Exploration of Fe-Chalcogenide superconductors: Fe-vacancy order, new AFM ground state and Superconductivity

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Cuprates and Fe-based compounds are two families with highest superconducting (SC) transition temperatures. A common feature in both families is that the superconductivity emerges as antiferromagnetic (AFM) long range order is suppressed. While the parent compound of cuprates is a Mott insulator where the electron repulsion is strong, the parent compound of Fe-based materials is metallic implying weak or moderate electron correlation. A key strategy to develop a unified picture for the Fe- and Cu-based high temperature superconductivity (HTSC) is to explore the possibility to tune the Fe-based compound into an insulator. This has not been successful albeit the worldwide efforts since its discovery in early 2008. The relationship between the antiferromagntic ground state in the Fe-chalcogenides, which is different from that in the Fe-pnictides, and superconductivity is another issue.

Here, firstly, I shall talk about the discovery of superconductivity with T_C=14K, determining of the lattice, magnetic structures in the parent of Fe(Te,Se,S) system and the correlation between bi-collinear AFM order and superconductivity in this system. Secondly, I shall discuss about our efforts on searching for new Fe-Chalcogenides with AFM insulating behavior, such as $La_2O_3Fe_2Se(S)_2$ compounds. Finally, I shall report our discovery of superconductivity above 30K in (Tl,K,Rb)Fe_xSe_2 system, which the onset SC transition temperature is as high as 40K. While the compound with more Fe vacancies shows an AFM insulator behavior, which may be associated with the Fe-vacancy ordering in the crystals. Our discovery represents the first Fe-based HTSC at the verge of an AFM insulator. A review on the results of Fe-vacancy super-lattice, magnetism and superconductivity in (Tl,K,Rb)Fe_xSe_2 system will be presented in this talk.

References:

1. Liling Sun, Minghu Fang, Zhongxian Zhao *et al.* ***Nuture*** **483**, 67(2012)
2. F. Ye, Wei Bao, X. H. Chen, Minghu Fang *et al.*, ***Phys. Rev. Letts***. **107**, 137003 (2011)
3. Chiheng Dong, Minghu Fang *et al.*, ***Phys. Rev. B*** 84, 224506(2011).
4. Minghu Fang *et al.*, ***EPL***, 94 (2011) 27009, **Editor's Choice**
5. Hangdong Wang, Minghu Fang *et al.*, ***EPL***, 93 (2011) 47004
6. Jian-Xin Zhu, Minghu Fang, and Qimiao Si *et al.*, ***Phys. Rev. Letts***. **104**, 216405 (2010)
7. Minghu Fang *et al.*, ***Phys. Rev. B*** **81**, 020509(R) (2010)
8. Yiming Qiu, Wei Bao, Minghu Fang, and Zhiqiang Mao *et al.* ***Phys. Rev. Letts***. **103**, 067008 (2009)
9. Wei Bao, Minghu Fang, Z. Q. Mao *et al.* ***Phys. Rev. Letts***. **102**, 247001 (2009)
10. M. H. Fang, Z.Q. Mao *et al.*, ***Phys. Rev. B*** 78, 224503(2008), **Editor's Suggestion.**

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