ESRF	**Experiment title:** Dependence of Phonon Anomaly on Carrier Concentration in the Electron-Doped Superconductor Nd2-xCexCuO4	**Experiment number**: HS-2043
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Report:

The experiment is a logical continuation of two previous experiments performed at ESRF, HS – 1501 and HS – 1748 [1, 2, 3]. These references also contain the scientific background.

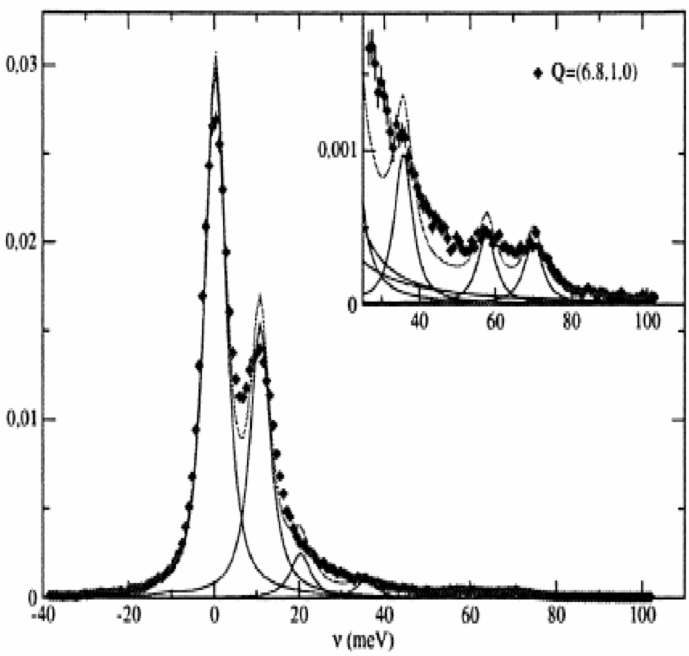

Fig. 1 *An energy scan at Q = (6.8 1 0) – q = (0.2 0 0) – for* $Nd_{1.98}Ce_{0.02}CuO_4$*. The resolution is determined by the Si (8 8 8) reflection. The largest peak is the elastic peak followed by the acoustic phonon mode. The continuus lines correspond to the fitting of the peaks where we have also taken into account the instrumental resolution. We also include a graph that shows the optical phonon modes under study.*

In this experiment we have studied the phonon dispersion along the [ξ, 0, 0] in-plane direction for for an underdoped sample of the electron-doped superconductor $Nd_{1.98}Ce_{0.02}CuO_4$. We have performed scans in the (6, 0, 0) and (7, 1, 0) Brillouin zones, along the directions Q = (6 + ξ, 0, 0) and Q = (7 – ξ, 1, 0). The first configuration is longitudinal and the second one almost longitudinal. The measurements were taken at T = 25 K, to reduce the contribution from low energy modes to the signal, and two resolution set – ups, Si (8 8 8) and (9 9 9) reflections, were used.

In Figure 1 we show an example of an energy scan at Q = (6.8 1 0). From a great number of such scans we have extracted the frequencies of the peak positions and thus established the dispersion of the longitudinal phonons along (ξ, 0, 0) (Fig. 2). We also present theoretical calculations based on the shell model [4] for the insulating compound Nd_2CuO_4 and a doped one. In this sample we do not observe the dramatic drop in the energy of the high energy modes starting at very low q (<0.1) that was observed in the optimally doped sample, but only a possible reduced deviation starting at about q=0.3 .

Thus, we have a established that there is a doping dependence of the location of the phonon anomaly and we have provided strong evidence that the softening is related to the appearance of metallic conduction.

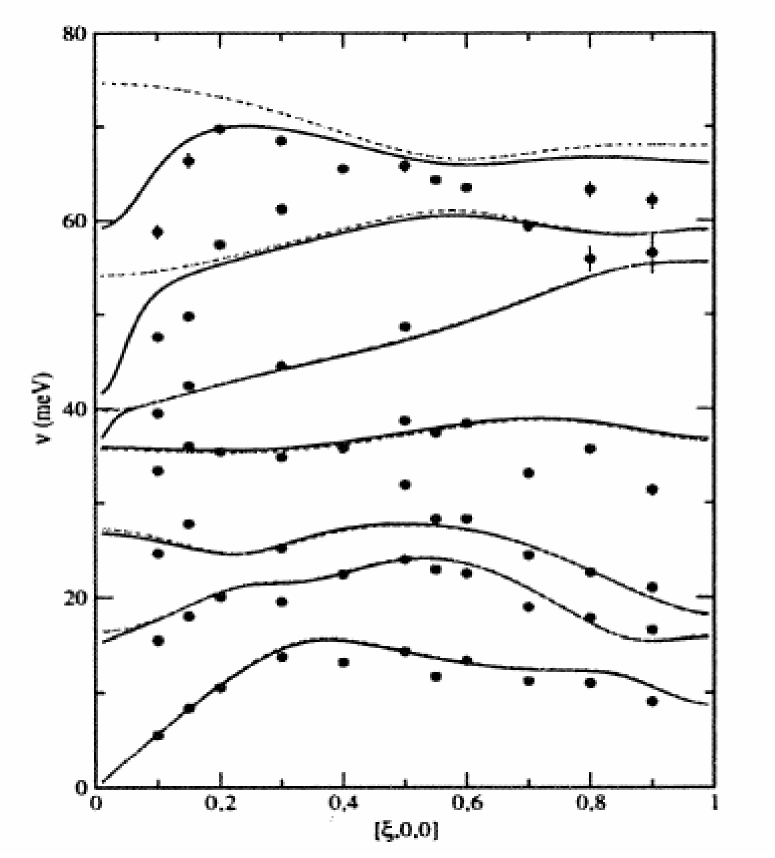

Fig. 2 *The dispersion of the longitudinal phonons in $Nd_{1.98}Ce_{0.02}CuO_4$. The solid and the doted lines correspond to theoretical calculations for both an underdoped sample and the insulating compound Nd_2CuO_4. We see that there is an apparent anti-crossing of the two highest optical phonon modes near the zone center.*

References

[1] M. d'Astuto et al., ESRF Report HS-1501.
[2] M. d'Astuto et al. Phys. Rev. Lett. 88167002 (2002).
[3] M. d'Astuto et al., ESRF Report HS-1748.
[4] S. L. Chaplot et al., Phys. Rev. B, 52, 7230 (1995)