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**X-Ray Imaging and Multiferroic Coupling of Cycloidal Magnetic Domains in Ferroelectric Monodomain $BiFeO_3$**[1] P.G. RADAELLI, R.D. JOHNSON, Clarendon Laboratory, University of Oxford, Oxford OX1 3PU, UK, A. BOMBARDI, Diamond Light Source,Didcot OX11 0DE, UK, Y.-S. OH, S.-W. CHEONG, Rutgers Center for Emergent Materials and Department of Physics and Astronomy, 136 Frelinghuysen Road, Piscataway 08854, NJ, USA, L.C. CHAPON, Institut Laue-Langevin, BP 156, 6, rue Jules Horowitz, 38042 Grenoble Cedex 9, France — $BiFeO_3$ is perhaps the most studied material among the multiferroics. It is both magnetic and strongly ferroelectric at room temperature, making it potentially suitable for applications. Understanding the interplay between ferroelectric and magnetic domains is, however, essential to control device functionality. In $BiFeO_3$, the Dzyaloshinsky- Moriya interaction promotes the formation of cycloidal magnetic domains with magnetic polarity *co-aligned* with the electrical polarization. We have imaged these magnetic domains at the surface of a ferroelectric monodomain $BiFeO_3$ single crystal by hard x-ray magnetic scattering. Domains up to several hundred microns in size have been observed, corresponding to cycloidal modulations along the wave vector $\mathbf{k} = (\delta, \delta, 0)$ and symmetry equivalent directions. The rotation direction of the magnetization in all magnetic domains, determined by diffraction of circularly polarized light, was found to be unique and in agreement with first-principle calculations. Imaging of the surface shows that the largest adjacent domains display a 120° vortex structure.

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