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High angular magnification for accessing structural information in Ultrafast Electron Diffraction

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Pulsed electron beams probe the dynamics of matter out of equilibrium with high spatial and temporal resolution. Ultrafast electron diffraction in particular is sensitive to sub-angstrom, sub-picosecond scale atomic motion. To collect all the structural information available in an electron diffraction pattern, the experimentalist must control the angular magnification onto the detector plane. We present a case study demonstrating the advantage of angular magnification: investigating periodic strain in moiré materials. Strain waves with 10 nm wavelength appear in diffraction as satellites closely clustered around brighter Bragg peaks. We describe a quadrupole lens triplet that varies the effective drift distance M_{12} between sample and detector from 80 cm to 8 m for our 140 keV electron beam, allowing us to zoom in on these moiré satellites. Three independently powered quadrupoles make it possible to eliminate astigmatism from a point-like probe. With the field strength achievable using quadrupole magnets, this magnification technique is also suitable for MeV beam energies.

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Footnotes

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