According to Cardona [3], allowance for the influence of the Γ_{15c} band leads to the following expression for the mass at the bottom of the Γ_{1c} band:

$$\frac{1}{m_n^*} \simeq \frac{1}{2m_n}\left(1 + \frac{\epsilon_{g1}}{\epsilon_{g2}}\right), \tag{3}$$

where m_n is determined by formula (1), $\epsilon_{g2} = \epsilon(\Gamma_{15c}) - \epsilon(\Gamma_{15v})$ and equals 3.4 eV for InSb, and $\epsilon_{g1} = \epsilon(\Gamma_{15}) - \epsilon(\Gamma_{2'})$ is the energy difference of the corresponding levels in gray tin and equals 2.8 eV. We have neglected in (3) terms that introduce an error not larger than 3%. Since there are no data on the variation of ϵ_{g1} and ϵ_{g2} with pressure in InSb and α-Sn, we can assume for estimating purposes that they are the same as in Si and GaP [4]. Assuming $d\epsilon_{g1}/dP = (+6 \times 10^{-6}$ to $+1 \times 10^{-5})$ eV/atm, we found no noticeable deviation from the theoretical curve of Fig. 3. To reconcile the calculated and experimental curves we must assume that the baric coefficients $d\epsilon_{gi}/dP$ greatly exceed the experimental values. The smallest values of $d\epsilon_{gi}/dP$ for which agreement can be obtained are:

$$d\epsilon_{g2}/dP \simeq 68 \times 10^{-5} \text{ eV/atm}, \; d\epsilon_{g1}/dP \simeq -8 \times 10^{-5} \text{ eV/atm}$$

or

$$d\epsilon_{g2}/dP \simeq +3 \times 10^{-4} \text{ eV/atm}, \; d\epsilon_{g1}/dP \simeq +1 \times 10^{-5} \text{ eV/atm}.$$

It is therefore unclear whether the influence of hydrostatic pressure on the electron effective mass can be explained within the framework of Kane's theory, since there are no experimental data on $d\epsilon_{gi}/dP$. The accepted semi-empirical approach to the analysis of the effect of pressure on the main characteristics of semiconductors is patently inadequate, and a quantitative theory that takes into account the dependence of the band structure on the lattice period.

In conclusion we note that the pressure dependence of the electron density (Fig. 2) likewise remains without adequate explanation.

We can propose the following: In region 1 the change of ϵ_g with pressure is slightly larger than 2kT, and the density n remains practically constant. With further increase in pressure (region 2) the lower edge of the conduction band moves more rapidly (i.e., with a larger baric coefficient) than the donor level [5] and the gap between them increases, while n decreases. At $P \approx 10^4$ atm the distance between the impurity level and the bottom of the conduction band reaches ~0.15 eV, i.e., the shallow level becomes essentially deep. In this connection it can be assumed, in analogy with Ge and Si [5], that the speed of the level increases appreciably with pressure: in region 3 it becomes equal to the speed of the bottom of the conduction band.

[1] E. S. Itskevich, PTE, No. 4, 148 (1963).

[2] I. V. Mochan, Yu. N. Obraztsov, and T. V. Smirnova, FTT 4, 1021 (1962), Soviet Phys. Solid State 4, 754 (1962).

[3] M. Cardona, Phys. Chem. Sol. 24, 1543 (1963).