An Analysis of OAM Modes for mm-Wave Wireless Communications

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Orbital Angular Momentum (OAM) has found many applications in optics, radio astronomy etc. but is only recently being considered for radio communication systems. Due to the inherent orthogonality of OAM modes and the theoretically infinite space of discrete states it offers immense potential for designing high capacity wireless communication links, especially at mm-wave radio frequencies where a vast amount of bandwidth is available. Since OAM is fundamentally different from the techniques based on linear momentum of EM waves employed in present day communication systems, its' properties need to be investigated in detail prior to the actual development of practical OAM communication systems.

The goal of this paper is to quantify the OAM propagation properties of spatially multiplexed OAM modes in a LOS environment as a pre-requisite for designing the vital parameters of an OAM communication system, from antenna topology to the modulation schemes to be used.

A numerical analysis of the phase and intensity profiles of the electric field is performed both in the near-field, at the Rayleigh distance and in the far-field domain to provide helpful information for developing methods for the detection of the OAM state at the receiver side.

The radial spread of the OAM beam vortex is characterized in these domains. Analyzing this phenomena is of great importance since it is in direct relationship to the receiver antenna array aperture, and provides insight to the limitations it would impose on the practical feasibility of an OAM communication system.

The attenuation of higher order OAM modes is further analyzed since it influences the information-carrying capacity of each OAM mode in the system, and subsequently the modulation schemes which can be employed.

Several guidelines which need to be followed when designing OAM communication systems are proposed as a conclusion to the aforementioned analyses.