LETTERS TO THE EDITOR

ASTROPHYSICS

Distinguishing between the Solar, the Interplanetary and Geomagnetic Fields

In a paper[1] to be published I derive the number density (n) distribution of particles trapped in a magnetic tube of force specified only in so much as the speed and the magnetic moment of each such particles are invariants. The derivation extends and amends that of Dowden[2]. The density distribution is made to relate to that at a point (denoted by a prime) where the number density per steradian is isotropic or nearly so. Collisions and external forces are neglected. It is found that at a part of the tube where $B > B'$, $n = n'$ and where $B \ll B'$:

$$n \approx KB \qquad (1)$$

where K is constant.

It follows that different tubes of force are distinguishable by different K values.

Smith[3] and others used the empirical relation:

$$f_c^2 = af_H \qquad (2)$$

(where $a \approx 10^6$ c/s) to describe the whistler medium of the Earth, where f_c is the plasma frequency and f_H the gyro-frequency of electrons. This is equivalent to equation (1) so that $K = a/4\ \pi\ ce$. Thus for the Earth $K \approx 10^4$ cm^{-3} gauss^{-1}.

Assuming a dipole coronal magnetic field of 1 gauss at the Sun, Ingham's[4] distribution of electron density in the outer solar corona implies a value of $K \approx 10^7$, or $a \approx 10^9$ for the corona. My assumed value of magnetic field, however, may be inappropriate for the corona.

Using a value of $B = 10^{-4}$ gauss for the interplanetary field near the Earth and $n = 1$, $K \approx 10^5$ and $a \approx 10^7$.

It is suggested then that geomagnetic field may be distinguished from interplanetary field by measurement of either the pair (n, B) or the pair (f_c, f_H). Likewise interplanetary field may be distinguished from solar field. The distinction may be difficult if irregularities exist in the fields, for it may be expected that the K value for any particular tube of force could differ from the mean for its parent magnetic field. It would be interesting to know whether the magnetic field at 1 A.U. from the Sun is part of the solar field.

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[1] Cole, K. D., *Planet. Space Sci.* (in the press).
[2] Dowden, R. L., *J. Atmos. Terr. Phys.*, **20**, 122 (1961).
[3] Smith, R. L., *J. Geophys. Res.*, **66**, 3709 (1961).
[4] Ingham, M. F., *Mon. Nat. Roy. Astro. Soc.*, **122**, 157 (1961).

PHYSICS

Pressure Temperature Projection of the Three-phase Line of the Gallium Antimony System

Previous work has been carried out on the phase diagram of the gallium antimony system by several workers[1–3]. However, their work was limited to the composition temperature projection of the phase diagram.

The interest shown in the semiconducting properties of gallium antimonide[4] makes it desirable to grow stoichiometric single crystals. Crystals so far produced have, however, contained large numbers of electrically active impurities[4]. Since most workers grow their crystals with conditions such that antimony can freely evaporate, it is possible that this may be due to antimony deficiency[5].

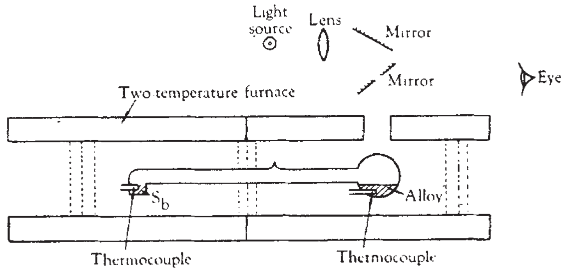

Fig. 1. Experimental apparatus

This communication describes an investigation undertaken to see whether the equilibrium pressure at the melting point was sufficiently large to cause this effect.

The apparatus used was very similar to that used for the Ga–Te system[6] and is shown in Fig. 1. The starting materials were zone refined GaSb and Sb. Before loading the materials were etched. (GaSb was etched with HF / HNO_3, 1 : 1 and the Sb with $HCl / H_2O_2 / H_2O$, 5 : 1 : 4.) The tube was evacuated and sealed off at a pressure of about 10^{-6} torr.

It was found that the alloys could be supercooled by up to 20° C so that only melting points were taken. The mode of operation was that the system was allowed to reach equilibrium for times of about 70 h just below the three-phase line. The melt temperature was then raised in about 3° C steps at intervals up to 24 h and the temperature at which the solid liquid transition occurred was noted.

Platinum–platinum 13 per cent rhodium thermocouples were used to measure the temperatures, which were computed from the thermocouple outputs using standard tables[7].

The results obtained are shown in Fig. 2, where they are plotted in terms of melt and reservoir temperatures. The pressures shown are taken from Honig's collection[8]. No attempt has been made to correct the reservoir temperatures for the effect of the pressure gradient in the tube. At the worst this would give a pressure correction of the form[9]:

$$\frac{P_A}{P_R} = \sqrt{\frac{T_A}{T_R}}$$

where P and T are pressure and temperature and the suffices refer to the alloy (A) and the reservoir (R). With

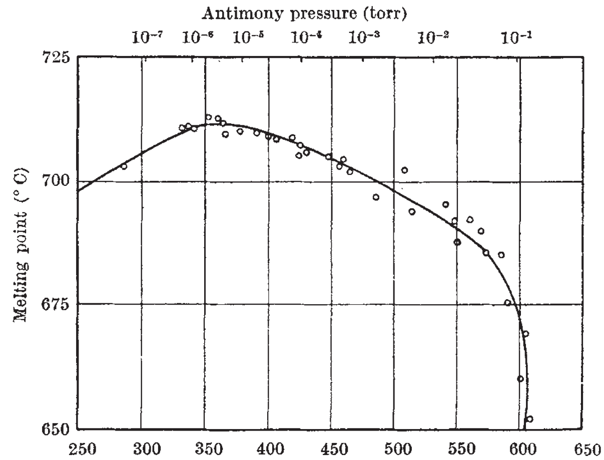

Fig. 2. Experimental results