Measurement of charge excitations in superconducting $PrFeAsO_{0.7}$ and $K_{0.8}Fe_{1.6}Se_2$ using Fe-*L* RIXS

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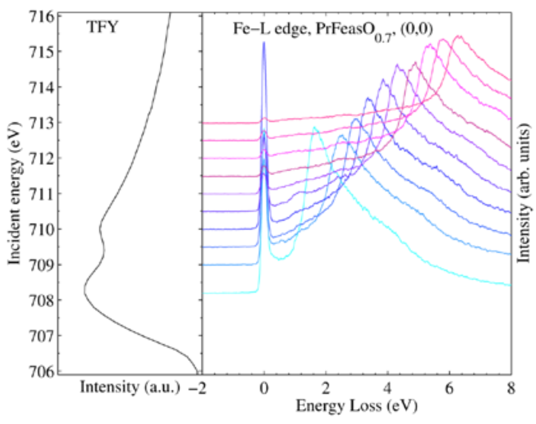
Not only has high-Tc superconductivity in the iron pnictides become one of the fastest-flourishing topics in recent condensed matter physics, but the extensive research effort it has generated has not abated to date. At the heart of this persistent interest lies the sharp contrast with the electronic properties of the strongly correlated, insulating, high-Tc cuprates, since the pnictides are metallic, albeit with sizeable correlations. Another distinctive aspect of the pnictides is the multiorbital nature of their low-energy electronic structure, which drives complex many-body interactions [1].

In this context, experimental investigations of electronic excitations are invaluable in exploring the multiband electron dynamics, and scrutinizing the corresponding novel theoretical frameworks. Resonant inelastic x-ray scattering (RIXS) allows such investigations to be carried out in an element-specific and momentum- resolved fashion, and in an energy range directly relevant to Coulomb and Hund interactions. However, the overwhelming fluorescence signal has been a hindering factor in the previous applications of RIXS to the pnictides [2,3].

Using the HORNET endstation at the beamline BL07SU, we have successfully observed charge excitations in single crystals of iron-based superconductors, $PrFeAsO_{0.7}$ and $K_{0.8}Fe_{1.6}Se_2$, owing to a combination of high resolution (160 meV) and strong flux. The incident energy dependence of the RIXS spectrum is shown for $PrFeAsO_{0.7}$ in Figure 1 and $K_{0.8}Fe_{1.6}Se_2$ in Figure 2. For both compounds, the spectra consist of two main features, dd interband transitions around 1.5 eV and As 4p - Fe 3d charge transfer around 4 eV. These excitations are found to be broader in $K_{0.8}Fe_{1.6}Se_2$. We observed that the electronic excitations show a sizeable momentum dependence. The spectra measured on $K_{0.8}Fe_{1.6}Se_2$ might contain a very weak spin excitation component at low energy, although it will be necessary to increase the statistics during future measurements.

Overall, these results show that Fe-L RIXS is better suited to study the iron-based superconductors than Fe-K RIXS, as with Fe-L RIXS the acquisition time is divided by 4 for comparable statistics, the resolution is about 30% better, and the intensity of the elastic line is reduced by a factor 1/7. Also, our study casts doubts over the previous report that the absence of Raman-like features in the RIXS spectra of the pnictides should be taken as an evidence for weak electronic correlations [4]. Rather, RIXS spectra of the pnictides do contain Raman-like peaks, which are weak and entangled between the elastic and the fluorescence peaks, and therefore require both high flux and resolution to be properly measured.



<u>Figure 1</u>: Fe-L RIXS spectra measured on $PrFeAsO_{0.7}$ at [0,0] (right panel), and Fe-L absorption spectrum measured in the total fluorescence yield mode.

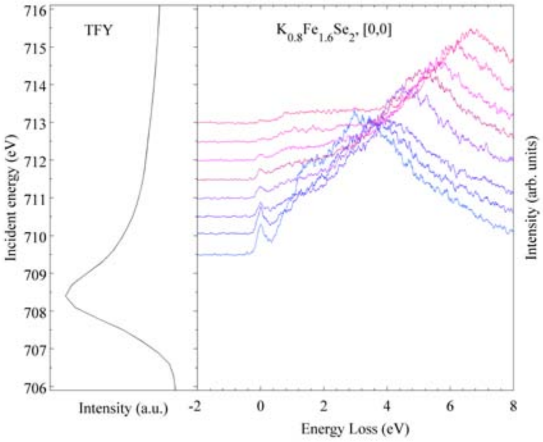


Figure 2: Fe-L RIXS spectra measured on $K_{0.8}Fe_{1.6}Se_2$ at [0,0] (right panel), and Fe-L absorption spectrum measured in the total fluorescence yield mode.

References

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