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Measuring the Gouy Phase of Matter Waves using Singular Atom Optics with Spinor BECs JUSTIN T. SCHULTZ, AZURE HANSEN, JOSEPH D. MURPHREE, MAITREYI JAYASEELAN, NICHOLAS P. BIGELOW, University of Rochester — The Gouy phase is a propagation-dependent geometric phase found in confined waves as they propagate through a focus. Although it has been observed and studied extensively both in scalar and vector optical beams as well as in electron vortex beams, it has not yet been directly observed in ultracold matter waves. The Schrödinger equation has the same form as the paraxial wave equation from electromagnetism; expansion of a BEC upon release from a trap has the same mathematical form as a beam propagating away from a focus. We employ and extend this analogy between coherent optical beams and coherent matter waves to include spin angular momentum (polarization), which enables us measure the matter wave Gouy phase using coreless vortex spin textures in spinor BECs. Because the Gouy phase is dependent on the orbital angular momentum of the wave, the vortex and core states acquire different Gouy phase shifts. Parameters that are sensitive to the relative phase such as two-dimensional maps of the Stokes parameters rotate during evolution due to this phase difference. Using atom-optic polarimetry we can access the evolution of the atomic Stokes parameters and observe this rotation.

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