where we have written $\langle\tau(E)\rangle$ as explicity dependent on the band gap $\Delta\epsilon$ (ie $\Delta E/kT$) at a particular pressure. A similar relation holds for the s valleys, and so equation (5) becomes

$$\rho(P) = \frac{1}{e\left\{n_g(P)\,\mu_g^*(P)\dfrac{\langle\tau_g\Delta\epsilon)\rangle}{\langle\tau_g(\infty)\rangle} + n_s(P)\,\mu_s^*(P)\dfrac{\langle\tau_s(\Delta\epsilon)\rangle}{\langle\tau_s(\infty)\rangle}\right\}} \tag{7}$$

We now examine the Hall constant for the two carrier model which can be written as

$$R_H(P) = \frac{-e^3}{3\sigma^2(P)}\left\{n_s(P)\,\langle\tau_s^2(\Delta\epsilon)\rangle\,\frac{(K_s+2)\,K_s}{m_{lg}^2} + n_g(P)\,\langle\tau_g^2(\Delta\epsilon)\rangle\,\frac{(K_g+2)\,K_g}{m_{lg}^2}\right\} \tag{8}$$

This is the same formula as that given by Nathan *et al.* (1961) apart from an extra e^2 factor. If we substitute for $K_x = m_{lx}/m_{tx}$ then from equations (3)

$$\mu_x = e\langle\tau_x(E)\rangle\,\frac{(1+2K_x)}{3m_{lx}} \tag{9}$$

and a further substitution in equation (8) yields

$$R_H(P) = \frac{-e}{\sigma^2(P)}\left\{n_s(P)\,\mu_s^{*2}(P)\,r_s^*\,\frac{\langle\tau_s^2(\Delta\epsilon)\rangle}{\langle\tau_s^2(\infty)\rangle}\,\frac{3K_s(K_s+2)}{(1+2K_s)^2}\right.$$

$$\left. + n_g(P)\,\mu_g^{*2}(P)\,r_g^*\,\frac{\langle\tau_g^2(\Delta\epsilon)\rangle}{\langle\tau_g^2(\infty)\rangle}\,\frac{3K_g(K_g+2)}{(1+2K_g)^2}\right\} \tag{10}$$

where $r_x^* = \langle\tau_x^2(\infty)\rangle/\langle\tau_x(\infty)\rangle^2$.

Now let $F_x = r_x^* 3K_x(K_x+2)/(1+2K_x)^2$ and take the values of K_g from the measured Ge ($\sim$20) and K_s from the measured Si ($\sim$5) results (Glickman (1956) found little variation in K_s in Ge–Si alloys before band cross-over) to give $F_g \sim 0{\cdot}78\,r_g^*$ and $F_s \sim 0{\cdot}87\,r_s^*$. It can be shown that for intravalley acoustic mode scattering $r_g^* = r_s^* = 1{\cdot}18$ (and hence $F_g = 0{\cdot}29$), $F_s = 1{\cdot}02$ and equation (10) becomes

$$R_H = \frac{-e}{\sigma^2(P)}\left\{0{\cdot}92 n_g(P)\,\mu_g^{*2}(P)\,\frac{\langle\tau^2(\Delta\epsilon)\rangle}{\langle\tau_g^2(\infty)\rangle} + 1{\cdot}02 n_s(P)\,\mu_s^{*2}(P)\,\frac{\langle\tau_s^2(\Delta\epsilon)\rangle}{\langle\tau_s^2(\infty)\rangle}\right\} \tag{11}$$

To take account of the intervalley scattering Nathan *et al* (1961) used the further scattering parameters S and S' defined by

$$S = \frac{B_g C_s' v_s}{A_g C_g'} \qquad \text{and} \qquad S' = \frac{B_s C_g' v_g}{A_s C_s'} \tag{12}$$

which give the relative strengths of the inter- to intra-valley scattering for the L_1 and Δ_1 states. The relaxation times to be used in equations (7) and (11) then become modified in the manner shown in the appendix.

We are left with a number of parameters which can be used to fit the data:

(*a*) ΔE_0 the atmospheric pressure $\Delta_1 - L_1$ sub-band energy gap

(*b*) N_0 the ratio of the density of states

$$\frac{N_{\Delta_1}}{N_{L_1}} \propto \left(\frac{m^*_{D\Delta_1}}{m^*_{DL_1}}\right)^{3/2}.$$

We have used initially the experimental value of $m^*_{DL} = 0{\cdot}54\,m_e$, and for $m^*_{D\Delta}$ have used predicted theoretical values (see table 1).

(*c*) The pressure coefficient of the sub-band gap $dE(\Delta_1 - L_1)/dP$ was taken as $5{\cdot}9 \times 10^{-6}$ eV bar^{-1}. This implies that the Δ_1 minima are moving towards the valence band maximum with a pressure coefficient of $-0{\cdot}9 \times 10^{-6}$ eV bar^{-1}, if the L_1 minima have the accepted coefficient of $5{\cdot}0 \times 10^{-6}$ eV bar^{-1}. The small negative coefficient of the Δ_1 minima was estimated from the slopes of the resistivity and mobility curves beyond 55 kbar. These were less than have been observed for Si which has a pressure coefficient of $-1{\cdot}5 \times 10^{-6}$ eV bar^{-1}. Our result is in agreement with the coefficient later used by Howard (1961) of $-1{\cdot}0 \times 10^{-6}$ eV bar^{-1} for unpublished magnetoconductivity measurements in n type Ge.

(*d*) The pressure coefficients of mobilities in the two bands. In the low pressure region, where the effect of the Δ_1 minima is small, the best fit for $\mu_g^*(P)$ was

$$\frac{\mu_g^*(0)}{(1 + 0{\cdot}008P)}$$

where P is in kbar. This 0·008 variation is larger than the result of 0·004 used by Nathan *et al.* (1961), but it gave the best fit in the 0–10 kbar range. The relatively large error in our results in this pressure range, however, (figure 1) limits the accuracy of such a fit, and the discrepancy should not be considered as serious. Our variation in μ_g^* is used for the whole pressure range. The variation in the Δ_1 mobility was ignored. This is reasonable in view of the small pressure coefficient of these minima.

(*e*) The anisotropy K_s of the Δ_1 minima is unknown, and to a first approximation we have used the Si value, $K_s \sim 5$. We have assumed that the anisotropies of both the L_1 and Δ_1 minima will not change with pressure. Early Hall and magnetoresistance measurements to 10 kbar by Benedek *et al.* (1955) implied that a change in K_g with pressure was taking place, but this was before any effect due to the Δ_1 minima was considered. W. E. Howard and W. Paul (unpublished) have found that K_g varies to a negligible extent from magnetoconductivity measurements at pressure, and Glickman and Christian (1956) found little variation in K_s on Si–Ge alloys before band cross-over.

5. Curve fitting

The two sets of results, resistivity and Hall mobility, were fitted separately. In the diagrams

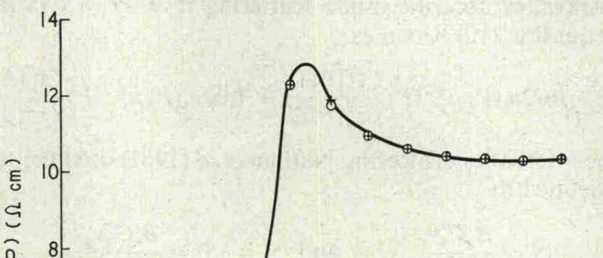

Figure 3. Theoretical fits of high pressure resistivity data in n type Ge which illustrates how higher values of N_0 lead to a greater sub-band gap ΔE_0 and scattering parameter S', when S (=4) is constant. Full curve, experimental: + $N_0 = 1{\cdot}55$, $S' = 0{\cdot}34$, $\Delta E_0 = 0{\cdot}177$ eV; ○ $N_0 = 4{\cdot}2$, $S' = 0{\cdot}123$, $\Delta E_0 = 0{\cdot}185$ eV.