

Another transport property of interest is the Hall effect. The Hall constant, R , is defined by

$$E_y = R J_x H_z \quad (I-11)$$

where E_y is the transverse electric field, J_x the current density, and H_z the magnetic field. Figure 1-1 shows the geometry involved; x, y, z , indicate direction. Derivations of the Hall constant based on a picture of free electrons give

$$R = 1/Nec \quad (I-12)$$

where e is the charge of the carriers and c the velocity of light. More accurate treatments of the Hall effect involve solving the Boltzmann transport equation and knowing $E(\vec{k})$ and $\tau(\vec{k})$. The Hall constant is then given as the quotient of two integrals involving the scattering time and energy derivatives taken over the Fermi surface [51]. It can be shown that for $\tau(\vec{k}) = \tau(E)$ and for spherical energy surfaces, $E(\vec{k}) = E(|\vec{k}|)$, the Hall constant is still given by Eq. (I-12). In general, anisotropy of the scattering time and of the energy surfaces will alter the expression for the Hall constant. We may then write

$$R = 1/Necn^* \quad (I-13)$$

where n^* , which we shall refer to as electrons/atom, is a factor which depends on the anisotropy of $\tau(\vec{k})$ and $E(\vec{k})$, and is of the order of one. In Table 1-1 we have listed the values of n^* for the alkalis, computed from the values of the Hall constant given in the literature. From the computations of Olson and Rodriguez one can obtain the Hall constant for an energy surface of the form (I-4) and an isotropic scattering time. This gives

$$n^* = \frac{[1 - r^2 (.190 + 1.85 t^2)]^2}{1 - r^2 (5.14 + 81.2 t^2)} \quad (I-14)$$

We see that the change of n^* from its free electron value of unity depends only upon the warping of the surface. Expression (I-14) will always give n^* larger than unity. When we discuss our results in Sec. IV we shall give an expression for n^* which takes into account both warped energy surfaces and

anisotropic scattering times; in that case n^* may be either greater or less than one. We shall see there that the magnitude of the scattering time does not enter the expression for n^* ; only its anisotropy. Except for a direct volume dependence of N , we can attribute any changes in R with pressure to changes in n^* ; these changes are due to changes in the anisotropy of the Fermi surface and/or the anisotropy of the scattering time. If the measurement were performed in the impurity scattering range, where the scattering time is probably nearly isotropic, the results of a pressure measurement could be interpreted more directly in terms of changes of the anisotropy of the Fermi surface; in a room temperature measurement the scattering is by the lattice and we shall have to consider the effect of a possible anisotropy in the scattering time arising from the elastic anisotropy of the crystal. We shall see in Sec. IV that this can be quite important.

The expression (1-14) shows that the Hall effect is quite sensitive to anisotropy of the Fermi surface, considerably more so than the conductivity (1-8). It can be measured at room temperature, single crystal samples are not necessary, and since the scattering is dominated by the lattice, small amounts of impurities are not important. We decided to study the Hall effect in the alkali metals under pressure.