

## Spiral spin order induced ferroelectricity in various type-II multiferroics

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In the past decade, one of the milestones associated with multiferroicity researches has been the experimental and theoretical identification of spin orders induced ferroelectricity in various spin frustrated oxide materials. These specific orders include the noncollinear spiral spin order, collinear spin order of exchange striction, E-type antiferromagnetic (AFM) order of double-exchange nature, and so on. Both the  $(S_i \times S_j)$ -type and  $(S_i \cdot S_j)$ -type spin interactions may contribute to the ferroelectricity generation. In consequence, experimentally observable multiferroic phenomena can be complex and reflected in multifold dimensions.

In this talk, we address the spiral spin order induced ferroelectricity in various multiferroics where the  $(S_i \times S_j)$ -type spin interaction is believed to contribute to the ferroelectricity. A modulation of such spiral spin order by various approaches is investigated and in particular the complex spin interactions in  $\text{RMnO}_3$  with magnetic and non-magnetic doping at the R-site and Mn-site will be discussed. Hopefully this talk may allow additional facts to our comprehensive understanding of the multifold interactions which eventually have impact on the magnitude of ferroelectric polarization in those multiferroics.

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