Fig. 12. Electron scattering through 180° by a phonon having the minimum wave number which can cause an Umklapp process.

same number of phonons excited. Roughly speaking, θ_R (which is a meas ure of the temperature dependence ρ_i) is proportional to the lowest tem perature at which ρ_i behaves classically —that is, the temperature at which departs from linearity with T. Thi temperature should therefore be lowe for metals in which Umklapp processe can persist to lower temperatures. Thus we should expect θ_R/θ_o to vary with the degree of distortion of the Ferm surface; for a metal with a distorted Fermi surface the ratio should be lowe than for a metal with an undistorted Fermi surface. The values of this rati are given in Table 2 (column 9), an they show roughly the sort of variatio we should expect: sodium and potas sium have exceptionally large values fo the ratio, the other metals have lowe values. Interestingly enough, thes lower values are all close to unity; wh the values of θ_o and θ_R should be abou equal for these metals is not, I thin altogether understood.

These comparisons suggest that th pressure coefficients might likewise h understood, at least qualitatively, i terms of distortion of the Fermi surface Table 2 (column 4) shows that th values of $d \ln K/d \ln V$, which measur the change of interaction constant wit volume, do fit into the pattern. Fo example, all the noble metals have ne ative values and so does lithium. Thes are the monovalent metals with th most distorted Fermi surfaces. Sodiu and potassium, the two metals wi nearly spherical Fermi surfaces, hav values of $d \ln K/d \ln V$ which are d cidedly positive; rubidium has an inte mediate value. For cesium the da needed here are not reliable, but as w shall see below, cesium too fits into th general picture.

Although there is a clear correlati between the pressure coefficients resistivity and distortion of the Fer surface, we still have to understand w in a metal with a spherical Fermi su face $d \ln K/d \ln V$ is positive where in a metal whose Fermi surface touch the zone boundary it is negative. Th is a theoretical problem which has yet been fully solved. Nevertheless, us consider first the example of spherical Fermi surface which, for si plicity, we shall assume does not dist under pressure (21). A positive val for $d \ln K/d \ln V$ means that a decr in volume causes the electrons to int act less with the lattice waves. Decr ing the volume increases the Fer
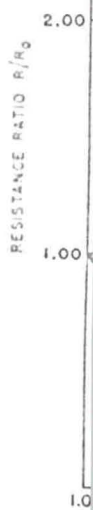
to eliminate the effects of their different lattice properties, the more distorted the Fermi surface the higher the resistivity. With these ideas in mind let us now look at the magnitude of the resistivities of the monovalent metals.

In comparing the resistivity of different metals it is important to compare not the resistance ρ of a cube of side 1 centimeter but rather that of a cube containing, for example, 1 gram atom of material—that is, the atomic resistivity $\rho/V^{1/3}$ where V is the gramatomic volume. Moreover, in order to bring out the dependence of the resistivity on the properties of the electrons (for example, the shape of the Fermi surface), the resistivities must be compared at temperatures at which the lattices are in similar states—that is, at temperatures at which the amplitude of the lattice vibrations is some certain fraction of the interatomic distance. This means that, in the high-temperature "classical" region, one should compare not the atomic resistivities but rather the "reduced" atomic resistivities $\rho(M\theta^2 V^{1/3}/T)$. (The derivation of this result is rather similar to that of the Lindemann melting formula; here M is the mass of the ions and θ, the characteristic lattice temperature.) The actual temperature T is immaterial since at high temperatures ρ/T tends to reach a constant value and it is this limiting value, at constant density, which we take. A comparison of the reduced resistivities is made in Table 2 (column 10), in which θ_o is taken from specific heat measurements (20). These Debye θ_o values, which can be taken as a measure of the temperature dependence

of the phonons, are now quite well established, although in sodium and lithium the low-temperature crystallographic transformations introduce some uncertainty. I should also point out that, since the noble metals have a face-centered cubic structure while the alkali metals have a body-centered cubic structure (except for sodium and lithium at low temperatures), the comparison between the two sets of metals cannot be taken too literally, although the general features should be correct.

It may be seen that of all the monovalent metals, potassium and sodium are outstandingly good conductors, rubidium and cesium are successively poorer, and lithium and the noble metals are worse still. Among the noble metals, silver has the lowest reduced resistivity. This classification corresponds broadly with what is at present known about the Fermi surfaces of the monovalent metals.

Having considered the magnitudes let us now consider the temperature dependence of the resistivity. This is largely governed by the temperature dependence of the number of phonons in the lattice—that is, by the Debye θ_o. But as we saw in discussing Umklapp processes, the low-temperature resistivity does not depend only on the behavior of the phonons; it also depends on the Fermi surface. If the metal has a distorted Fermi surface, the electrical resistivity tends to remain higher (because of the increased number of Umklapp processes) at low temperatures than that of a metal with a spherical Fermi surface at the same reduced temperature (that is, with the