(Invited) Nanometer Lorentz microscopy using direct electron detection

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The advent of aberration correction has enabled the imaging of the magnetic structure of materials in a transmission electron microscope, so called Lorentz microscopy, with nanometer scale resolution [1]. Whilst this has been one of the major developments of the last decade, it can be argued that the advent of pixelated detectors has enabled advancement of Lorentz microscopy in at least an equal measure [2]. Whilst the limiting resolution will always be a headline figure for microscopists the sensitivity of a particular imaging technique also exposes limitations in terms of inherent issues with materials properties which contribute helpfully or otherwise to the ultimate useful information that can be extracted from images. Direct electron detection in the pixelated detector geometry has allowed the sensitivity of differential phase contrast in STEM to improve dramatically. Results will be presented from 2 distinct studies to highlight the capability of Lorentz microscopy with direct electron detection:
i) FeRh a magnetic memristive material [3] and ii) chiral magnetic multilayers [4,5]. Funding is acknowledged from European Union grant MAGicSky No. FET-Open665095 and EPSRC through grants EP/M024423/1 and EP/M019020/1.

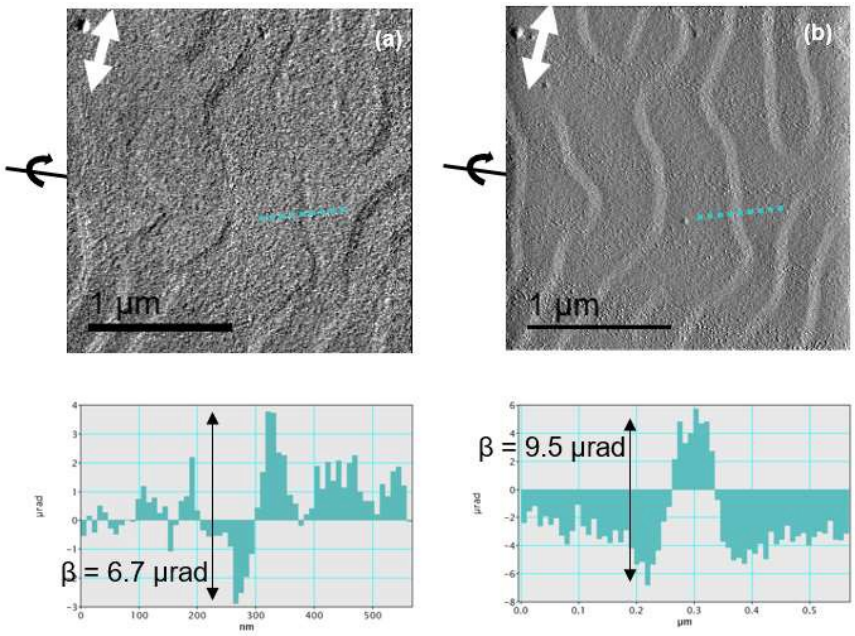

Figure 1. (Upper) DPC images of titled 15× layer repeat chiral magnetic multilayer sample with closely spaced pairs of domain wall at varying sample tilt in the TEM. (Lower) Corresponding intensity linetraces from these images. The images confirm the presence of Bloch wall components.

References:

[1] S. McVitie et al. Ultramicroscopy 152, 57-62 (2015).
[2] M. Krajnak et al. Ultramicroscopy 165, 42-50 (2016).
[3] T.P. Almeida et al. Physical Review Materials 4, 034410 (2020)
[4] K. Fallon et al. Physical Review B 100, 214431 (2019)
[5] K. Fallon et al. Small 16, 1907450 (2020)