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Report:

We have performed a series of *inelastic x-ray scattering* (IXS) experiments in order to measure the lattice dynamics of $Nd_{2-x}Ce_xCuO_4$, the most investigated compound of the electron-doped cuprate family. We set up our experimental condition in order to optimize the signal for high energy longitudinal optic (LO) and transverse optic (TO) phonon branches. The experiment has been carried out on the high resolution, high Q spectrometer at ID16 (vertical arm). We measured the dispersion along [ξ00] in-plane direction, as shown in figure 1.

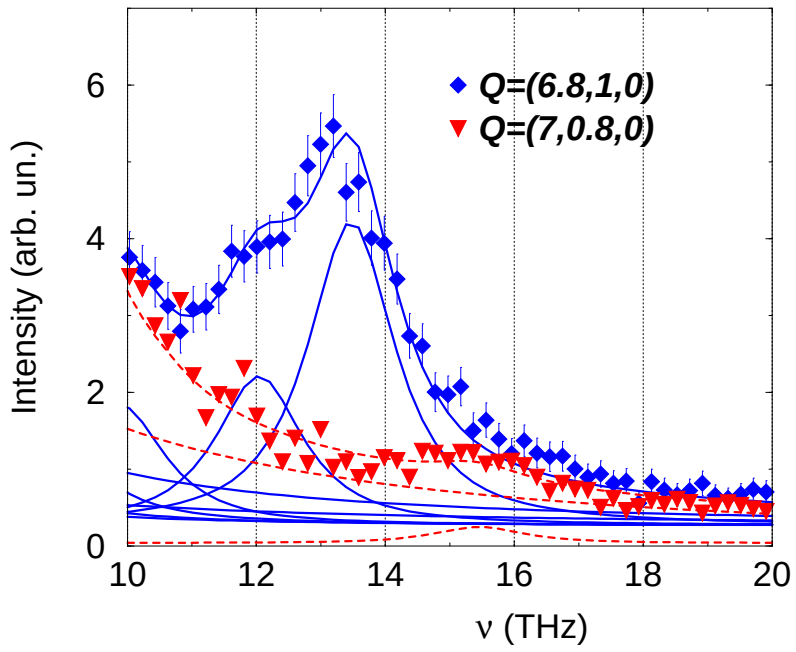

fig.1: *Experimental IXS phonon spectra of superconducting $Nd_{1.84}Ce_{0.16}CuO_4$ at $T = 15K$. Both scans has been done at around the Γ point with vector $Q = (7, 1, 0)$ r.l.u., and a reduced $q = 0.2$ r.l.u.. Diamond: the reduced q vector is along the a^* direction, in a almost longitudinal configuration. Triangles: the reduced q vector is along the b^* direction, in a almost transverse configuration.*

Then we compared the frequency to a lattice dynamics calculation, using an in-house program adapted for IXS data (1). The result is shown in figure 2. A large energy shift of the high energy bands due to electronic screening effects was expected, as the *Lyddane-Sachs-Teller* (LO-TO) splitting goes to zero when the system become metallic. In the case of the highest energy optic band in Nd_2CuO_4, the splitting is $\Delta\nu = 3THz$, pushing up the LO band to 18 THz in the *un-doped* specimens. In our measurements we confirm that the same LO branch starts at about 15 THz, as the TO branch of the same energy (see figure 2). The in-plane screening effect is not so large in the hole-doped compounds. That implies a substantial difference in the dielectric function between the hole and electron doped systems. Moreover we observe an additional softening in frequency (up to 15%) for the highest longitudinal branch around $q = (0.2, 0, 0)$. As shown in figure 2, the frequency of the highest LO is well below the expected value (between 15 and 16 THz). Indeed his frequency is lower than the frequency of the highest TO branch. This was observed for the first time here in electron-doped HTcS. Similar results was reported in hole-doped systems (2,3). The observed anomaly is thought to be due to an atypical electron phonon interaction. Finally, we stress that we have not been able to extend the present experiment to the second main symmetry in-plane direction [ξ00] during the allowed 30 shift. This because the large variation on the observed dynamics required more careful measurements than forseen.

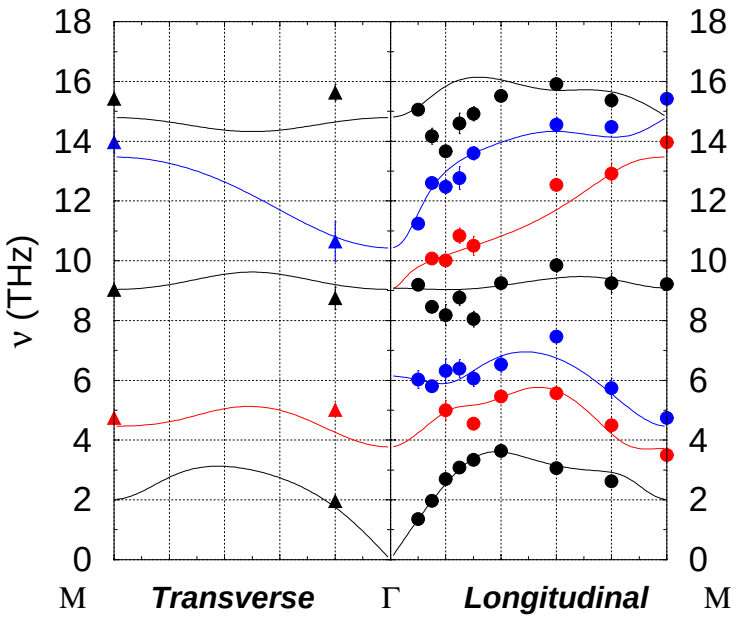

fig. 2: *Experimental phonon dispersion curve in superconducting* $Nd_{1.84}Ce_{0.16}CuO_4$ *at* $T = 15K$ *along the* $\Gamma \rightarrow M$ *direction.*

In conclusion our results point out that:

1) Complex systems like HTcS can be measured routinely with IXS.

2) It exist a substantial difference in the screening of the high energy LO phonon branches between electrons and holes doped compounds.

3) An anomalous softening of the highest optical longitudinal phonon branches is an universal property of both electrons and holes doped compounds.

References.

1) *OpenPhonon code* for lattice dynamical calculation and dynamical structure factor for X-ray, developed by A. Mirone.

2) L. Pintschovious *et al., Phys. Rev. B* **60** (1999) 15039

3) R.J.McQueeney *et al., Phys. Rev. Lett.* **82** (1999) 628