Title : Superconducting piezoelectric effect

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Abstract :

The magnetopiezoelectric effect (MPE) is a lattice distortion induced by an electric current in metals lacking both inversion symmetry and time-reversal symmetry. It was theoretically proposed [1,2] and experimentally observed [3-5] recently. These results revealed the potential of metals for piezoelectric devices. In addition, since the distortion is strongly constrained by symmetry, this phenomenon can be used to identify the symmetry of the system. However, unlike the conventional piezoelectric effect, the MPE is always accompanied by Joule heating. This property makes its application difficult.

In superconductors, the conventional piezoelectric effect is prohibited because the electric field should vanish due to the zero resistivity. On the other hand, the MPE-like response induced by a supercurrent can be realized. We call this phenomenon the superconducting piezoelectric effect (SCPE). The SCPE is more practical than the MPE because of the absence of Joule heating. Moreover, the SCPE is expected to be a probe of inversion and time-reversal symmetry breaking in superconductors.

In this seminar, we formulate the SCPE and compare the calculations of the MPE and SCPE of a typical noncentrosymmetric superconductor, that is, a two-dimensional Rashba s-wave superconductor under the in-plane magnetic field [6]. The magnitude of the SCPE is comparable to that of the MPE, and thus our result implies the nonnegligible coupling between the supercurrent and lattice distortion in noncentrosymmetric superconductors. Furthermore, we clarify that finite total momentum of Cooper pairs in helical superconducting state plays a crucial role in the SCPE. Our result reveals that the SCPE can also be a direct probe of the helical superconductivity, which has been awaited for a long time.

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References :

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