MAR08-2007-002179

Abstract for an Invited Paper
for the MAR08 Meeting of
the American Physical Society

Observation of ferrotoroidic order in $LiCoPO_4$[1]

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Domains are an essential property of any ferroic material. Three forms of ferroic order (ferromagnetism, ferroelectricity, ferroelasticity) are widely known. It is currently debated whether to include an ordered arrangement of magnetic vortices as fourth form of ferroic order termed ferrotoroidicity [1]. Although there are reasons to do this from the point of view of thermodynamics a crucial hallmark of the ferroic state, i.e., a ferrotoroidic domain structure, has not been observed before. Here ferrotoroidic domains are spatially resolved by optical second harmonic generation in $LiCoPO_4$ where they coexist with independent antiferromagnetic domains [2]. The origin of ferrotoroidicity in $LiCoPO_4$ is discussed and the general relation between ferrotoroidicity and antiferromagnetism or spin-spiral magnetism will be highlighted. Their space- and time asymmetric nature relates ferrotoroidics to multiferroics with magnetoelectric phase control and other systems in which space and time asymmetry leads to exciting possibilities for future application.

[1] C. Ederer, N.A. Spaldin, arXiv:0706.1974v1 [cond-mat.str-el], Phys. Rev. B, in press (2007)

[2] B.B. Van Aken, J.P. Rivera, H. Schmid, M. Fiebig, Nature **449**, 702 (2007)

[1]Support by the SFG608 of DFG is acknowledged.