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Colossal magnetoelectric effect in Co_3TeO_6 family of compounds¹

SERGEY ARTYUKHIN, YOON SEOK OH, Rutgers University, JUN JIE YANG, Pohang University, Korea, VIVIEN ZAPF, JAE WOOK KIM, Los Alamos Natl Lab, Natl High Magnet Field Lab, SANG-WOOK CHEONG, DAVID VANDERBILT, Rutgers University — Multiferroic Co_3TeO_6 and related materials attracted much attention recently due to their rich phase diagrams, magnetic field – driven electric polarization and incommensurate spin structures. We model the interacting magnetic and ferroelectric degrees of freedom in these compounds with Landau-type theory and calculate the phase diagram. Comparison of our results with experiment reveals that a particular magnetic anisotropy in some of the compounds results in a second-order spin-flop transition, associated with a large change of polarization. In the vicinity of the transition the spin-flopped phase can be stabilized by a small external magnetic field, which gives rise to a colossal magnetoelectric effect, recently demonstrated experimentally. Furthermore, we analyze the types of domain walls that can occur in these materials, and study their interactions. The clamping of domain walls of different types enables the cross-control of ferroic orderings, although they may not be coupled in the bulk. We corroborate our results with ab-initio computations of the polarization, piezoelectric response and optical properties. Our results could pave the way to the design of a new generation of magnetoelectric devices.

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Sergey Artyukhin
Rutgers University

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