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Free-space Optical Communications through Turbulence

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Abstract content
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Due to exponentially increasing internet bandwidth demands, existing subterranean and undersea fiber optic links will soon become saturated in terms of their information capacity, as dictated by the Shannon Limit. Installation of additional fiber optic links is expensive and can only lead to a linear increase in bandwidth. Free space optical communications may provide a solution to this problem by enabling very high bandwidth point-to-point communications between satellites in orbit as well as buildings on the ground, compared to traditional radio-based systems.

Modes carrying Orbital Angular Momentum provide a basis for both modulation and multiplexing due to their orthogonal nature. Both scalar, Laguerre-Gaussian modes as well as vector vortex modes have been used to dramatically increase the information capacity of optical links in lab environments. Outside the lab, however, atmospheric turbulence degrades the orthogonality of the modes upon propagation, lowering their information capacity. It has been suggested that vector modes, due to their weaker coherence compared to scalar modes, are more resilient to atmospheric turbulence and would therefore be a more suitable basis for communication.

Here we present an experimental investigation into whether there is indeed a significant difference between scalar, Laguerre-Gaussian modes and vector vortex modes by propagating them through simulated Kolmogorov turbulence of varying strengths and measuring the crosstalk between modes. We use the results to demonstrate a practical link using a commercial device, potentially increasing the bandwidth by a factor of four.

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Main supervisor (name and email)
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