MS25-O2 Escaping the quantum critical singularity; modulated magnetism in PrPtAl

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The transition between ferromagnetism and paramagnetism is one of the simplest examples of a continuous phase transition. Interesting behaviour is expected when the transition temperature becomes small because incoherent fluctuations above the transition temperature then exist to low temperatures. Ultimately new forms of order must appear to satisfy the third law of thermodynamics or the transition must become first order.

The talk will explore how the fluctuations themselves drive order formation by a mechanism known as “order by disorder”. It will then focus on the application of this theory to the material PrPtAl where complex modulated states form at the interface between ferromagnetism and paramagnetism [1]. The origin of the magnetism will be described in PrPtAl as well as the identification of the complex magnetic states with neutron and X-ray diffraction.

[1] G. Abdul-Jabbar et al, *Nature Physics* **11**, 321–327 (2015).

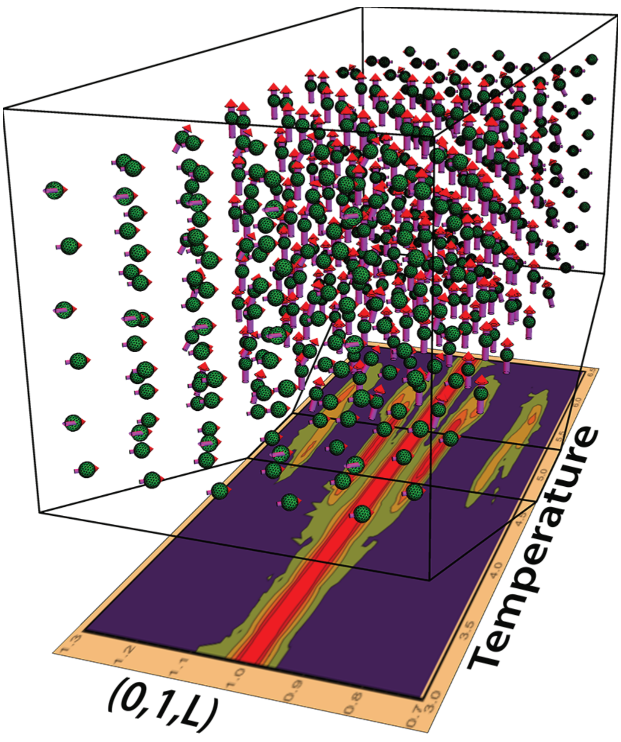

Figure 1. The horizontal plane shows neutron diffraction intensity (colour scale) plotted against reciprocal lattice position (0,1,L) and temperature. The 3 D image above is a magnetic structure consistent with the satellites and other data over the temperature range indicated.

Keywords: magnetism, modulated order, strongly correlated electrons.

MS25-O3 Multiferroic properties of GFO ferrite nanoparticles

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Gallium iron oxide (GFO) nanoparticles were obtained by the sol-gel method in an environment of the different concentrated nitric acid and with different aging and heating temperatures. X-ray powder diffraction (XRD), neutron powder diffraction (ND), magnetization and Mössbauer spectroscopy (MS) measurements together with Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy(SEM) techniques allowed to determine the chemical and physical properties of the samples. Results of these analyses confirmed a growing contribution of an extra hexagonal phase in direct proportion to the concentration of nitric acid and the lack of corundum-type precipitations at reduced temperatures of annealing steps. The structural and magnetic properties of GFO multifferoics have been intensively studied recently for its potential switch applications. The physical properties, especially magnetism in $GaFeO_3$, depend strongly on the method of preparation. Therefore many efforts have been expended on fabrication of gallium iron oxide by Pechini modification of the sol-gel (SG) method. The gallium iron oxide (GFO) crystallizes in an orthorhombic crystal structure. The crystallographic unit cell contains 4 different cation sites and 6 oxygen anion sites all in general position (4a: x, y, z) of the $Pc2_1n$ space group (no. 33).

In the perfectly ordered structures sites labeled by Ga(1), Ga(2), and Fe(1), Fe(2) are entirely occupied by Ga^{3+} and by Fe^{3+}ions, respectively. In such a case, there are no chance to form uncompensated antiferromagnetism thanks to which spontaneous electric polarization could be steered. Such simple and effective mechanism works in so called switch materials with non-centrosymmetric chemical units, which can become an origin of ferroelectricity and simultaneously contain the magnetic ions.

The targeted preparation allows controlling the chemical order and, consequently, distribution of the magnetic ions.

Keywords: Multifferoics, nanoparticles, X-ray and neutron diffraction, Mössbauer spectroscopy