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An orbital angular momentum spectrometer for electrons[1]
TYLER HARVEY, Univ of Oregon, VINCENZO GRILLO, CNR-Istituto Nanoscienze and CNR-IMEM, BENJAMIN MCMORRAN, Univ of Oregon — With the advent of techniques for preparation of free-electron and neutron orbital angular momentum (OAM) states, a basic follow-up question emerges: how do we measure the orbital angular momentum state distribution in matter waves? Control of both the energy and helicity of light has produced a range of spectroscopic applications, including molecular fingerprinting and magnetization mapping. Realization of an analogous dual energy-OAM spectroscopy with matter waves demands control of both initial and final energy and orbital angular momentum states: unlike for photons, final state post-selection is necessary for particles that cannot be annihilated. We propose a magnetic field-based mechanism for quantum non-demolition measurement of electron OAM. We show that OAM-dependent lensing is produced by an operator of form $U = \exp\left(i\frac{L_z\rho^2}{\hbar b^2}\right)$ where $\rho = \sqrt{x^2+y^2}$ is the radial position operator, L_z is the orbital angular momentum operator along z, and b is the OAM dispersion length. We can physically realize this operator as a term in the time evolution of an electron in magnetic round lens. We discuss prospects and practical challenges for implementation of a lensing orbital angular momentum measurement.

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