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Intertwined superconducting and nematic orders in $NaFe_{1-x}Ni_xAs$ without antiferromagnetic order WEIYI WANG, YU SONG, Rice University, CHONGDE CAO, Northwestern Polytechnical University, YU LI, Rice University, LELAND HARRIGER, NIST Center for Neutron Research, WEI TIAN, SONGXUE CHI, Oak Ridge National Laboratory, RONG YU, Renmin University of China, ANDRIY NEVIDOMSKYY, PENGCHENG DAI, Rice University
— We use neutron scattering to study antiferromagnetic (AF, T_N) and tetragonal-to-orthorhombic structural (T_s) phase transitions in $NaFe_{1-x}Ni_xAs$. Compared to $BaFe_{2-x}TM_xAs_2$ (TM = Co, Ni) and $NaFe_{1-x}Co_xAs$, AF order in $NaFe_{1-x}Ni_xAs$ remains commensurate and long-range upon approaching optimal superconductivity while exhibiting strong competition with superconductivity. For $NaFe_{0.987}Ni_{0.013}As$ with $T_s \approx 33$ K, $T_N \approx 20K$, and $T_c \approx 15$ K, we find that while magnetic order is completely suppressed by superconductivity below $T_r \approx 10$ K, the suppression of lattice orthorhombicity stops abruptly below T_r. These results demonstrate that orthorhombicity only indirectly competes with superconductivity through coupling with the magnetic order parameter and there is no structural re-entry into the tetragonal phase in $NaFe_{1-x}Ni_xAs$. The lack of direct coupling between superconductivity and the lattice in the absence of magnetic order is similar to that observed in FeSe, suggesting the nematic order and associated lattice distortions in these compounds are intertwined rather than competing with superconductivity.

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