Towards High Spatial Resolution Studies of Magnetism with Transmission Electron Microscopes

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Abstract. Electron magnetic circular dichroism (EMCD; [1]) has been proposed in 2003 and for the first time experimentally realized in 2006. Since then the method went through a rapid development at both fronts – experimental and theoretical. Dynamical diffraction effects severely complicate EMCD detection and often reduce the its strength. To circumvent this, numerous ways of acquiring EMCD have been proposed and many of them were experimentally tested. Recently, EMCD was detected using astigmatic electron beams on antiferromagnets [2], or with convergent probes [3], resolving magnetic signals from areas smaller than a square nanometer [4]. In high-resolution TEM setting, EMCD signal from individual atomic planes was detected using the PICO instrument [5], where a crucial role was played by chromatic aberration corrector. Theory predicts that electron vortex beams should be efficient probes of EMCD at atomic resolution [6]. Successful realization of this experiment could be extended further to probe the third dimension by means of magnetic depth sectioning [7]. We will review the recent history of EMCD, its present state-of-the-art and discuss some of its challenges for the near future.

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