THE NANOSCALE PHASE SEPARATION IN STRONGLY CORRELATED ELECTRON SYSTEMS (NMR and EPR view)

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There are numerous experimental data that are suggestive of an inherent tendency to the nanoscale phase separation in the materials with the strong electron correlations. The coexistence of different phases expresses itself in the various physical properties of these materials. We present here the analysis for two limiting cases of the phase separation: the dynamical and static ones, which take place in cuprates and manganites.

We show that the pseudogap behavior of the nuclear spin relaxation $1/^{63}T_1$ for cuprates may be understood in terms of the dynamical phase separation to the “metallic” and “magnetic” regions. It stems from the 1-st order phase transition that starts well above T_c but becomes frustrated because of broken electroneutrality in the CuO_2 plane. The temperature variation of the relative volumes of the coexisting phases with different fluctuation rates would result in the transfer of the fluctuation spectral weight away from the NMR resonance frequency to be seen as a pseudogap suppression of $1/^{63}T_1$. We analyze anew experiments on the NMR in cuprates and find an important information on their phase separation and its stripe character hidden in the dependence of $1/^{63}T_1$ on degree of doping. We argue that in a temperature interval above T_c and below some T^* for a broad class of cuprates the relaxation comes from two independent mechanisms: relaxation on the incommensurate stripe-like excitations that leads to a temperature independent contribution and an universal temperature dependent term ascribed to moving “metallic” and AF sub-phases. We conclude that stripes always come about with external doping and may be pinned by structural defects. For LSCO our estimations are in a quantitative agreement with the inelastic neutron scattering data for this compound.

The doped manganites are known for their tendency toward the static phase separation, typically involving ferromagnetic metallic and antiferromagnetic charge and orbital ordered insulating domains. To investigate the local properties of coexisting phases we carried out the ESR measurements in a wide temperature range. The special attention was addressed to the $La_{1-x}Ca_xMnO_3$ system in the vicinity of Ca doping equal to ½ where the phase separation is most effective. The analysis of the temperature evolution of the resonance spectra made it possible to confirm the local coexistence of the static antiferromagnetic and ferromagnetic phases in a wide temperature range from 160K down to the 4.2K and to elucidate their properties.