Magnetism and its coupling to structure and superconductivity in iron pnictides

The discovery of high-temperature superconductivity in the fluorine-doped LaFeAsO has triggered intensive interest in superconductivity and also in itinerant magnetism in general in the “1111” and “122” families of layered iron pnictides. In this talk, I will present the complex magnetic structures in Fe and Ce sublattices determined by the elastic neutron scattering technique in CeFeAsO crystal. We found a spin-reorientation transition of Fe moments prior to long-range ordered Ce moments at lower temperatures, revealing a strong interplay between 4f Ce$^{3+}$ and 3d Fe$^{2+}$. The effect of the strong Ce-Fe coupling on the rearrangement of Fe ordering is yet another example of the vulnerability of the Fe spin density wave to perturbations such as minute doping or relatively low applied pressures.

While the previous studies have focused on the impact of superconductivity on the magnetic and orthorhombic phases, the interplay between these two ordered states has been a topic of intense debate and so far lacks a universal picture. Here, I will also present an evidence of sharp enhancement of the spin fluctuations, in particular the spin-spin correlation length below tetragonal-to-orthorhombic structural transition in LaFeAsO and underdoped Ba(Fe$_{1-x}$Co$_x$)$_2$As$_2$ by inelastic neutron scattering measurements, in contrast with what one expects from a typical antiferromagnetic system. Our findings can be consistently described by a model that attributes the structural/nematic transition to magnetic fluctuations, unveils the key role played by nematic order in promoting the long-range stripe antiferromagnetic order in iron pnictides and also indicate the nematicity may help enhancing superconducting temperature in some circumstances in iron pnictides.