Achieving fundamental limits to free-space optical system capacity imposed by atmospheric turbulence

Aniceto Belmonte, Department of Signal Theory and Communications, Technical University of Catalonia, Spain; and Joseph M. Kahn, E. L. Ginzton Laboratory, Department of Electrical Engineering, Stanford University, USA

We need to understand fundamental limits to free-space optical (FSO) system capacity caused by atmospheric turbulence and to recognize transmission schemes that can approach these limits in practice. This is particularly true in spatial-division-multiplexed FSO systems, where our ongoing work shows that the choice of transmit and receive modal bases is crucial for approaching these limits. We consider the problem of finding optimal transmission beams, or eigenmodes, for propagation through the random atmosphere.

Making a realistic assumption that a transmitter has knowledge of atmospheric turbulence statistics, but not the instantaneous state of the atmosphere, we find the optimal transmit and receive bases and show that these stochastic eigenmodes are Laguerre-Gauss modes with beam radius chosen properly relative to the field coherence length in the receiver plane.

For this workshop, we will discuss how transmission of this mode family over a general atmospheric channel are likely to function in FSO, achieving high capacity transmission through increased spatial multiplicity.