Phonon Softening in Triangular Lattice

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In the case of the two-dimensional square lattice system with Su-Schrieffer-Heeger (SSH) type electron-lattice interaction and with a half-filled electronic band, when the temperature is lowered, many phonon modes are simultaneously softened at the critical temperature. They include those which have wave vectors not only equal to the nesting vector **Q**=(π,π) but also parallel to **Q**. Then there are many degenerate states. Only the transverse modes are softened for the wave vectors parallel to **Q**, while both of the transverse and longitudinal modes are softened for the wave vector equal to **Q**. Besides, the degeneracy of the lowest energy states is found at lower temperature. It is thought that there are a number of degrees of degeneracy in the lowest energy state [1].

Motivated by the excellent work explained above, we have studied the phonon softening in a triangular lattice system with the SSH-type interaction. In the present system, the Fermi surface has a hexagonal structure at a three-quarter filling.

Consequently, the softening of phonon modes is observed at a critical temperature and there are several degenerate states. But, these modes are concerned with the vectors connecting between two neighboring vertices of the hexagonal structure of the Fermi surface. Therefore, this phenomenon which will occur when the temperature is lowered is thought to be not a conventional Peierls transition.

In the present work, we have mainly studied the temperature dependence of the phonon dispersion at temperatures higher than the critical one. It will be worthwhile to study the degeneracy of the lowest energy states by lowering temperature and examine what kind of symmetry is related to this degeneracy. These are open problems to be studied in future.

[1] Y.Horita and Y.Ono , J. Phys. Soc. Jpn. , **78** , (2009) 024711.