Title: Nematic Order in Fe based superconductors

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ABSTRACT: Understanding the true nature of microscopic coexistence between magnetism and superconductivity in the 122 iron based superconductors requires a thorough examination of various phase diagrams at temperatures above and below the observed structural phase transitions especially in the region where the two “mutually exclusive” states actually meet. Superconductivity emerges only when the Spin Density Wave (SDW) magnetic state is sufficiently but not necessarily fully destabilized. Magnetic instabilities in these materials are even proposed to be the main ingredient for superconductivity. Destabilizing the magnetic SDW state can be achieved in a number of ways that include, for example, chemical substitutions at literally every crystallographic site, temperature, pressure and applied magnetic fields. Common to all these materials is the association of an orthorhombic (C2) structure with the SDW magnetic state and of a tetragonal (C4) structure with the normal state and superconductivity. The boundary line between the normal and SDW states strongly depends on the sign of the charge carriers. We have shown that simultaneous sharp first-order magnetic and structural transitions take place in hole-doped Ba$_{1-x}$A$_x$Fe$_2$As$_2$ (where A = K or Na) whereas the two transitions are clearly separated by a few degrees in the electron-doped BaFe$_{2-x}$Co$_x$As$_2$ analogs. In either case, there’s some evidence for the existence of nematicity at slightly higher temperatures. In this talk, we discuss the possible origin of the coupling mechanism between nematic order and magnetism. We have recent neutron diffraction results showing that for specific compositions close to the onset of superconductivity, magnetic interactions change character and a novel SDW phase is accessed in which the tetragonal four-fold rotational symmetry is recovered at a temperature below $T_N$ but also significantly higher than $T_C$. A theoretical model developed to explain these observations will be briefly discussed.

Dr. Chmaissem received his Ph.D. from Universite Joseph Fourier, France, 1992. Currently he is an associate professor in Department of Physics at NIU, and also holds a Special Term Appointment at Neutron and X-ray Scattering Group, Materials Science Division, Argonne National Laboratory. He is a specialist of Neutron diffraction techniques and characterization of solids. His current research interest is the structure and properties of complex oxides.