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NEW INSIGHTS INTO CHARGE ORDERING PHENOMENA IN CMR OXIDES

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New insights into charge ordering phenomena in CMR oxides

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Manganites have long been known to exhibit unusual lattice, electronic, and magnetic properties. In particular, within some regions of their phase diagrams, a form of spatial modulation known as the charge-ordered state is encountered. These phases are insulating and often antiferromagnetic so that understanding the origin of the phenomenon may provide the key to the origin of ferromagnetism and colossal magnetoresistance in these materials. However, in spite of extensive studies dedicated to this topic, the underlying physics remains an open issue. So far, experimental techniques such as diffraction and scanning probe microscopy have provided only limited information, averaged over long length scales and confined to the materials surfaces, respectively. Here, we report new experimental results for $Bi_{0.37}Ca_{0.63}MnO_3$ obtained by atomic-resolution Z-contrast microscopy and electron-energy-loss spectroscopy and new theoretical results obtained by first-principles density-functional calculations. We find atomically-resolved striping of the Mn $L_{2,3}$ EELS spectra, which demonstrates inequivalent Mn planes that correlate with two distinct formal charge states (+3 and +4). Theoretical results reproduce the structural relaxation that leads to the striping and shows that it is driven by a Peierls-like instability with minimal charge transfer.

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