Exploring Inter-Orbital-Induced Magnetic Excitations in hole-doped $LiFe_{1-x}V_xAs$

Beijing Normal University   Xingye Lu

1. Introduction

Iron Pnictides has been intense researched since they been discovered. However, the microscopic origin of superconductivity in those materials is not clear and it not is insistent conditional BCS theory. In iron pnictides, superconductivity always occurs at the boundary of antiferromagnetic phase by turning parameters (such as impurity doping, press). That shows antiferromagnetic fluctuation has great contribution to the formation of superconducting phase. So that, researching the magnetic properties in those materials become important. Nesting picture could well describe the antiferromagnetic characters and superconductivity in many iron pnictides [1,2]. However, LiFeAs likes an exception. Parent samples has highest T_c (18K) with poor nesting and T_c becomes decrease with doping while non-fermi liquid behavior could be discovered with good nesting [3]. One way to understand the whole spin excitation picture, nesting and superconductivity is doing some work in the hole-doping LiFeAs since electron-doping LiFeAs was well researched. In this experiment, we want to capture the spin excitation in hole-doping $LiFe_{1-x}V_xAs$ to get deeper understand of spin excitation, nesting picture and superconductivity in hole-doping $LiFe_{1-x}V_xAs$.

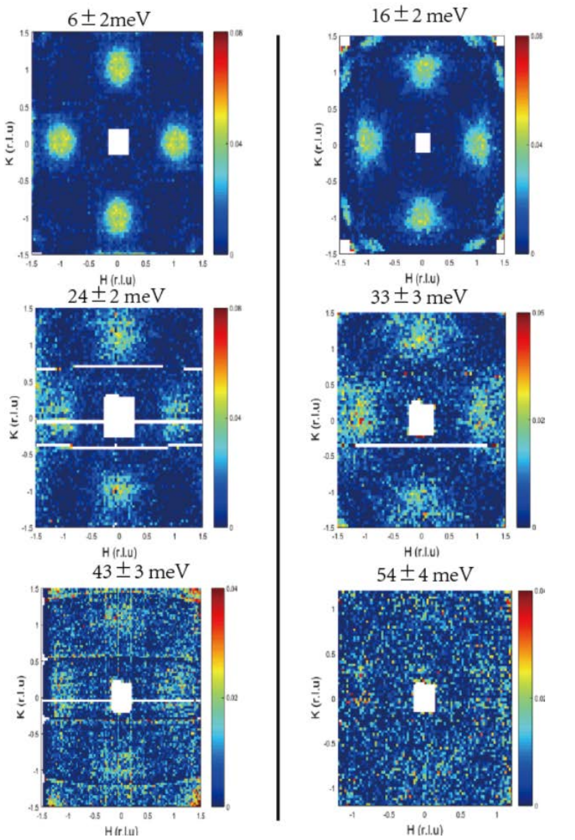

Figure.1 Two-dimensional constant-energy cut images of the spin wave excitation with 6 ± 2 meV,16 ± 2 meV ,24 ± 2meV, 33 ± 3meV,45 ± 3 meV and 54 ± 4 meV in 7 K.

2. Experiment

We preformed inelastic neutron scattering experiment on time-of-flight spectrometer (4SEASON) with proposal number:2017B0216. We prepared 7.2g LiFe1-xVxAs (x= 0.045) high quality crystals in which there is 1.8 grams Li-7 isotope and 5.4 grams Li-6 crystals. They are covered by cytop and aluminum foils since $LiFe_{1-x}V_xAs$ sample is air sensitive. All crystals were aligned along [100] direction and placed in 7 aluminum sheets. Our mosaics are most 15 degrees along [HH0] and [00L] because our sample is covered by aluminum foils. All measurements were executed at base temperature (7 K) during our beamtime (7 days). First incident energy(E_i) is 200meV with 300 Hz frequency of Fermi choppers. That configuration can simultaneously get experimental data of sub incident energies (75 meV,39meV,16meV) thanks to the design of 4SEASON spectrometer. Mslice will be used to analysis our data and background will be removed likes Ref. [4] method.

3. Results

We get good analyzable experimental data below energy transfer 60 meV in 4EASON time-of-flight spectrometer with 7 days counting. Unfortunately, we could not get available information above 60 meV with 200 meV incident energy that is due to intense background. Though mosaics along [HH0] and [00L] both are almost 15 degrees, they have not much influence in low energy region. Figure.1 summarizes the energy dependence of spin wave excitation at base temperature 7K. Clear circle spin excitation in low energy is identical to the ARPES results. That shows the magnetic excitation can origin from the nesting between isotropic fermi surfaces. With energy increasing, peak becomes broader and disappear at high energy due to the intense background in our preliminary analysis.

To capture the whole spin excitation picture in LIFeAs system. We compared the transverse 1-D cut of spin excitations of electron-doping, hole-doping and parent samples with 6 ± 2 meV around 7 K. Intensity increase apparently and FWHM becomes broader in hole-doping LiFeAs may be due to the magnetic impurity.

4. Conclusion

We preformed inelastic neutron scattering of hole-doping LiFeAs crystals and got good experimental data. This is the first microscopic magnetic measurement in hole-doping LiFeAs. Although superconductivity is not inconsistent with nesting picture in LiFeAs, the magnetic excitation could be illuminated by that. This implies that superconductivity could not match the itinerant electron model in this system. Compared with parent samples and electron-doping samples, intensity and FWHM both become increase, that may come from vanadium as the magnetic impurity.

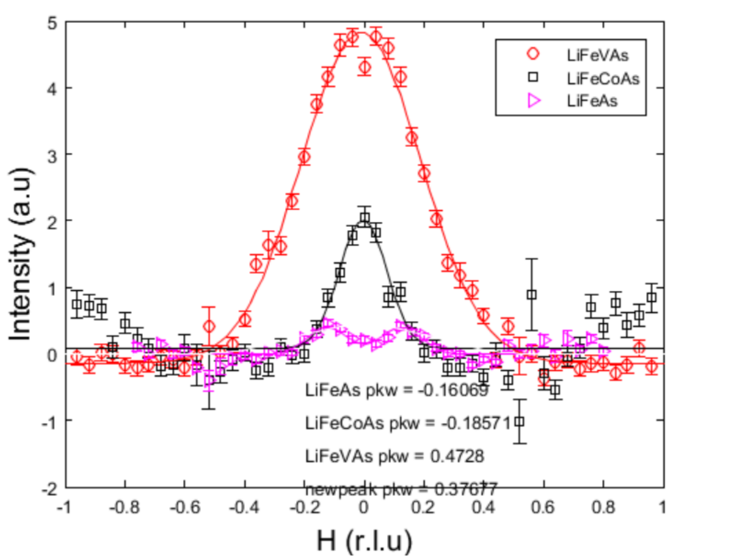

Figure.2 Constant energy cuts of the spin wave excitations along transverse antiferromagnetic order vector of LiFe$_{0.955}$V$_{0.045}$ (red thombus),LiFe$_{0.88}$Co$_{0.12}$As(black square) and LiFeAs(pink triangle)

Reference

[1] Dai, P. "Antiferromagnetic order and spin dynamics in iron-based superconductors". Reviews of Modern Physics, **87**(3), 855(2015).

[2] Terashima.K., *et al*. "Fermi surface nesting induced strong pairing in iron-based superconductors." Proceedings of the National Academy of Sciences **106**.18 (2009): 7330-7333.

[3] Li.Yu, *et al*. "Orbital selective spin excitations and their impact on superconductivity of LiFe$_{1-x}$Co$_x$As." Physical review letters **116**.24 (2016): 247001.

[4] Carr.Scott., *et al*. "Electron doping evolution of the magnetic excitations in NaFe$_{1-x}$Co$_x$As." Physical Review B **93**.21 (2016): 214506.