X-ray diffraction studies have revealed no readily apparent differences in the crystal structure of the two materials characterized by curves A and B. Similarly, annealing below the melting point does not affect the position of the limit of absorption. It would therefore seem that the transmission between 3.2 and 7.0 microns is caused by some impurity which is removed by zone refining. Although this proposal is somewhat unusual, there is other evidence to support it. Material, whose transmission is at first of the type in curve A, can be converted to material similar to B by sufficient zone refining. In addition, by sampling the material between zone refining cycles, the long-wavelength limit of absorption was observed to progress from 3.2 to 7.0 microns. Curve C is the transmission curve of a 0.007-inch slice of such a partially refined sample. Its resistivity was 2.5×10^{-4} ohm cm. Similarly, if a heavily refined bar is examined along its length, it is observed that the limit of absorption moves to shorter wavelengths as one proceeds from the pure to the impure end of the bar. Thus, it appears that the intrinsic limit of absorption lies at 7.0 microns, and the anomalous transmission from 3.2 to 7.0 microns is caused by an impurity with distribution coefficient less than unity.

Selective doping should reveal the nature of the impurity responsible for this behavior, and experiments have been performed in which material with an intrinsic limit of absorption at 7.0 microns is doped with lead, nickel, arsenic, excess indium, and excess antimony. These five agents were chosen since chemical analysis has shown them to be the most abundant impurities in the 3.2-micron material. Doping with up to 0.05 percent lead, arsenic, indium, or antimony produced no observable shift in the long-wavelength limit of absorption. However, an equal amount of nickel caused a shift of about one micron. By adding 0.1 percent of nickel, the long-wavelength limit has been moved to 5 microns. Thus it seems that nickel is at least partially responsible for the anomalous transmission between 3 and 7 microns.

If a single crystal of InSb with a long-wavelength limit of absorption at 7.0 microns at room temperature is cooled to 77°K, the long-wavelength limit shifts to 4.5 microns corresponding to an optical gap of 0.28 ev. Assuming that the change in energy gap is essentially linear over this temperature range, this corresponds to a temperature coefficient for the energy gap of -4×10^{-4} ev/degree K. This coefficient is in excellent agreement with the electrical properties of InSb if the effective mass of the charge carriers is assumed to be 0.083.[4]

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Magnetic Self-Focusing of Auroral Protons

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THE recent beautiful experiments of Meinel[1] on spectra of the aurora show that protons are entering the upper atmosphere at the commencement of an auroral display. From the Doppler spreading to the violet which he observed in H_α, Meinel concluded that the primary protons enter auroral zones with velocities probably greater than 3×10^9 cm sec^{-1}. These speeds are in accord with the original Birkland-Störmer[2] theory of a charged stream of solar particles bent into auroral zones by the earth's magnetic field. The observations therefore throw doubt on criticisms[3] of the theory which argued that such charged streams could not exist as streams because of spreading due to the electrostatic repulsion of the charges.

It is the purpose here to bring to attention an effect which has not been considered in auroral stream theories, namely, the magnetic self-focusing action of ionized streams which was worked out in some detail in 1934.[4] Calculations of this focusing action show that a stream of protons and electrons ejected from the sun in a wide angle cone will rapidly focus itself into a stream having a diameter of the same order as the diameter of an auroral display. Such a stream will be bent into the auroral zones in agreement with the calculations of Störmer. The amount of focusing into the stream depends on the rate of emission of the particles from the sun and on the density of the ionization (which we assume to be electrostatically neutral) in the region between the sun and the earth. Quantitative estimates appear reasonable and will be published. The bearing of the focusing action on corpuscular theories of magnetic storms is being considered.

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Anisotropic Resistivities of Selenium Crystals at High Frequencies

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THE electrical properties of liquid and hexagonal selenium have been presented in four reports.[1–4] The temperature dependence of the resistivity of the crystals grown in a melt[2] was measured at 200 Mc/sec with the same care as described in that report to avoid contributions of end contact resistance and capacitative shunting of the specimens (Boella or Howe effects). The dark resistivities of representative crystals in a rough vacuum are compared with simultaneous dc values in Fig. 1. The dc curves

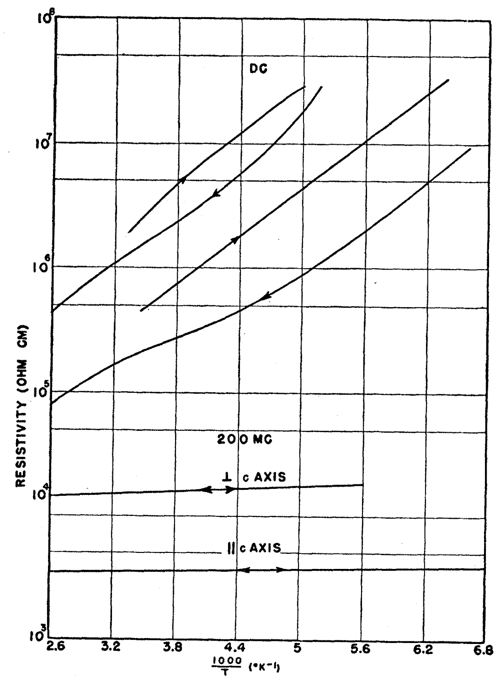

FIG. 1. Anisotropic resistivities of selenium crystals at high temperatures.

behave as previously described.[2] There was, however, no hysteresis in the ac measurements. Data for a number of crystals are presented in Table I. The ratio 3.5 of the average value of $\rho\perp c$