impurity scattering potential

$$\hat{V}_q = \int V_{imp}(\vec{r})\, e^{-i\vec{q}\cdot\vec{r}}\, d\vec{r} \qquad (39)$$

$\nabla_q u$ is the momentum gradient of the dispersion relation Eq. (37), and dS_q is a volume element appropriate for integrating over the momentum surface defined by u=0. As the electrons lose momentum, they drift in the direction of $\vec{\varepsilon}$ and dissipate energy. One may obtain σ_{xx} by identifying this power dissipation with ohmic loss, in the manner

$$e\vec{\varepsilon}\cdot\left(\frac{d\vec{p}}{dt}\right) a_0^2 = \sigma_{xx}\, \varepsilon^2 L^2 \qquad (40)$$

For ease of interpretation, I shall assume that V_q is constant and express σ_{xx} in terms of the classical conductivity

$$\sigma_{xx}^{(0)} = \left[\left\{\frac{\rho_{imp}}{2\pi m a_0^2}\right\} \frac{|\hat{V}_q|^2}{(\hbar\omega_c)^2} \right] \frac{e^2}{\hbar} \qquad (41)$$

in the manner

$$R = \left(\frac{2\Delta}{\hbar\omega_c}\right)^2 \frac{\sigma_{xx}}{\sigma_{xx}^{(0)}} \qquad (42)$$

R, calculated for simplicity using the sum rule $S_{total}(q)$ given by Eq. (26), is plotted with and without exciton binding in

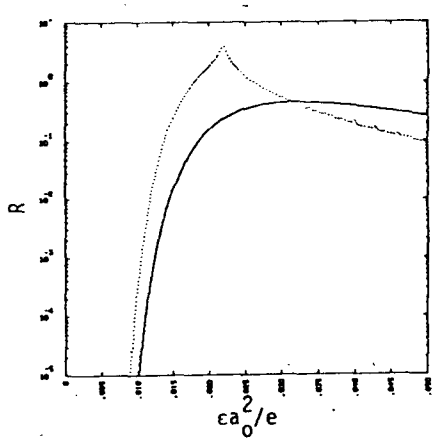

Fig. 3. R, as defined in Eq. (42) versus dimensionless electric field $a_0^2\varepsilon/e$. The dotted and solid curves are calculated with and without the excitonic binding, respectively.

Fig. 3. One sees in both cases a low-field conductivity proportional to $\exp[-\frac{1}{2}(\frac{2\Delta}{ea_0|\vec{\varepsilon}|})^2]$ and a peak value of order 1. The singularity at 0.022 is a real effect caused by the competition between the exciton binding forces and dipole force. It occurs when $\sqrt{2m}\, q\, a_0 = 6.4$, which can be seen from Fig. 1 to be well outside the core repulsion region.

REFERENCES

(1) R. B. Laughlin, Phys. Rev. Lett. 50 (1983) 1395.
(2) R. B. Laughlin, Surf. Sci. 141 (1984) 11; Springer Series in Solid State Sciences 53 (1984) 279.
(3) D. C. Tsui, H. L. Stormer and A. C. Gossard, Phys. Rev. Lett. 48 (1982) 1559.
(4) Yu A. Bychkov, S. V. Iordanskii and G. M. Eliashberg, Sov. Phys. JETP Lett. 33 (1981) 143; C. Kallin and B. I. Halperin, submitted to Phys. Rev. B.
(5) F. J. Rogers, J. Chem. Phys. 73 (1980) 6272.
(6) J. P. Hansen, G. M. Torrie and P. Vieillefosse, Phys. Rev. A16, (1977) 2153.
(7) B. I. Halperin, Phys. Rev. Lett., 52 (1984) 1583.
(8) J. P. Hansen and D. Levesque, J. Phys. C14 (1981) L603.
(9) M. B. Cage, R. F. Dziuba, B. F. Field, E. R. Williams, S. M. Girvin, A. C. Gossard, D. C. Tsui, and R. J. Wagner, Phys. Rev. Lett. 51 (1983) 1374; O. Heinonen, D. L. Taylor and S. M. Girvin, Phys. Rev. B15 (Sept., 1984, in press).