Striking similarities in magnetism and superfluid density of FeAs and cuprate systems: implication to mechanisms

Y.J. Uemura[1], J. P. Carlo[1], T. Goko[1,2,3], G.J. MacDougall[2], J.A. Rodriguez[2], W. Yu[2], G.M. Luke[2], Pengcheng Dai[4], N. Shannon[5], S. Miyasaka[6], S. Suzuki[6], S. Tajima[6], G.F. Chen[7], W.Z. Hu[7], J.L. Luo[7], N.L. Wang[7]

[1] *Department of Physics, Columbia University, New York, New York 10027, USA*
[2] *Department of Physics and Astronomy, McMaster University, Hamilton, Ontario L8S 4M1, Canada*
[3] *TRIUMF, 4004 Wesbrook Mall, Vancouver, B.C., V6T 2A3, Canada*
[4] *Department of Physics and Astronomy, University of Tennessee, Knoxville, Tennessee 37996, USA*
[5] *H H Wills Physics Laboratory, University of Bristol, BS8 1TL Bristol, United Kingdom*
[6] *Department of Physics, Osaka University, 1-1 Machikaneyama, Toyonaka, Osaka 560-0043, Japan*
[7] *Beijing National Laboratory for Condensed Matter Physics, Institute of Physics, Chinese Academy of Sciences, Beijing 100080, Peoples Republic of China*

Recently, we performed Muon Spin Relaxation (μSR) measurements in iron oxy-pnictide systems. The results have revealed: (1) commensurate long-range order in undoped LaOFeAs; (2) Bessel function line shape in $La(O_{0.97}F_{0.03})FeAs$ which indicates possible incommensurate/stripe/random magnetism; (3) scaling of superfluid density and T_c in the Ce, La, and Nd-FeAs superconductors following a nearly linear relationship found in cuprates, and (4) a rather large superfluid density for low-T_c LaOFeP [1]. Similar results were also reported by several other MuSR groups [2-5]. In this talk, we will compare these results with the case of the cuprates, and demonstrate overwhelming similarities found both in magnetism and superfluid density. We then discuss implications of this feature in an energy-scale phenomenology based on concepts of BE-BCS crossover and significance of soft-modes and closeness to competing magnetic states [6,7]. We will point out that a charge motion resonating with dynamical spin fluctuations, which we shall term as a "traffic-light resonance", can provide a qualitative understanding of a possible pairing mechanism for many exotic superconductors including FeAs, cuprate, alkali-doped C60, organic BEDT, and heavy-fermion systems. Superconductivity of these systems emerges as static magnetism of parent compounds changes into dynamic magnetism in their superconducting states [6,7]. The "traffic-light resonance" can be expected when the energy scale of dynamic spin fluctuations, represented by the exchange interaction J, is comparable to the energy scale of moving charges, i.e., the effective Fermi temperature $k_B T_F$ derived from the superfluid density [6,7].

[1] J.P. Carlo *et al.*, Cond-mat arXiv:0805.2186 (2008)
[2] H. Luetkens *et al.*, Cond-mat arXiv:0804.3115 (2008)
[3] H.H. Klauss *et al.*, Cond-mat arXiv:0805.0264 (2008)
[4] A.J. Drew *et al.*, Cond-mat arXiv:0805.1042 (2008)
[5] R. Khasanov *et al.*. Cond-mat arXiv:0805.1923 (2008)
[6] Y.J. Uemura, J. Phys. Condens. Matter **16** (2004) S4515
[7] Y.J. Uemura, Physica **B374-375** (2006) 1.