Contribution ID: **63** Type: **Poster**

# Precursor superconducting phase at temperatures as high as 180 K in superconducting cuprate crystals from infrared spectroscopy

*Tuesday, 24 July 2012 20:00 (2 hours)*

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We present results of our detailed study of the infrared c-axis response of underdoped cuprate high-temperature superconductors RBa2Cu3O7 (R=Y; Gd; Eu) [1]. In addition to competing correlations which give rise to a pseudogap that depletes the low-energy electronic states below T*»Tc, our analysis enables us to identify the onset of another phase below Tons >Tc. In this phase in contrast to that of related with T*, the low-energy spectral weight increases with decreasing temperature. Below Tc, it transforms into the condensate and the underlying electronic states are susceptible to magnetic fields. All these characteristics are hallmarks of superconducting fluctuations and thus we conclude that the phase corresponds to a precursor superconducting state. Our conclusions are strongly supported by the data of the in-plane infrared conductivity where a gap opens below Tons which is accompanied by the shift of spectral weight towards lower frequencies [2]. We map out the doping phase diagram of Tons which reaches a maximum of 180 K at strong underdoping. A very intriguing property of the precursor superconducting phase is that it involves a very large fraction of the low-energy electronic states that increases with underdoping to that extent that for very strongly underdoped samples, the effects above Tc are much stronger than those below Tc. Our results helps to understand the mysterious phenomenology of the pseudogap showing that this phase involves two different phenomena which is likely a source of the ongoing dispute of the origin of the pseudogap.

[1] A. Dubroka et al., Phys. Rev. Lett. 106, 047006 (2011)
[2] See supplemental material at http://link.aps.org/supplemental/10.1103/PhysRevLett.106.047006

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**Session Classification:** Poster Session 2

**Track Classification:** High-Tc Cuprates