# Focused azimuthally polarized vector beam and its application on artificial optical magnetism

Mehdi Veysi, Caner Guclu and Filippo Capolino*
*Department of Electrical Engineering and Computer Science, University of California Irvine, CA, 92697, USA*

**f.capolino@uci.edu*

**Abstract**: We describe an Azimuthally Polarized Vector Beam (APVB) focused through a lens, using both plane wave spectral calculations and Fresnel diffraction theory. Such a beam is the superposition of right- and left-hand circularly polarized Laguerre Gaussian (LG) beams having, respectively, the orbital angular momentum states of -1 and +1. APVBs possess electric field purely transverse to the propagation direction; moreover on the beam axis, electric field and transverse components of magnetic field are ideally null, where longitudinal component of magnetic field has a peak. Thanks to the APVB it is possible to create very large magnetic to electric field contrast over an area through a self-standing propagating beam without resorting to use of engineered near-field scattering. Upon focusing the APVB through a lens, the magnetic field intensity along the beam axis is further enhanced. We study extensively the diffraction limited tightly focusing of such beams where we characterize the magnetic field peak and electric field suppression region. The exotic features of magnetic-dominant region of such beams are then exploited in excitation of magnetically polarizable nanostructures where the APVB excites a resonance with a loop-like current. These nanostructures are special in that they are used as building blocks of artificial magnetism at optical frequencies. The possibility of magnetic-dominant excitation of these nanostructures can further enhance the magnetic field. As an example we report magnetic field enhancement over an area where electric field is negligible, when the nanostructure is illuminated by an APVB, using both full-wave simulations and analytical results based on single-dipole approximation. APVBs and their applications utilizing magnetic nanostructures can be valuable in development of optical spectroscopy systems based on magnetic dipolar transitions which are in general weaker than their electric counterparts.