Far-Infrared and Submillimeter-Wave Conductivity in Electron-Doped La$_{2-x}$Ce$_x$CuO$_4$

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LCCO

In-Plane Properties

- Sample: thin film on a transparent substrate.
- Points: submillimeter transmittance (calculated), lines: infrared reflectance.
- Sharp structures are due to the phonons of the substrate ($\text{SrLaAlO}_3$, upper frame).

Comparison to MgB$_2$

- Sample: thin film on a transparent substrate.
- The "knee" around 23 cm$^{-1}$ is a clear indication of the superconducting gap.

Far-infrared reflectance of a tilted LCCO film for different polarizations of the incident radiation. The inset shows the LO phonon.

LCCO / Tilt Geometry

- The onset of absorption in the superconducting state of LCCO appears gradual in frequency and is inconsistent with a BCS gap.
- This is in contrast to MgB$_2$ where a clear onset of absorption can be observed both in conductivity and in reflectance.
- The suppression of the quasiparticle scattering rate in LCCO is qualitatively similar to the results in the hole-doped cuprates.
- The effective conductivity of LCCO measured in the tilt geometry reveals an intensive peak at finite frequency even in the normal state, which is due to a mixing of the in-plane and out-of-plane properties.
- The c-axis conductivity shows a Josephson plasma resonance in the superconducting state.

Scattering Rate

- Experiment: Data obtained from the two-fluid analysis of the conductivity spectra (3-30 cm$^{-1}$).
- BCS: The same type of analysis as applied to the BCS-conductivity.

c-axis Plasmon

- $\sigma_c$ properties as obtained from the comparative analysis of the in-plane and mixed ac spectra.
- The peak around 12 cm$^{-1}$ is a c-axis plasmon.

SUMMARY