Letters to the Editor

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The Temperature Dependence of Drift Mobility in Germanium

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THE occurrence of values of current gain greater than 3.1 in n-type germanium triodes has been attributed by Sittner[1] to hole traps. If this explanation is correct, a study of the drift mobility of holes in n-type germanium at low temperatures should indicate such trapping. Haynes and Shockley[2] have pointed out that trapping will not influence the temperature dependence of the Hall mobility.

In the present experiments, a modification reported by Lawrance and Gibson[3] to the method of Haynes and Shockley[2] has been used to measure the drift mobility of holes in 0.02 ohm-meter resistivity single crystal n-type germanium in the temperature range 100°K to 360°K. This method involves the use of a dc emitter current and a pulsed sweeping field.

As the temperature is lowered the drift mobility increases and then decreases rapidly as trapping occurs. By increasing the emitter current so that the ratio of the number of holes trapped to the number available becomes small, the trapping is observed to occur at a lower temperature. The temperature at which trapping occurs for a given emitter current is variable from specimen to specimen and depends upon surface treatment and the age of the specimen. It is therefore concluded that these traps are on the surface. The traps may be completely filled and made ineffective by illuminating the specimen with light from a tungsten lamp, and by this means it has been possible to carry out the drift mobility measurements at temperatures much lower than those at which trapping cannot be eliminated by increasing the emitter current alone.

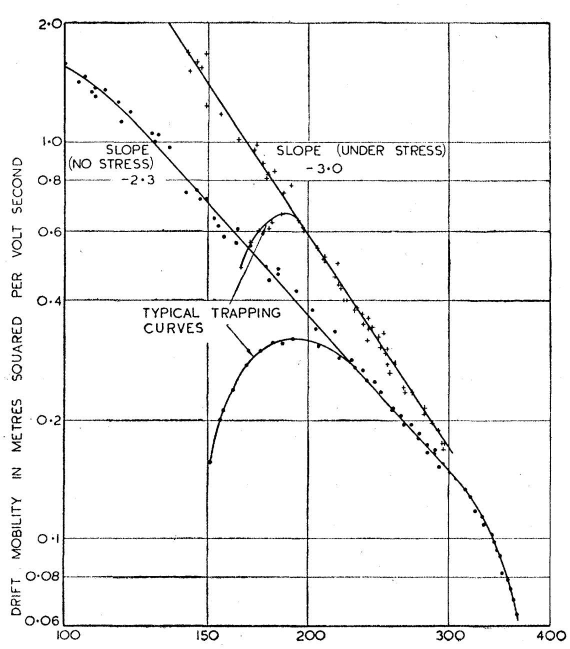

FIG. 1. The drift mobility of holes in n-type germanium as a function of temperature.

Initial experiments have given a temperature variation of drift mobility proportional to T^{-3}, but this has been found to be due to strains produced by differential expansion of the germanium and the "perspex" base. Subsequent experiments in which the germanium was free to move relative to the base have given a $T^{-2.3}$ relationship, in substantial agreement with the results for the Hall mobility of holes published by Dunlap.[4] The Hall mobility for electrons in the sample of germanium used by the author has been measured by Dr. E. H. Putley of this establishment and found to vary as $T^{-\frac{3}{2}}$.

It is interesting to note that, in the case where the germanium was under stress, the drift mobility was higher than it should have been at any given temperature. The holes were therefore moving faster than they would have done in a strain-free lattice at the same temperature.

The accompanying graph (Fig. 1) shows the relationship between $\log\mu$ and $\log T$ over the temperature range already stated. It is not possible at present to calculate the trap depth from these measurements, since the present method of measuring in the trapping region is a complicated function of the delay time.

A fuller account of this work is to be published elsewhere.

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Proton-Proton Scattering for a Nucleon Isobar Model

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A NUMBER of phenomenological static potentials have been used in the analysis of p–p scattering.[1] It has been found to be quite difficult to account for the experimentally observed large isotropic cross section at high energies (about 5 mb/sterad in the energy interval of 100 to 350 Mev[2]) with a potential which also fits the low energy experiments; only Jastrow's hard core model gives reasonably good agreement with the data.

We have investigated the effect of excited isobaric states on the p–p scattering. The particular model used was based on the strong coupling approximation of meson theory.[3] According to the pseudoscalar charge-symmetric theory in the strong coupling approximation, nucleons can exist in states with any half-odd integral spin and isotopic spin (spin and isotopic spin being equal in a given state). The energy of such a state is proportional to $(\text{spin}+\frac{1}{2})^2$. The interaction energy of two nucleons is of the form $[\Omega V(r)+T'U(r)]$, V and U being functions of the distance between the two nucleons only, and Ω and T' depending on the spins and isotopic spins.[4] With respect to states in which both nucleons have spin $\frac{1}{2}$, the interaction reduces to that obtained in the weak coupling approximation:

$$\Omega=(1/9)(\tau_1\cdot\tau_2)(\sigma_1\cdot\sigma_2),\quad T'=(1/27)(\tau_1\cdot\tau_2)S_{12}.$$

T' is a somewhat unusual tensor force in the sense that it has an effect on the ^1S scattering.