resistance. The thickness of the mica block, perpendicular to the cleavage planes, was found from its weight; it was thought that a direct measurement of the thickness would have been inaccurate owing to the composite nature of the sample.

The thermal conductivity was also determined indirectly from the thermal diffusivity, using the apparatus described by Green and Cowles[5]. Temperatures were measured with 46 S.W.G. chromel-alumel thermocouples inserted in the composite mica sample. In calculating the thermal conductivity, a specific heat of 0·86 joule/gm. ° C. was assumed[6].

The results obtained by the two methods were in good agreement with each other. The indirect method yielded a value of 0·0190 cm.^{2}/sec. for the thermal diffusivity at 27° C., leading to a thermal conductance of 0·0163 ± 0·0009 W./° C. for a rectangular block 1 cm. long, with a mass of 1 gm. Using the direct method, this quantity was found to be 0·0185 ± 0·0018 W./° C.; within the limits of experimental accuracy, it showed no variation over the temperature range −85° to 35° C. Thus, assuming a density of 2·8 gm./c.c. (ref. 6), the values for the thermal conductivity corresponding to the two methods are 0·046 and 0·052 W./cm. ° C. respectively.

It is concluded that the thermal conductivity of phlogopite along the planes of cleavage is about 0·05 W./cm. ° C. This is an order of magnitude greater than the values which are typical for the perpendicular direction[1].

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[1] Powell, R. W., and Griffiths, E., *Proc. Roy. Soc.*, **163**, 189 (1937).

[2] "International Critical Tables", **2**, 315 (1927).

[3] "International Critical Tables", **5**, 231 (1929).

[4] Goldsmid, H. J., *Proc. Phys. Soc.*, B, **69**, 203 (1956).

[5] Green, A., and Cowles, L. E. J., *J. Sci. Instr.* (in the press).

[6] Warren, H., "Electrical Insulating Materials" (Ernest Benn, 1931).

Measurement of Slip (*Ko*) and Viscous (*Bo*) Flow Coefficients of Permeable Solids

IT is usual to measure the slip (Ko) and viscous (Bo) flow coefficients of permeable solids by plotting $K = \frac{u_1 p_1}{\nabla p}$ as a function of mean specimen pressure $\bar{p}$, and using the slope and intercepts of the curve to find Bo and Ko. It is also possible to find Bo and Ko in one measurement (at a single $\bar{p}$), of K, p_1 (inlet), p_0 (outlet) and the centre-specimen pressure. By knowing that the mass flow:

$$Q_m = -\frac{MA}{RT} K(\bar{p}) \frac{\partial p}{\partial z}, \text{ that } K = a + b.\bar{p}$$

$$\text{where } a = Ko.\frac{4}{3}\sqrt{\frac{8RT}{\pi M}}$$

and $b = Bo/\eta$ (η is gas viscosity), and that the divergence of Q_m is zero (Z — axial flow only, that is, a rod or bar test-piece), a pressure distribution $p(Z)$ can be calculated; by putting $p(Z) = p(\frac{1}{2})$, that is, pressure half-way along the bar-length ($Z = L/2$), a/b can be found as:

$$\frac{\frac{1}{2}(p_1^2 + p_0^2) - p^2(\frac{1}{2})}{2\,p(\frac{1}{2}) - (p_0 + p_1)}$$

by measurements of pressures at three points, independently of flow. Since $K = b.\bar{p}\left[1 + \frac{a}{b} \cdot \frac{1}{\bar{p}}\right]$, by finding K from flow measurements, b can be found, and hence a: that is, Bo and Ko can be found.

$p(\frac{1}{2})$ = R.M.S. value, $\sqrt{\frac{p_1^2 + p_0^2}{2}}$, for the case $Ko = 0$, and $= \bar{p}$ when Bo is zero.

It is hoped to publish this method fully elsewhere.

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[1] Hutcheon, J. M., *et al.*, "Flow of Gases through a Fine-Pore Graphite". S.C.I. Carbon Conference paper (Sept. 1957).

ASTROPHYSICS

Temperatures reached in Electrical Discharges in the Solar Atmosphere

IN a contribution[1a] to the Institution of Electrical Engineers Convention on Thermonuclear Processes, of which a somewhat fuller account was published later in *Nature*[1b], I suggested that the electrical discharge theory of solar flares and the associated magnetic storms and auroræ led to the surprising result that the temperature of these discharges must reach values of the order of 100,000,000° K. somewhere between the Sun and the Earth's orbit. In another account[1c] of this work, I suggested that this need not come as too great a surprise, as temperatures of the order of 1,000,000° K. had been obtained some years earlier in electrical discharges in the laboratory (I. V. Kurchatov, Moscow, 1956), and for long have been known to exist in the solar corona.

Furthermore, a similar increase in temperature is observed when long electrical discharges are propagated down the corresponding, but lesser, density gradients in some stellar atmospheres—those of the combination spectra stars, such as *Z* Andromedæ and *AX* Persei, for example. In these the temperature is initially that leading to the ionization of the metals, hydrogen and helium, that is, probably of the order of 5,000° or 10,000° K. However, by the time the discharge reaches the outer regions of these stellar atmospheres, after periods of the order of 100–200 days, the discharge temperature reaches values of the order of 1,000,000° K. as lines of Fe X and Fe XIV appear in the star's spectra.

Though there was thus some additional theoretical support for the surprising conclusion to which the theory led when applied to these solar phenomena, it is satisfactory to learn that satellite observations made by the U.S. Navy scientists have confirmed[2] that these high temperatures do exist in the disturbances associated with solar flares. As I emphasized many years ago[1d], it is difficult to see how these high temperatures can be built up by any other mechanism than that of an electrical discharge.

Similar temperatures are reached in galactic electric discharges, and can be measured, as I have suggested, by the proposed 'cosmic gas-velocity thermometer'[1e], of which the basic conception is that these high gas velocities observed in stars and galaxies are always the result of electrical discharges, the velocities of these jets being linked closely with their temperatures[1f], in contradistinction to the assumptions