Title: Accessing high-dimensional information of light

Abstract: Acquiring information carried by light/photons is crucial for fundamental studies of information science as well as many applications of light at both quantum and classical level. In this talk, we present some recent work on addressing the challenges of efficiently characterizing high-dimensional photon systems with example applications in secure communication and imaging. First, we describe an implementation of a "perfect sorter" to facilitate high-dimensional free-space secure quantum key distribution using orbital angular momentum of light. We then describe a scan-free "direct" quantum state metrology approach that can measure directly the entire complex-valued state vector charactering a pure quantum state. We demonstrate our approach by measuring of a one-million-dimensional photon transverse spatial state with an improvement by a factor of one million in time and photon efficiency as compared to conventional scanning quantum state tomography. We extend this philosophy to measure a mixed quantum state by showing direct measurement of the entire density matrix of a thousand-dimensional mixed quantum state in a single experimental setup. We also have recently developed a direct tomography method that can fully characterize a vector beam. Based on a similar concept of "direct" measurement, we present a self-interference polarization holographic imaging (Si-Phi) method that can essentially capture both the position and momentum information of light and consequently can lead to the reconstruction of a 3-D incoherent scene in a single shot. At last, we show some recent experiment result of a high-information capacity communication protocol using structured light that is resilient to atmospheric turbulence.

Biography: Zhimin Shi received his Ph.D. degree in Optics from the University of Rochester in 2011. Before that, he received his Bachelor and M.S. degree in Optical Engineering, both with honors, from Zhejiang University in 2001 and 2004, respectively. Dr. Shi is currently holding the position of Assistant Professor at the Department of Physics, The University of South Florida. His research interest falls in the general area of quantum nonlinear photonics. His recent research topics include quantum state metrology, imaging and communication with structured light, quantum information science, slow and fast light, metamaterials, nonlinear plasmonics, and optical techniques using nonclassical nature of light.