

by the appropriate lattice they provide a means by which information can be communicated. They therefore provide an immediate and important because G is small, U-processes make this particularly important

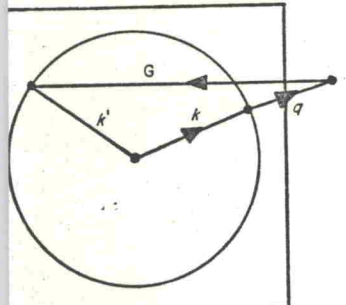


Fig. 17. Umklapp process.

Equation 37) severely limits because $\hbar\omega$ (which is of order kT at low temperatures) is so small compared to kT itself is very small. At low temperatures, only very few electrons are excited into other states (which are empty) because of the Pauli exclusion principle. This is shown in the Brillouin zone diagram as the Fermi surface is shown as a small circle that does not touch the zone boundary.

process (or N-process) and as shown, the Fermi surface does not touch the Brillouin zone boundary. It is that the Fermi surface

does not touch the zone boundary and this corresponds to the case of the alkali metals at least at normal pressures. As we saw above, their Fermi surfaces are nearly spherical and do not touch the zone boundaries. (For the noble metals, however, the Fermi surfaces do touch the zone boundaries and the distinction between N- and U-processes is no longer useful.)

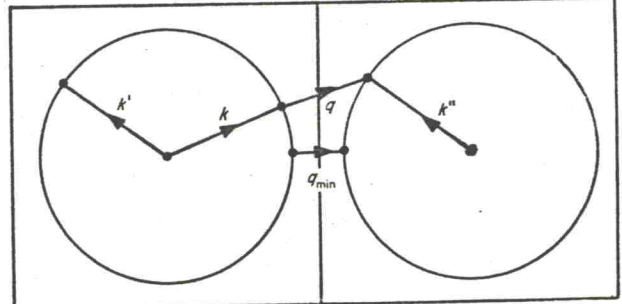


FIG. 18. A U-process in the repeated zone scheme showing minimum q vector for a U-process.

It is seen from Fig. 18 that when the Fermi surface does not touch the zone boundaries, there is a minimum value of q required to induce a U-process. Let us suppose that q_{min} is this minimum value in a particular direction and that ω is the corresponding frequency of the phonon propagating in this direction. Then at low temperatures the number of such phonons excited is proportional to $e^{-\frac{\hbar\omega}{kT}}$. If c is the phonon velocity, this probability may be re-written in terms of q_{min} as $e^{-\frac{\hbar cq_{min}}{kT}}$. Clearly, therefore, under these circumstances, U-processes must die out at sufficiently low temperatures. On the other hand, their importance may persist down to quite low temperatures, if in some directions c is particularly small and q_{min} not too large. Bailyn has shown that this is true in the alkali metals. These metals are very strongly anisotropic in their elastic properties and in certain directions there are low-lying transverse modes of vibration which can cause U-processes down to quite low temperatures. Moreover, because they almost reverse the electron momentum, these processes dominate the resistivity throughout the temperature region in which ρ_{ph} is still measurable (at the lowest temperatures ρ_{ph} is lost in the background of residual scattering).