Symmetry constraints on the electrical polarization in novel multiferroic materials

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There has been a recent surge of interest for a new class of ferroelectric transition-metal where the onset of electrical polarization coincides with a magnetic ordering transition[1]. Much of the discussion in the literature has focused on establishing the microscopic mechanism that couples the magnetic moments with lattice displacements, such as symmetric or antisymmetric superexchange. Comparatively little attention has been devoted to the systematic study of the effect of magnetic symmetry breaking. I will present examples in the $REMn_2O_5$ [2-4] and $REMNO_3$ systems where the direction of the electrical polarization can be directly inferred from the symmetry of the proposed magnetic structure, regardless of the exact magneto-elastic coupling mechanism. I will also present a general method, based on co-representation analysis, to determine the structural point group symmetry of the magnetically ordered structure, in both commensurate and incommensurate cases. I will show that ferroelectricity can develop even when the magnetic structure is described by a single order parameter, and that **P**//**k** is allowed by symmetry in some cases. Furthermore, the analysis evidences the crucial difference between *incommensurate* and *commensurate* magnetic structures for propagation vectors inside the Brillouin zone, and, for the latter, that the global phase has an influence on symmetry.

References

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