Abstract for the Eurasia-Pacific Summer School and Conference 2012 (Invited talk)

Neutron Scattering Study on the New Iron Selenide Superconductors

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We determine using neutron and x-ray diffraction method the sample composition, crystalline structure and magnetic order of the recently discovered $A_2Fe_4Se_5$ superconductors (A=K, Rb, Cs, Tl/K or Tl/Rb). Contrary to initial belief derived from ARPES experiments that these materials are heavily electron-doped variety of the $BaFe_2As_2$ family of the Fe-based superconductors, they are almost charge balanced with the Fe valence close to 2+ as in the 11 family of iron selenide superconductors, and crystalize in an Fe vacancy-ordered lattice structure [1,2]. Coexisting with superconductivity is a novel block antiferromagnetic order which conforms to the tetragonal crystalline symmetry, different from all previous families of iron-based superconductor materials, and possesses a very large ordered magnetic moment $3.3\mu_B$ per Fe and a very high ordering temperature above 500 K [3]. Such Fe vacancy ordered crystal structure and the block antiferromagnetism occur in all 5 types of new iron selenide superconductors discovered so far, discounting the initial incorrect quantum-critical-point picture. With Fe vacancy number departs from the chemical formulas $A_2Fe_4Se_5$, an imperfect version of the Fe vacancy order results at base temperature while phase separation into two vacancy-ordered phases exists at the intermediate temperature range [4]. The Fe site disorder renders the materials insulating through the Anderson weak localization mechanism and destroys the superconductivity, like spin-glass disorder does in previous 11 iron selenide superconductors [5].

References:

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