Medium Range Ordering of Local Polarizations in $Pb(Mg_{1/3}Nb_{2/3})O_3$

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Local polarizations and the interaction between them play a crucial role in the relaxor behavior of relaxor ferroelectric $Pb(Mg_{1/3}Nb_{2/3})O_3$ (PMN). We report the temperature evolution of the local and medium-range crystal structure of PMN from 1000K to 15K using neutron pair distribution function analysis [1]. We present evidence for both local atomic displacements (local polarization) and for medium-range (~ 5 Å - 50 Å) ordering, called polar nanoregions (PNRs). These medium-range correlations are modeled using rhombohedral symmetry, enabling for the first time an estimate of the temperature dependence of the volume fraction of the PNRs. We show that this fraction steadily increases from 0% to a maximum of ~30% as the temperature decreases from 650K to 15K. Below T ~ 200K the volume fraction of the PNRs becomes significant, and PNRs freeze into the spin-glass-like state.

[1] Jeong I.-K., Darling T. W., Lee J. K., Proffen Th., Heffner R. H., Park J. S., Hong K. S., Dmowski W., Egami T.. *Phys. Rev. Lett., in press*.

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