The effect of K dosing on the electronic structure of superconducting $FeSe_{1-x}S_x$

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Abstract

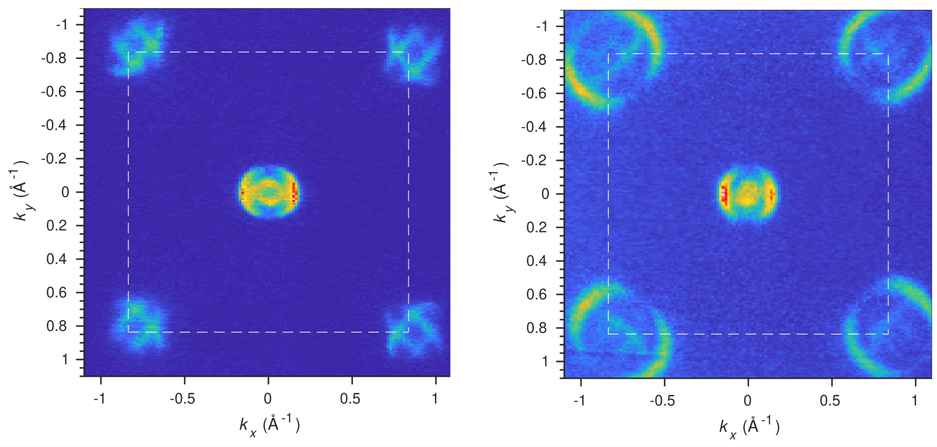
Understanding superconductivity requires a detailed understanding of the band structure of superconducting materials. This could allow us to engineer these materials to higher critical temperatures. Recent discoveries of enhanced superconductivity below 100K in FeSe monolayer films have sparked much debate as to the cause, however theory has yet to fully explain these findings.

In this poster, we investigate the effect of surface potassium dosing of $FeSe_{1-x}S_x$ (x ~ 0.18) by analysing the electronic band structure with **A**ngle **R**esolved **P**hoto**E**mission **S**pectroscopy (**ARPES**). By fitting peaks to MDCs we extract the shape of the bands near high-symmetry points. We find that hole pockets in the Brillouin zone close up, leaving a single large electron pocket at the M point. Under dosing, superconductivity is strongly enhanced with superconductivity below 40K from its pristine value of 8K.

Fermi Surface

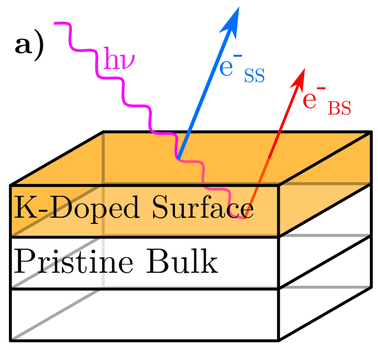
Before dosing, there are two hole pockets at the Γ point and two petal shaped electron pockets at the M point.

After dosing both hole pockets are pushed below the Fermi level. The two electron pockets have grown into large doubly-degenerate circles.

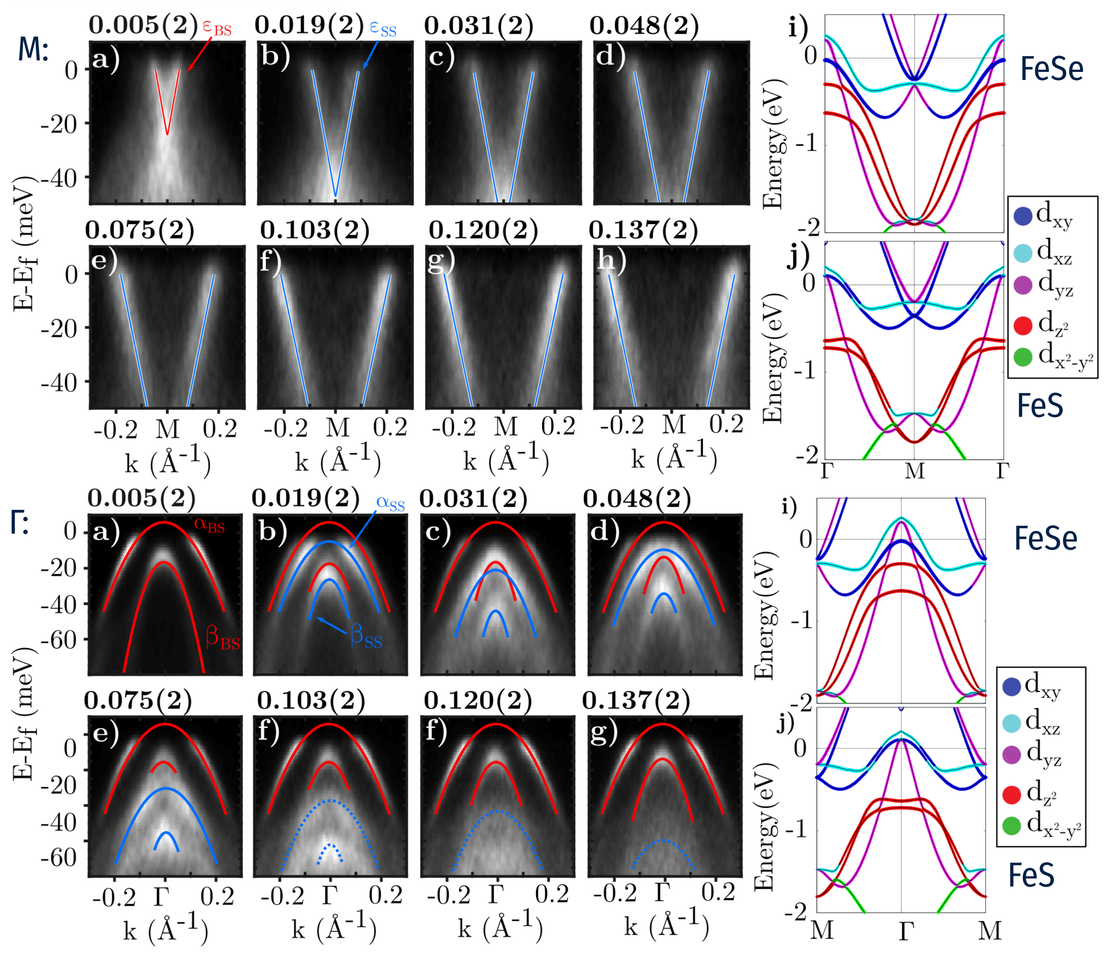


Bulk States and Surface States

The K-dosing is limited to a thin layer on the surface and so, while ARPES is surface sensitive, photoelectrons are received from both the bulk and the surface. The resulted ARPES data are a superposition of the signal from the bulk, pristine material and that from the surface, electron-doped material.



Band Structure



The figures above show cuts in the Γ-M direction near the M and Γ points. Calculated band structures for FeSe and FeS are shown. The d_{xy} band is not visible due to matrix element effects. Extracted parameters from the bands near the M point show a steady increase in k_f. This is accompanied by an increase in effective mass m*. This increase in m* is consistent with other similar studies. (Wen *et al* 2015, *Nat Commun* 7, p.10840) and (Seo *et al* 2016, *Nat Commun* 7, p.11116.)

Superconductivity

The dosing leads to a robust high-temperature phase of around 40K in the surface layer as the size of the electrons pockets increases and density of states in enhanced.