

## Structural Modulation in the Charge-Ordered Phase of $\text{Bi}_{0.3}\text{Ca}_{0.7}\text{MnO}_3$

V. Kiryukhin, B. G. Kim, S-W. Cheong (Rutgers U.), and J. P. Hill (BNL)

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Charge ordering into stripes has recently attracted significant attention due to its important role in superconducting cuprates and colossal magnetoresistance (CMR) manganites. In the manganites of the general formula  $\text{A}_{1-x}\text{B}_x\text{MnO}_3$ , charge stripes are observed in several compounds with  $x > 0.5$ . The only good quality single crystal samples exhibiting striped charge order are  $\text{Bi}_{1-x}\text{Ca}_x\text{MnO}_3$  samples. Electron diffraction measurements have shown<sup>1</sup> that charge-ordered structure with the propagation vector  $(\delta, 0, 0)$  in the  $Pbnm$  notation, with  $\delta$  varying from 0.5 to 0.2 as  $x$  changes from 0.5 to 0.8, forms in these compounds at low temperatures. This structure was described in terms of the charge and orbital stripes running along the diagonal  $(1, 1, 0)$  direction in the primitive cubic perovskite lattice underlying the distorted orthorhombic (or monoclinic) structure of  $\text{Bi}_{1-x}\text{Ca}_x\text{MnO}_3$ .

In this work, we report resonant x-ray diffraction studies of the charge-ordered (CO) state in  $\text{Bi}_{0.3}\text{Ca}_{0.7}\text{MnO}_3$ . We find that in this compound, the CO phase exhibits a new type of lattice modulation with the propagation vector  $(2/3, 2/3, 0)$  in the  $Pbnm$  notation. That is, the lattice constant in the  $(1, 0, 0)$  direction in the primitive cubic lattice triples in the CO state. Tripling of the lattice constant is expected in the vicinity of the Ca concentration  $x=2/3$ . However, the direction of the lattice modulation found in our experiments is different from that characteristic to the striped CO structure proposed before. The observed superlattice peaks exhibit a clear resonant structure in the energy scans taken in the vicinity of the Mn K-edge. This suggests that these peaks result from charge or orbital ordering of d-electrons and, therefore, directly reflect the CO structure of  $\text{Bi}_{0.3}\text{Ca}_{0.7}\text{MnO}_3$ . To unambiguously determine the low-temperature structure of the charge- and orbitally ordered state in this compound, it is necessary to conduct detailed polarization and energy analysis for a number of superlattice peaks. Such measurements are currently under way. The experimental results obtained thus far, however, already clearly demonstrate that the microscopic structure of the CO state in highly doped manganites is more complex than previously believed.

**References:** <sup>1</sup>C. H. Chen, S-W. Cheong, Phys. Rev. Lett. **76**, 4042 (1996)