Designing the spatial structure of optical vortices

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Optical vortices comprise of photons which possess an external degree of freedom called orbital angular momentum. This is different from the familiar spin angular momentum which is related to the polarization of light. As a result, the transverse beam profile has a helical phase front, which when interfered in a Mach-Zehnder interferometer forms interesting spatial mode profiles. We generate optical vortices using a spiral phase plate, and sculpt various exotic transverse optical structures by interfering co-propagating, counter rotating optical photons emanating from the near field of the phase plate. We expect these optical structures to have broad applications in areas ranging from fundamental atomic physics to material science and quantum state engineering. For example, these exotic optical structures can be imprinted on ultra-cold atoms and used as an inertial sensor for an ever more precise measurement of rotation (such as the earth's rotation).