Study of OAM waves reflection on different types of surfaces or objects at 2.45 GHz

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Application of OAM waves in radiofrequency bands presents very interesting perspectives in communication and radar domains [1] [2]. These applications are based on the orthogonality property between the different topological charges of the received wave. In free space, this property can be conserved along the propagation path, but in a real environment, multipath effects can degrade the orthogonality between OAM modes, in particular due to the reflection on surfaces (ground, buildings …) or objects, and the interference between waves.

We study the reflection of OAM waves on different types of surfaces using the optical ray matrices or ABCD matrices [3], applied to Laguerre-Gaussian (LG) beams. Firstly, LG beam is decomposed into a Cartesian base, using Hermite-Gaussian representation. Secondly, an ABCD matrix representing a specific surface or object, is created. Thirdly, this matrix is applied on each Hermite-Gaussian beams to determine the beam deformation due to the surface curvature. Finally, the Hermite-Gaussian beams are combined to reconstruct the deformed Laguerre-Gaussian beam

Different surfaces or structures are considered: planar surface, concave and convex mirrors, cylinders (Figure 1), spheres (Figure 2) … for different angles of the incident wave on the surface, at the 2.45 GHz frequency. Estimation of the OAM topological charges as the function of the incident topological charge is presented. It is observed that the incident topological charge is mainly conserved after a reflection for a low curvature radius of the surface. Then, for higher curvature radius of the surface, an increase of “parasitic” modes is observed.

References

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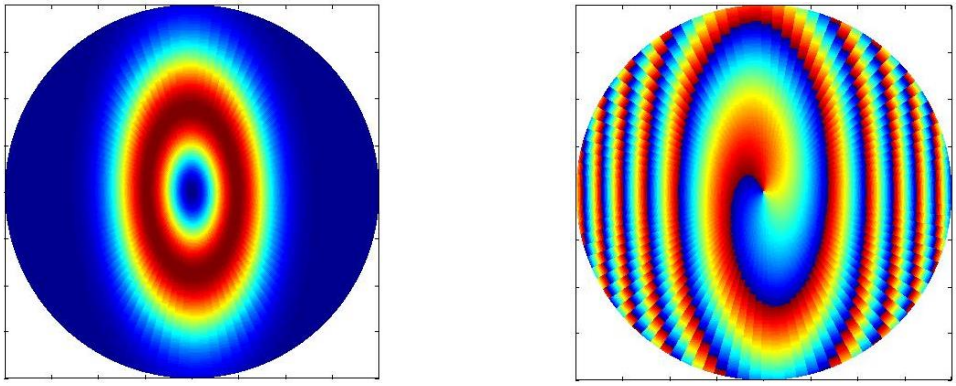
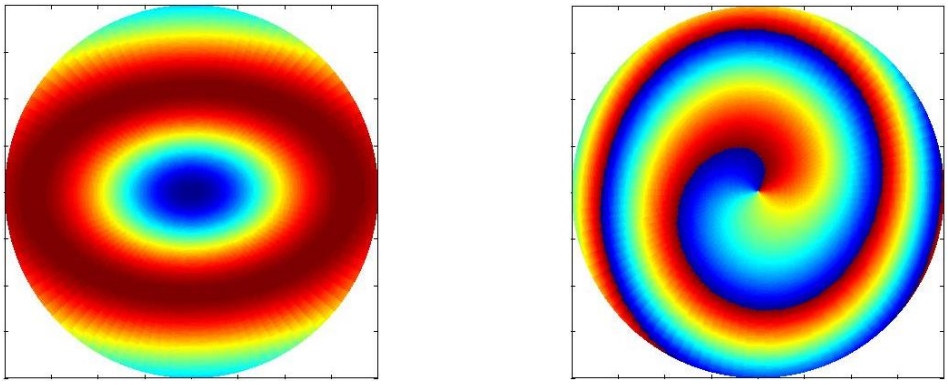


(a) (b)

Figure 1. Intensity (a) and phase (b) of the OAM reflected beam ($\ell = 1$) at normal incidence and a frequency of 2.45 GHz, on a concave cylinder (curvature radius = 5 m).



(a) (b)

Figure 2. Intensity (a) and phase (b) of the OAM reflected beam ($\ell = 1$) at a 60° incidence angle and a frequency of 2.45 GHz, on a sphere (radius = 15 m).