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Quantum Measurements with an Electron Matter Wave Interferometer BENJAMIN MCMORRAN, ALICE GREENBERG, CAMERON JOHNSON, AMY TURNER, University of Oregon — New developments in electron optics enable quantum-inspired measurements with electrons. For example, nanoscale diffraction holograms can produce free electron wavefunctions with non-trivial phase profiles that provide a new way to probe the chirality and spatial coherence of nanoscale plasmonics. We report results demonstrating symmetry-breaking inelastic interactions between electron vortex beams and chiral nanoparticle clusters. Nanoscale material phase gratings can also serve as optimized beamsplitters for electrons. We used this in an electron Mach-Zehnder interferometer with large path separation – up to 200 microns – and have demonstrated its use to measure and image electric and magnetic fields at the nanoscale. More recently, we demonstrated interaction-free measurements with this matter wave interferometer. These early demonstrations may also serve as key steps towards novel forms of electron microscopy and spectroscopy that could potentially be used to coherently probe quantum systems – perhaps even manipulate them – as well as image sensitive phase objects like biological molecules with atomic resolution.

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