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Superconductivity amid phase inhomogeneity: the case of $\mathbf{K}_x\mathbf{Fe}_{2-y}\mathbf{Se}_2$ DESPINA LOUCA, University of Virginia — The recently discovered Fe-based superconductors, $K_xFe_{2-y}Se_2$, is studied using neutron diffraction and the pair density function analysis to investigate the nature of the atomic disorder induced by the K and Fe site vacancies. In this system, both superconductivity and magnetic ordering can coexist, while superconductivity is observed in a narrow range of potassium concentration, between $0.6 < x < 0.8$. While no crystal transition occurs across with x, the Fe site vacancies are ordered in the $\sqrt{5} \times \sqrt{5}$ structure. At high temperatures, the Fe vacancies are not ordered. Why does superconductivity appear in the vicinity of the 0.8 composition? To provide a clue towards the answer, instead of probing the periodic structure, we probed the local atomic structure that provides information regarding the short-range correlations in real space. The results suggest a strong dependence of the Fe-Fe bond lengths to the K concentration. What is unique to this system is that a double-well bond distribution of short and long Fe - Fe bonds exists, originating from the fully occupied Fe site. As the K concentration increases to x=1, the distribution shifts weight from the short to the long while in the superconducting case, it is equal between the two.

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