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Lattice distortion and magnetic quantum phase transition in $CeFeAs_{1-x}P_xO$

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With the advent of Fe-based superconductivity initially discovered in the prototypical electron doped Fe-pnictide LaFeAsOxF1$-x$, came a surge of renewed interest in high temperature superconductivity. The discovery of ubiquitous antiferromagnetic (AFM) order in the parent compounds of iron arsenide superconductors has brought attention to the understanding of the interplay between magnetism and high-transition temperature (high-Tc) superconductivity in these materials. Although superconductivity in iron arsenides arises from charge carrier doping of their semimetal parent compounds, the resulting electronic phase diagrams are dramatically materials dependent, ranging from first-order-like AFM to superconductivity phase transition for LaFeAsO1-xFx, to the gradual suppression of the AFM order before superconductivity for CeFeAsO1-xFx, and finally to the co-existing AFM order with superconductivity in SmFeAsO1-xFx. A feature of the parent compounds is the structural distortion that occurs in the vicinity of the onset of long range magnetic order of the Fe-spins. In the RFeAsO(R=rare earth) family, the magneto-structural transition is suppressed in favor of superconductivity upon doping charge carriers into the system, which alters the system electronically and crystallographically as well. To understand the lattice effect on the suppression of the AFM ground state itself by quantum fluctuations, it is important to isoelectronically tune the crystal lattice structure without the influence of charge carrier doping and superconductivity. Here we use neutron scattering to show that replacing the larger arsenic with smaller phosphorus in CeFeAs1-xPxO simultaneously suppresses the AF order and orthorhombic distortion near x= 0.4, providing evidence for a magnetic quantum critical point. Furthermore, we find that the pnictogen height in iron arsenide is an important controlling parameter for their electronic and magnetic properties, and may play an important role in electron pairing and superconductivity. Preliminary work on systematic phosphorous doping in LaFeAs1-xPxO was also done to possibly identify characteristic changes in the lattice that may be correlated with the phosphorous doping induced superconductivity in the La system and in turn give insights as to the absence of superconductivity in the Ce system.