Evolution of the CO-OO and AF ordering in the single-layer manganite \( \text{Pr}_{1-x}\text{Ca}_{1+x}\text{MnO}_4 \) near half doping

FENG YE, J. A. FERNANDEZ-BACA, Oak Ridge National Lab., SONGXUE CHI, PENGCHENG DAI, Univ. of Tennessee, Knoxville, J. W. LYNN, NIST Center for Neutron Research, R. MATHIEU, Y. KANEKO, ERATO-SSS, Y. TOKURA, Univ. of Tokyo — Manganese oxides have attracted considerable attention due to the CMR effect observed in the perovskite manganite \( A_{1-x}A'_x\text{MnO}_3 \) near \( x = 0.3 \). A peculiar charge/orbital (CO-OO) accompanied by antiferromagnetic (AF) order occurs when the carrier concentration is close to half doping \((x=0.5)\). To understand the interplay between the charge, lattice and spin degrees of freedom in such insulating state, we used elastic neutron scattering to study the evolution of the CO-OO as well as the AF correlations in the single-layer manganite \( \text{Pr}_{1-x}\text{Ca}_{1+x}\text{MnO}_4 \) \((x = 0.40, 0.45\) and \(0.50)\). Upon cooling, all three samples exhibit long-range CO-OO near 300 K. However, only the \( x = 0.50 \) system displays long-range AF order at low temperatures. The CE-type AF correlations are quickly suppressed and become short-ranged as more \( e_g \) electrons are introduced to the \(\text{MnO}_2\) plane. More interestingly, the CO-OO and AF order associated with Mn\(^{3+}\) ions appears at incommensurate positions while the AF order associated with Mn\(^{4+}\) ions remains commensurate. Our observations indicate that the orbital physics play an important role in the understanding of the electronic and magnetic properties of doped manganites.

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