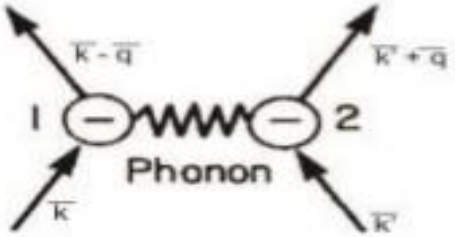
BCS theory

Explanation

Consider the 1st electron with wave vector k distorts the lattice, there by emitting a phonons of wave vector q. This result in the wave vector k - q for the 1st electron. Now if the 2nd electron with wave vector k', seeks the lattice, it takes Up the energy from the lattice and its wave vector changes to k + q as shown in fig. *Two electrons with wave vector* $k-q$ *and* $k'+q$ *from a pair of electrons known as* ***Cooper pairs***.



Cooper pairs

The pairs of electrons formed due to *electron - lattice – electron* (phonons), electron - electron interaction (forces of attraction) by overcoming the electron – electron interaction (force of repulsion) with equal and opposite momentum and spins i.e., with wave vector k - q and k + q are called cooper pairs.

Coherence length

In the electron - lattice - electron interactions, the electrons will not be fixed, they move in opposite directions and their co-relations may persist over lengths of maximum of 10^{-6} m. *This length is called coherence length.*

Electron –Lattice –Electron Interaction :

When an electron (1st) moves through the lattice, it will be attracted by the core (+ ve charge) of the lattice. Due to this attraction, ion core is disturbed and it is called as lattice distortion. *The lattice vibrations are quantized in terms of phonons.*

The deformation product a region of increased positive charge. Thus if another electron (2nd) moves through this region as shown in fig. It will be attracted by the greater concentration of positive charge and hence the energy of the 2nd electron is lowered.

Hence the two electrons interact through the lattice (or) the phonons field resulting in lowering of energy of the electron. This lowering of energy implies that The force between the two electrons are attractive. This type of interaction is called Electrons – lattice – electron interaction. *The interaction is strong only when the two electrons have equal and opposite momentum and spins.*