

will select a smaller range of phonon wave vectors and sound velocities than the  $F(\theta)$  for potassium and will probably give more anisotropy in  $\tau$ .

In Tables 4-5, 4-6, and 4-7 we list  $qa/2\pi$  as a function of  $\theta$  for various initial  $k$ . The values were obtained by measuring on a diagram such as that in Fig. 4-2. We also tabulate  $(\frac{2\pi}{qa})^2$  and  $F(\theta)(\frac{2\pi}{qa})^2$ ; the latter is proportional to the integrand in Eq. (IV-40). We used  $F(\theta)$  evaluated with both the potassium and lithium matrix elements. The integrand of Eq. (IV-40) was plotted as a function of  $\theta$  and  $I(\vec{k})$  evaluated graphically. The results are shown in Table IV-8; we have also evaluated the integral  $I(\vec{k})$  counting U.K. processes only. This takes account of the large velocity of sound for the longitudinal phonons used in normal processes by not counting these processes at all.

As was pointed out before, the integration for  $k$  in the 111 direction is unrepresentative because the possible scattering processes depend strongly on the angle  $\phi$ , that is on the particular great circle on the Fermi sphere for which we have chosen to do the  $\theta$  integration. Because of this strong  $\phi$  dependence no two-dimensional integration will give a very meaningful estimate of  $\tau(111)$ ; on the other hand, Eq. (IV-40) can give a meaningful estimate for  $\tau(100)$  and  $\tau(110)$  because of the weak  $\phi$  dependence.

The results of the integration using the K matrix element show a difference of about 20% in the values of  $I(\vec{k})$  for the 110 and 100 directions counting both N and U.K. processes; if only the U. K. processes are counted the values differ by nearly 70%. The lithium matrix element gives a difference of about 20% between  $I(100)$  and  $I(110)$  for N and U.K. processes and a 60% difference if only the U.K. processes are counted.

We have also tabulated  $1-.3Y_6$  for the three principal directions. This gives the dependence of  $\tau(\vec{k})$  on the sixth-order Kubic harmonic with  $C_1 = -.3$ . We should point out that we have no way of knowing what  $C$  is; there is no reason for  $C$  and  $C_1$  to be simply related in the way  $A$  and  $A_1$  were for certain shapes of the  $E$  vs.  $k$  curves. In addition, even though the influence of  $C$  on  $n^*$  may be small because of the smaller size of the coefficients arising from the fourth-order Kubic harmonic its influence on

$\tau$  is not. It is interesting to note that both matrix elements give  $\tau(110) > \tau(100)$ , as would be the case if  $\tau$  were proportional to  $1 - 3Y_6$ .

We conclude that if the matrix elements obtained by Bailyn are correct, then the geometry of the U.K. processes alone is sufficient to produce appreciable anisotropies in  $\tau$  for both potassium and lithium. We have seen that the velocity of sound is highly anisotropic in the alkalis and may produce further anisotropy in  $\tau$ ; like the geometrical factor  $(1/|q|^2)$  it is most significant in the umklapp region.

The highly anisotropic  $\vec{\tau}(\vec{k})$  for lithium is in line with the large deviation of  $n^*$  from unity for this metal noted in Table 1-1; however, it is not clear why the same deviation does not occur in the case of potassium where the anisotropy is also large. The form of  $F(\theta)$  for lithium also suggests a possible explanation for the strong temperature dependence of  $n^*$  shown in Fig. 3-15. Although  $F(\theta)$  peaks at  $75^\circ$ , scattering processes at  $\theta = 90^\circ$  are still quite heavily weighted. The wave vectors for  $\theta = 90^\circ$  and  $k$  in the 110 are quite large ( $qa/2\pi = .88$ ; see Table 4-5); as the temperature is lowered some of these phonons are no longer excited and the scattering should be changed severely. The high Debye temperature,  $\theta_D = 430^\circ\text{K}$ , suggests that there should actually be "freezing out" of phonons at nitrogen temperature even though we are interested in the Debye temperature for transverse phonons which will be lower than the specific heat  $\theta_D$ . However, there is also the possibility that the change in  $n^*$  may be connected with the martensitic transition occurring near  $77^\circ\text{K}$ .

The small changes in  $n^*$  with temperature for sodium and potassium may also be due to the beginning of the "freezing out" of some phonons. However, the scattering function  $F(\theta)$  is much less sharply peaked in the case of potassium than in the case of lithium and so the total scattering is much less sensitive to the freezing out of large  $q$  phonons. In addition, the Debye temperatures are lower for these metals. Both factors should decrease the temperature effect in sodium and potassium.