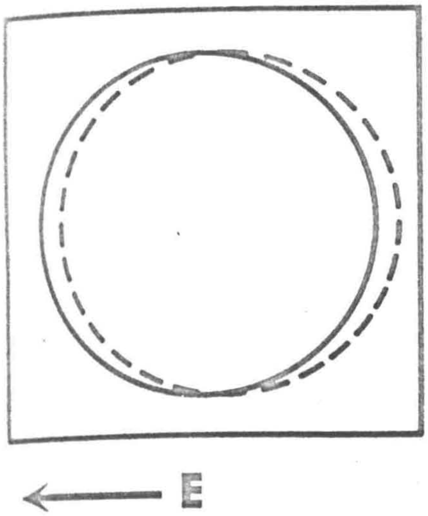

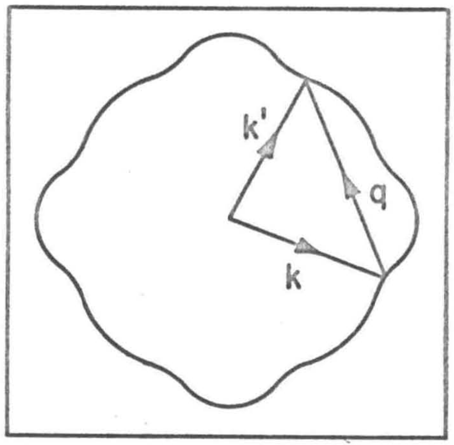

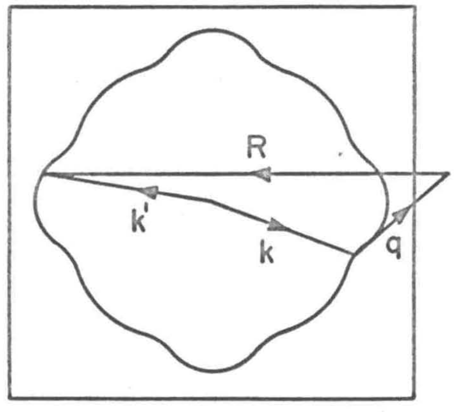

Fig. 8 (left). Displacement of the Fermi surface under the influence of an electrical field. Fig. 9 (middle). A "normal" scattering process. Fig. 10 (right). An Umklapp process.

true for the other reciprocal lattice vectors. Thus, the possible $k + R$ vectors lie on a set of surfaces consisting of the original Fermi surface suitably displaced, as in Fig. 11. In order to satisfy the requirement of conservation of energy, all the vectors k' of the electrons after scattering must lie on the original Fermi surface; so, to satisfy Eq. 8, we must look for vectors $-q$ which go from one of the repeated Fermi surfaces back to the original Fermi surface. Such phonon vectors, illustrated in Fig. 11, give rise to Umklapp processes.

If the Fermi surface does not touch the zone boundary, then q must exceed a certain minimum value or else Umklapp processes are impossible. This minimum value is equal to the distance of closest approach of two adjacent Fermi surfaces—for example, the vector CD in Fig. 11. An Umklapp process with this minimum vector scatters the electron through the maximum angle of 180° (Fig. 12). q vectors which are larger than the minimum usually produce rather smaller scattering angles; nevertheless all Umklapp processes in a monovalent metal cause comparatively large angle scattering.

The existence of a minimum value of q for Umklapp processes means that at low temperatures the number of such processes must begin to fall off because the number of phonons with a large enough wave vector begins to fall off. Thus, the shape of the Fermi surface can influence the temperature dependence of electrical resistivity at low temperatures. It also affects the magnitude of the resistivity, since at all temperatures the more closely the Fermi surface approaches the zone boundary the greater is the number of phonons that can take part in Umklapp processes. Since, as has been emphasized, these are wide-angle scattering processes, this implies that the nearer the Fermi surface is to the zone boundary the higher is the electrical resistivity, other things being equal. (By "other things" I mean in particular the number of phonons available for scattering the electrons; this point is discussed in more detail in the next paragraph.) Distortion of the Fermi surface changes not only the number of possible Umklapp processes but also, for example, the velocity of the electrons at the Fermi level, and this too can alter the resistivity. In general, however, it seems that, if the resistivities of the monovalent metals are compared under conditions such as

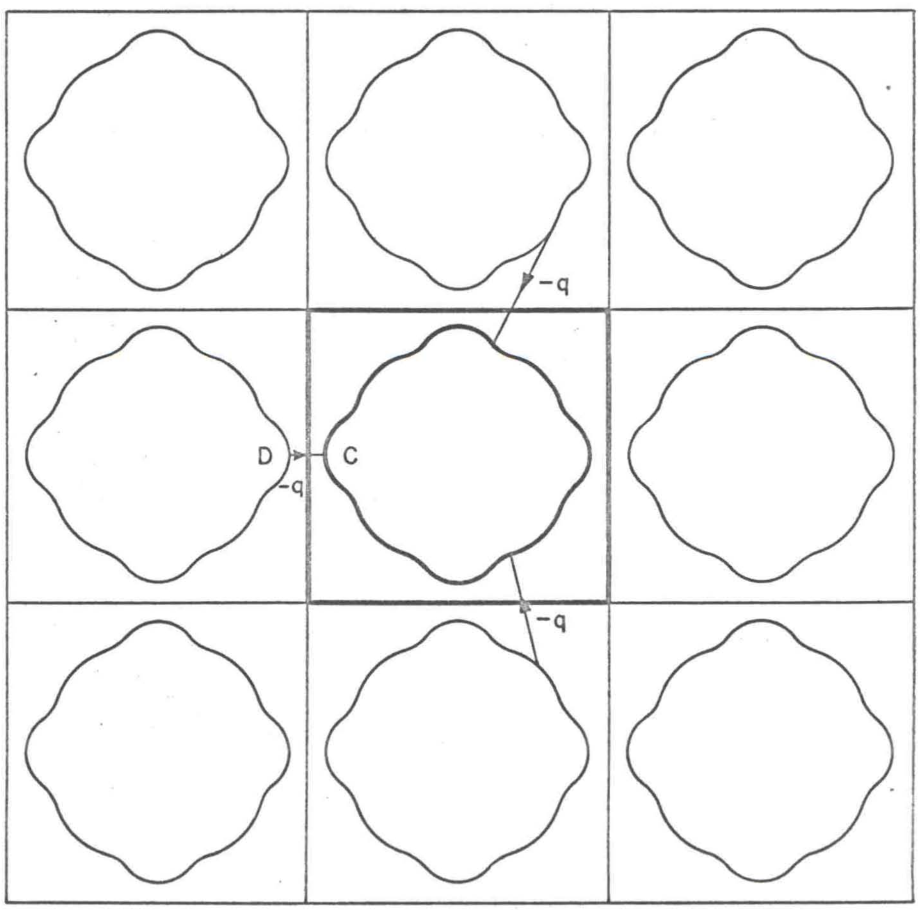

Fig. 11. Repeated zone scheme to illustrate the possible wave vectors which can give rise to Umklapp processes.