Broken Symmetries, Non-reciprocity and Multiferroicity

Sang-Wook Cheong
Rutgers Center for Emergent Materials
Rutgers, the State University of New Jersey, USA

When the motion of an object in one direction is different from that in the opposite direction is called non-reciprocal directional dichroism (or simply a non-reciprocal effect). The object can be electron, phonon (lattice wave), magnon (spin wave), or light in crystalline solids, and the best known example is non-reciprocal charge transport (i.e. diode) effects in p-n junctions, where a built-in electric field (***E***) breaks the directional symmetry. In addition to p-n junctions, numerous technological devices such as optical isolators or spin current diodes can utilize non-reciprocal effects. We, fist, introduce the concept of symmetry-Operational Similarity (SOS). Then, we will discuss how non-reciprocal effects can be understood in terms of SOS. Furthermore, we will demonstrate that the SOS approach can readily explain various mechanisms for multiferroicity with magnetism-induced electric polarization.