha.c_r, \quad (1)$$

where q is the amount of solute adsorbed per gm. of adsorbent, x_t is the total amount of adsorbent in the column (gm.), α is the pore space of the adsorbent (c.c./gm. adsorbent), μ_c is the total eluate after the point of concentration c .

In the case of strongly coloured solutes, however, where the movement of the front boundary of the chromatographic band can be followed easily, it is simpler to obtain the adsorption isotherm from the volume v of pure solvent used and from the amount of adsorbent x_f through which the coloured front has travelled from the top of the column.

The position of the front is governed by equation 1 in the form:

$$m = q_f.x_f - (v - \alpha.x_f).c_f, \quad (2)$$

where m is the total amount of solute used. With m , v and x_f known, equation 2 represents a linear relationship between q and c with a gradient $dq/dc = (v - \alpha.x_f)/x_f$. However, as shown by De Vault² and by Weiss³

$$(v - \alpha.x_f)/x_f = [df(c)/dc] c = c_r.$$

Thus equation 2, taken as a function of the variables q and c , corresponds to the tangent to the adsorption isotherm $q = f(c)$ at the point q_f , c_f , and, with a sequence of coexistent values of v and x_f , equation 2 gives a family of straight lines, from which the adsorption isotherm can be easily constructed as the envelope.

The relative accuracy of the equilibrium values so obtained is approximately that of v and x_f , which, for a well-made column, can be determined to at

ADSORPTION ISOTHERM AS ENVELOPE OF THE FUNCTION
 $m = x_f.q - (v - \alpha.x_f).c$

least ± 1 per cent. This method thus gives the complete adsorption isotherm without requiring a single concentration measurement by just following the movement of the front boundary, and this with an accuracy at least equal to that of the best classical methods of measuring adsorption equilibria.

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¹ Glueckauf, E., *Nature*, **156**, 748 (1945). Experimental details in *J. Chem. Soc.*, in the press.

² De Vault, D., *J. Amer. Chem. Soc.*, **65**, 532 (1943).

³ Weiss, J., *J. Chem. Soc.*, 297 (1943).

Slip Flow in Granular Beds

THE Poiseuille type of equation for capillaries of any shape takes the form,

$$u_e = \frac{m^2}{k_0\eta} \cdot \frac{\Delta p}{L_e} \quad (1)$$

for capillaries of any cross-section, where $k_0 = 2$ and $m = r/2$ for a circular capillary of radius r , and k_0 has generally values between 2 and 3 for other shapes¹. Application of this to granular beds follows by putting $u = u_e \cdot \epsilon \cdot L/L_e$, $m = \epsilon/S\sigma(1-\epsilon)$, $k = k_0 \cdot (L_e/L)^2$, whence

$$u = \frac{\epsilon^3}{(1-\epsilon)^2} \cdot \frac{\Delta p}{k\eta S^2\sigma^2 L} \quad (2)$$

k is known as Kozeny's constant, and is approximately equal to 5^{1,2}, Δp is pressure drop in dynes/cm.², and other symbols are as in the paper of Lea and Nurse².

When slip takes place in a capillary, giving a velocity, u_0 , at the wall, this must be added to the right-hand side of (1). Now, by balancing momentum transfer and pressure difference, Millikan³ obtained an expression for u_0 in a circular capillary in terms of a coefficient of external friction, β . In brief, tangential force on wall, $F' = 2\pi r L_e \beta u_0 = \pi r^2 \cdot \Delta p$. This is readily generalized to non-circular capillaries, giving

$$u_0 = \frac{m}{\beta} \cdot \frac{\Delta p}{L_e} \quad (3)$$

The Poiseuille type of equation, corrected for slip, thus becomes

$$u_e = \frac{m^2}{k_0\eta} \cdot \frac{\Delta p}{L_e} \cdot \left(1 + \frac{k_0\eta}{m\beta}\right) \quad (4)$$

Millikan further showed that β is given by

$$\beta = \frac{1}{2} \rho \bar{c} \div \left(\frac{2}{f} - 1\right) \quad (5)$$