

MAR15-2014-000157

Abstract for an Invited Paper
for the MAR15 Meeting of
the American Physical Society

James C. McGroddy Prize Lecture: Iron-Based Superconductors: Discovery and Progress

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The largest breakthrough in the history is the discovery of high T_c Cuprates by G.Bednorz and A.Muller in 1986 and the maximum T_c exceeded 77K, boiling temperature of liquid nitrogen in 1987. However, no new superconductors with high T_c had been reported since then except MgB₂ ($T_c=39K$) discovered by J.Akimitsu in 2001. We found LaFePO superconductor with $T_c=3K$ in 2006 and LaFeAsO_{1-x}F_x with $T_c=26K$ (42K at under high pressure of 5GPa) in early 2008. The latter discovery rekindled the extensive superconductivity research globally, and more than 10,000 papers have been published to now. This excitement originates from disproof of a widely accepted belief that iron with a large magnetic moment is harmful for emergence of superconductivity and relatively high T_c . Extensive research on iron-based superconductors pushed up the maximal T_c to 56K, which is next to high T_c cuprates and has led to the discovery of more than 50 new iron-based superconducting materials to date. Seen are so many advances in elucidation of superconducting properties and pairing mechanism. In this talk, I introduce a tale to the discovery and show the current status by reviewing progresses in materials, properties, mechanism and the application covering the recent hot topics. Emphases are placed on the unique characteristics arising from multi-orbital nature which totally differs from high T_c cuprates.