

Multi-functional Materials with Polarization

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Multi-functional materials can respond to more than one external stimulus. One important family of such materials would be those with magnetization-polarization interactions: however, prior searches for such systems with strong exchange have proven elusive. In this talk, we will discuss recent advances in magnetoelectric materials that use a different approach: '*Zhong young zhi dao*' the ancient Chinese 'doctrine of the mean or middle grounds', where inherent compromise to conflict is essential. Investigations of multi-ferroic behavior will be present in magnetoelectric (i) single crystals and epitaxial films of BiFeO_3 ; and (ii) laminate composites of piezoelectric and magnetostrictive layers. We will demonstrate that strong interaction can be achieved between the spin and polarization subsystems. The results offer an approach to a complete electromagnetic packaging material: which could have important ramifications in sensors, voltage reading of spin states, power electronics, and antennas.