KN-5 Evolution of symmetry-broken states in the pseudo-gap regimes of nickelates and cuprates

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Realization that many emerging phenomena, such as colossal magnetoresistance and unconventional superconductivity to name but a few, may be governed by complex disorder exemplifies the importance of utilization of local probes sensitive to short range correlations. To that effect the knowledge of the local atomic structure may reveal relevant nanometer lengthscale footprints important for more comprehensive understanding of the character of symmetry broken states. Atomic pair distribution function (PDF) is one of the few experimental methods that can speak to this problem. Systematic approach in charting both long and short range structural orders, on an equal footing, across the (x, T) phase diagram of materials emerges as a powerful identification tool for grasping the relevance and hierarchy of length scales reflecting competing and/or coexisting orders, such as that seen in e.g. $La_{1-x}Ca_xMnO_3$.Revealing the nature of the symmetry broken states and fluctuations of short-range order in strongly correlated electron systems in general and in the pseudo-gap (PG) phase of cuprates in particular, remains instrumental in understanding the underlying physical properties.

Mounting experimental evidence suggests that the PG phase of cuprates may represent an electronic state in which the four-fold rotational symmetry (C_4) of the CuO_2 planes is broken (down to at least C_2), pointing to stripe or nematic character. Here the former is referred to as orthogonally equivalent, and the later as orthogonally inequivalent (OI) state. Recent neutron total scattering based results extending the systematic approach to the nickelate and cuprate systems will be presented. In order to benchmark the sensitivity of powder-based methods for this class of problems, we initially explored T-evolution of structural effects associated with the melting of well-established stripe order in $La_{1.67}Sr_{0.33}NiO_4$ across the charge-order temperature, T_{co}. In this model stripe system structural features sensitive to both long and short range stripe order are identified, further suggesting that dynamic charge-stripe correlations survive to T ~$2T_{co}$. Encouraged by these observations, underdoped $La_{2-x}Ba_xCuO_4$ that hosts stripes was studied next over a range of doping and temperature. PDF and complementary inelastic neutron scattering measurements reveal that dynamic nanoscale OI-type tilt correlations do persist well above T_{co} and peak coincidentally near x = 0.125, where stripe order is the strongest.

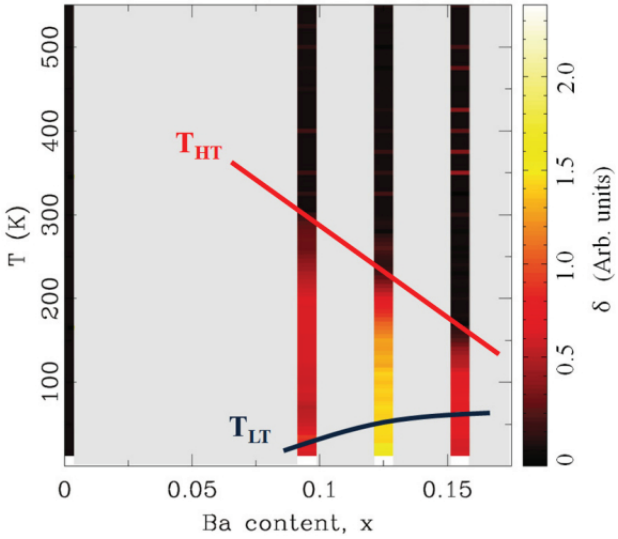

Figure 1. (x, T) evolution of the nanoscale dynamic broken symmetry state, expressed through parameter δ obtained from PDF analysis. Solid lines mark structural transition temperature: T_{HT} (red) and T_{LT} (blue). After E. S. Bozin *et al.*, Phys. Rev. B 91, 054521 (2015).

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