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Magnetic-field-induced first-order phase transitions in $Ca_3(Ru_{1-x}Fe_x)_2O_7$ with unusual irreversible behaviors MENGZE ZHU, Michigan State Univ, JIN PENG, Nanjing Univ, China, TAO ZOU, Michigan State Univ, TAO HONG, Oak Ridge National Lab, KAREL PROKES, Helmholtz Zentrum Berlin, Germany, S. D. MAHANTI, Michigan State Univ, ZHIQIANG MAO, Tulane University, XIANGLIN KE, Michigan State Univ — Neutron diffraction measurements reveal a magnetic-field-induced incommensurate-commensurate magnetic structure transition in a bilayer ruthenate $Ca_3(Ru_{1-x}Fe_x)_2O_7$ ($x = 0.05$). The transition is of first-order in nature, and exhibits intriguing irreversible behaviors at low temperature, i.e. the zero-field incommensurate state before and after field sweeping showing very distinct magnetic ordering wave vectors. The difference in the wavelength of magnetic ordering is strongly temperature-dependent, and disappears gradually as temperature raises. This unusual irreversibility in magnetic ordering vector is rarely observed, and in disagreement with phase coexistence phenomena that is commonly seen in other irreversible first-order phase transitions. Nevertheless, our results demonstrate that thermal fluctuations also play an essential role in this unusual behavior.

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