ESRF	Experiment title: Resonant magnetic X-ray scattering in $Nd_{2-x}Ce_xCuO_4$ with x=0 and 0.15	Experiment number: HE294
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Report:

In Nd_2CuO_4, the Cu^{2+} spins order antiferromngnetically below the Néel temperature $T_N^{Cu} \approx$ 250K. Two spin reorientation transitions are observed at $T_1 \approx 75\ K$ and $T \approx$ 30K. They are due to the different balance of the free energy terms arising from the interactions between the Cu^{2+} and the Nd^{3+} ions. The hierarchy of these terms change with the temperature because the Nd^{3+} magnetic moment is enhanced with decreasing temperature, while the copper moments stay nearly constant below $\approx$ 2OOK. The three ordered phases are called I $(T_1 < T < T_N)$, II $(T_2 < T < T_1)$, and III $(T < T_2)$. From neutron diffraction data, the Nd^{3+} magnetic moments are strongly enhanced around $T^{Nd} \approx$ 1.5 - 3 K. When Nd^{3+} is substituted by Ce^{4+} yielding $Nd_{1-x}Ce_xCuO_4$, the ground state initially stays antifcrromagnet,ic, then $T_N(x)$ decreases with the Ce^{4+} concentration x and vanishes at $x \approx$ 0.15. Nevertheless, a correlated Nd^{3+} magnetic phase still persists even for $x \geq$ 0.15.

Nd_2CuO_4 In the Nd_2CuO_4 parent compound, we have investigated the L_{II} (6722 eV) and L_{III} *(6208* eV) edges of the Nd^{3+} ion, scanning accessible magnetic reciprocal lattice points $Q = (\frac{1}{2}, \frac{1}{2}, l)$: $l = 6-8$ for the L_{II} ***edge,*** **and** $l = 6-9$ for the L_{III} ***edge.***
After a premiiinary analysis, the main results are the following:
i) The ($\frac{1}{2}$, $\frac{1}{2}$, I) magnetic Bragg peak at the L_{III} edge displays a two peak structure which depends on l (see figure 1 top left); the two peaks, located around $\approx$ 6.205 keV and 6.211 keV respectively, could be interpreted as due to a quadrupoiar and a dipoiar transition. A polarization analysis is necessary to confirm this interpretation;
ii) No Nd^{3+} Néel temperature has been found well above the re-orientation temperature $T_2 \approx 30\ K$, i.e. the Nd^{3+} resonant signal is still visible both on the L_{II} and on the L_{III} ***edge*** at 6.211 keV: a step in the intensity, both resonant and non-resonant has been measured at T_2 (not shown), due to the change of magnetic ordering; whether the signal at $\approx$ 6.205 keV disappears at this transition or before is not clear, **because** of the influence of the strong non-resonant signal, e.g. at the $(\frac{1}{2}, \frac{1}{2}, 6)$, the out-of resonance is about one half of the resonant one at $T \approx 1.7\ K$ (see figure 1 top);

iii) There is no cvidcuce of a q-width evolution of the $(\frac{1}{2}, \frac{1}{2}, \ell)$ magnetic Bragg peak at, resonance (figure 1 bottom left), both for the L_{II} edge and for the two contributions at the L_{III} edge at $\approx$ 6.205 keV and 6.211 keV;
iv) At T = 100 K, where the magnetism is due mainly to the copper moments, a signal is still visible well away from resonance (ε = 6.040 keV) (see figure 1 bottom right); this signal could be clue to the ordered copper magnetic moments, but this observation has to be confirmed by a complete temperature measurement up to the copper Néel temperature ($T_N^{Cu} \approx$ ***250*** K).

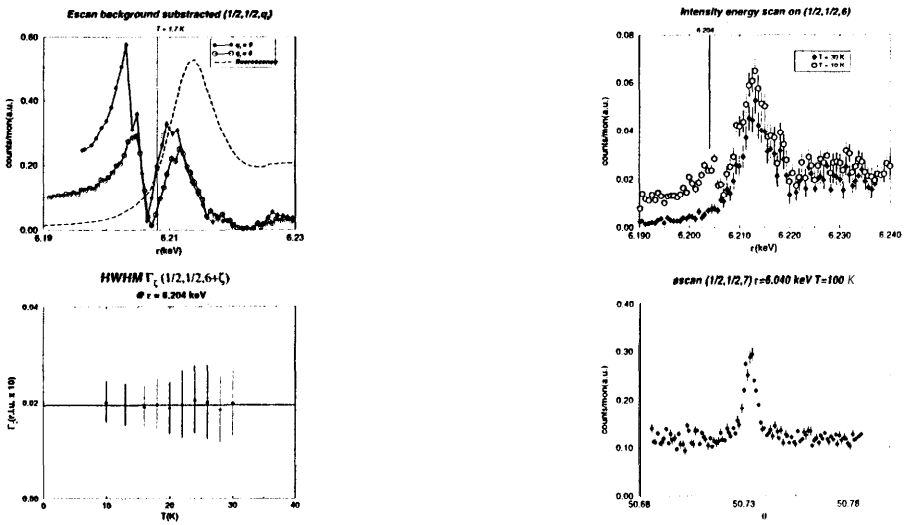

FIGURE 1 Top left: $(\frac{1}{2}, \frac{1}{2}, \ell)$ $\ell = 6, 9$ magnetic Bragg peak intensities recorded as the incident, photon energy is tuned through the Nd^{3+} L_{III} edge at $T \approx 1.7\ K$. ***Top right:*** ($\frac{1}{2}$, $\frac{1}{2}$, 6) magnetic Bragg peak intensities recorded as the incident photon energy is tuned through the Nd^{3+} L_{III} edge at T = 10 K and 30 K. Bottom *left:* $(\frac{1}{2}, \frac{1}{2}, 6)$ magnetic Bragg peak width vs temperature at the incident photon energy ε = 6.204 keV. ***Bottom right:*** $(\frac{1}{2}, \frac{1}{2}, 6)$ magnetic Bragg peak at T = 100 K at, the incident photon energy ε = 6.040 keV (off resonance).

$Nd_{1-x}Ce_xCuO_4$ Because of the new and features observed at the L_{III} absorption edge (double peak structure, q_ℓ dependence), the measurement on Nd_2CuO_4 has required more time than expected leaving no time to study the superconducting doped sample. We have therefore re-submitted a continuation proposal to study this sample on ID20.

Conclusion and perspective These measurements have made it possible to complete the picture of the Nd^{3+} magnetism in Nd_2CuO_4 in the low temperature regime, from phase III through $T_1 \approx 30\ K$ up to phase II. New feature, require a more complete investigation in the high temperature regime between $T_1 \approx 30\ K$ and the copper Néel tcmperaturo T_N^{Cu} both at, resonance and off resonance. Furthermore, a polarization analysis should be performed at low temperature to investigate the nature of the double peak structure.

References

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