Abstract Submitted
for the MAR14 Meeting of
The American Physical Society

Local disorder and superconductivity in $\mathbf{K}_x\mathbf{Fe}_{2-y}\mathbf{Se}_2$ DESPINA LOUCA, University of Virginia, KEESEONG PARK, DGIST, BING LI, University of Virginia, Y.-Q. YAN, University of Tennessee, JOERG NEUEFEIND, Oak Ridge National Laboratory — In the $K_xFe_{2-y}Se_2$ family of Fe-based superconductors, superconductivity is observed between a semi-metallic region below x $\sim$ 0.7 and an insulating and antiferromagnetic region above x $\sim$ 0.85. By probing the local structure we observe that superconductivity emerges in a locally distorted Fe sublattice that accommodates two kinds of bonding environments, forming a double-well distribution. Consisting of short bonds which are metallic in nature and of long ones which are insulating and antiferromagnetic, their distribution changes with x. Even though crystallographically the atomic structure changes slowly on average by adding K, a continuous transition from the short to the long Fe bonds is observed across this region. What is unique to this system's superconducting state is the presence of the double-well distribution in equal proportions, in contrast to other Fe-based materials where only one kind of Fe bond is present. This suggests that superconductivity is intertwined with magnetism, appearing at the crossover from metallic to insulating conditions and is not due to phase separation.

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Date submitted: 15 Nov 2013 Electronic form version 1.4