Dept. of Physics & Engineering Physics
Fall 2021 Physics Colloquium Series

remotely via ZOOM
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Accessing High-Dimensional Information of Light

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Facebook Reality Labs - Research

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, I will first present a family of direct tomography protocols that can characterize various types of structured light or high-dimensional photon states. First, we show some high-performance mode sorters for OAM states, Laguerre-Gauss modes and Hermite-Gauss modes. We then introduce some scan-free direct tomography protocols that can measure high-dimensional spatial modes, spatial vector modes and partially-coherent modes (mixed states). These direct tomography methods directly relates the readouts to the complex-valued state vector or other quantities that describe the quantum system to be measured, and therefore can significantly reduce the complexity of tomography procedures for high-dimensional states. Moreover, we show that it is possible to design the tomography protocol such that all the information needed to describe the photon states can be acquired in a single experimental setup without any need of scanning. This is particularly interesting for real-time metrology of both quantum and classical photon states. In the second part of the work, I will present some recent work on robust high-information-capacity optical communication protocols in turbulent environment. I will show a turbulence-resilient vector beam based communication scheme as well as a phase conjugation based scheme to realize communication using OAM modes with low crosstalk through a 340m free-space-link. At last, I will also present a vector phase conjugation scheme that can enable 210-spatial mode communication through 1 km of multi-mode fiber. These implementations can lead to practical carryout of high-dimensional optical communications in realistic environment.

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. After taking the faculty position at the Department of Physics, The University of South Florida from 2013 to 2020, he recently joined Facebook Reality Labs – Research and is currently working on new optical and photonic technologies for next generation AR/VR systems. 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. Dr. Shi is a senior member of Optica (formerly OSA) and a life member of SPIE.