showing that the incoherent radiation shifts more than $3\frac{1}{2}$ times as fast as the individual modes. This is the reason for the earlier statement that the modes could only be followed over a limited pressure range.

DISCUSSION

The results for the pressure dependence of the peak of the incoherent radiation are in agreement with the published values for the pressure shift of the energy gap. The results of experiments to determine this latter shift differ appreciably, however,[5] so that no information can be gained by a direct comparison of the two experiments. If the assumption is made that there is a one-to-one correspondence between the shift of the peak of the radiation and the gap itself, then the pressure coefficient derived from our experiments falls near the mean of the published values.

In the case of the coherent emission we find for the resonance frequency of a mode $\nu_{res}(l,n)$

$$\frac{d\nu_{res}}{dp}=\frac{cs}{2}\left[-\frac{1}{l^2 n}\frac{dl}{dp}-\frac{1}{ln^2}\frac{dn}{dp}\right].$$

Remembering that the index of refraction n is a function both of pressure and of frequency we find for the relative shift of a particular mode

$$\frac{1}{\nu_{res}}\frac{d\nu_{res}}{dp}=\frac{1}{\lambda_{res}}\frac{d\lambda_{res}}{dp}$$
$$=\frac{-\frac{1}{3}n\kappa}{[n+\nu_{res}(\partial n/\partial\nu_{res})]}+\frac{\partial n/\partial p}{[n+\nu_{res}(\partial n/\partial\nu_{res})]}. \quad (2)$$

On substituting the values $\kappa=13.2\times10^{-7}\,\text{atm}^{-1}$ for GaAs,[6] $n=3.59$, and $n+\nu(\partial n/\partial\nu)=5.2$ from Marple's measurements,[7] the first term on the right of Eq. (2) turns out to be

$$-\tfrac{1}{3}\kappa n/[n+\nu_{res}(\partial n/\partial\nu_{res})]=-3.04\times10^{-7}\,\text{atm}^{-1}.$$

Comparing this with the measured value, it becomes apparent that the major portion of the shift is due to the change in dielectric constant with pressure.

We employ a simple model to show that this result is reasonable. Since the photon frequency ν is close to that of the [000] band gap ν_g, we make the assumption that the dispersion of the index is determined largely by this gap and is a function only of $\nu-\nu_g$. This is in agreement with the analysis by Stern,[8] who predicts a sharp maximum for the index at the band edge of the [000] minimum. Further, we assume that the dispersion as a function of $\nu-\nu_g$ does not vary appreciably with pressure. This implies that $\partial n/\partial p$ at a given frequency ν is determined solely by the variation of ν_g if the effect of pressure on the dc dielectric constant and the interband transitions at higher energies is neglected. By translating the n versus frequency curve rigidly along the ν axis by an amount determined by the known pressure shift of the [000] gap[5] we therefore estimate:

$$\partial n/\partial p/[n+\nu(\partial n/\partial\nu)]=-2\times10^{-6}\,\text{atm}^{-1}.$$

It should be noted that the rigid shift with pressure assumed here for the dispersion in the vicinity of ν_g appears also to be characteristic of the corresponding variation with temperature, as shown by Marple's data.[7]

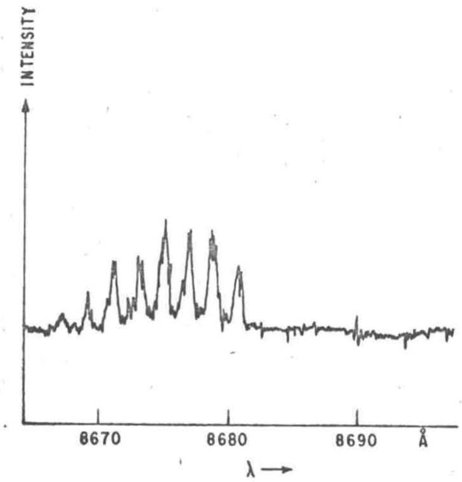

FIG. 2. Intensity vs wavelength at $T=190°$K and 136 atm pressure (diode L351).

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