➢ Interaction of Non-classical Light with Simple Material System (T, Vyas)

Research interests are in the areas of quantum optics, nonlinear optics, and laser physics. We are studying the fundamental nature of light and its interaction with simple material systems. Various effects, which cannot be understood from a classical theory of light-matter interaction such as photon antibunching, other nonclassical correlations, quantum discord and entanglement between the dots are being investigated. These studies of quantum effects are important not only fundamentally but also for potential applications in atomic spectroscopy, optical precision measurements, optical computing, optical storage, and optical communication.

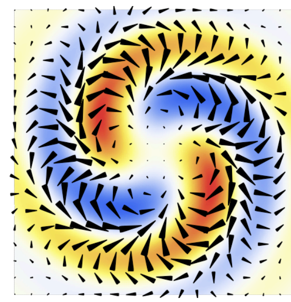

Fig. 6: Cylindrically polarized LG beam.

The undergraduate summer research will be part of our research program to study the properties of non-classical states and their interaction with simple systems consisting of quantum dots and two and three-level atoms. The atom can be in free space or inside an optical cavity. In both cases we will include dissipation due to atomic and cavity decays. The introduction of nonclassical light in the model will allow us to explore regimes, which from the start have no classical analogs. The research will focus on the quantum nature of the atom-field interaction and how it is reflected in the fluctuation and correlation properties of the emitted light.

Another project involves studies of polarization and angular momentum properties of the Maxwell-Gaussian beams. Linearly polarized laser beams are usually modeled as scalar solutions of the paraxial wave equation multiplied by a constant unit polarization vector. This provides an adequate description of laser beams for many purposes. But these solutions do not describe the polarization and focusing properties correctly. Maxwell's equations require that a linearly polarized light beam of finite cross section must be accompanied by small longitudinal polarization and cross polarization components. The project will be to investigate polarization properties of different types of Maxwell-Gaussian beams.

The undergraduate student will work on one of the above mentioned projects and will be involved in developing theoretical models, performing analytic calculations, and computer simulations. Both analytical and computer simulation approach will be followed. REU students will have opportunities to learn about random number generation and statistical methods, computer programming (Mathematica, or Fortran), and numerical techniques. These skills will be useful in many other areas of science, engineering, and even disciplines such as economics and social sciences.