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Symmetry of reentrant tetragonal phase in $Ba_{1-x}Na_xFe_2As_2$: Magnetic versus orbital ordering mechanism DMITRY KHALYAVIN, ISIS facility, Rutherford Appleton Laboratory, STEPHEN LOVESEY, Diamond Light Source Ltd, PASCAL MANUEL, ISIS facility, Rutherford Appleton Laboratory, FRANK KRUGER, London Centre for Nanotechnology, University College London, STEPHAN ROSENKRANZ, JARED ALLRED, OMAR CHMAISSEM, RAY OSBORN, Materials Science Division, Argonne National Laboratory — Magneto-structural phase transitions in $Ba_{1-x}A_xFe_2As_2$ (A = K, Na) materials have been analyzed for both magnetically and orbitally driven mechanisms, using symmetry methods formulated within the Landau theory of phase transitions. Both mechanisms predict identical orthorhombic space group symmetries for the nematic and magnetic phases observed over much of the phase diagram, but they predict different tetragonal space-group symmetries for the newly discovered reentrant tetragonal phase in $Ba_{1-x}Na_xFe_2As_2$ ($x \sim 0.25$). In a magnetic scenario, magnetic order with moments along the *c*-axis, as found experimentally, does not allow any type of orbital order, but in an orbital scenario, we have determined two possible orbital patterns, specified by *P4/mnc1'*and *I4221'* space groups, which do not require atomic displacements relative to the parent *I4/mmm1'* symmetry and, in consequence, are indistinguishable in conventional diffraction experiments. We demonstrate that the three possible space groups are however, distinct in resonant X-ray Bragg diffraction patterns created by Templeton & Templeton scattering. This provides an experimental method of distinguishing between magnetic and orbital models.

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