ELLIPTICAL SHAPE AND ORBITAL ANGULAR MOMENTUM OF SPATIOTEMPORAL OPTICAL VORTICES

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Spatiotemporal optical vortices (STOVs) are optical wavepackets carrying orbital angular momentum (OAM) flowing in the spatial and temporal domains [1][2]. STOVs can be seen as propagating in space or evolving in time.

The correctness of the shape and the amount of OAM carried by STOVs is a subject of debate [3][4][5]. Here, we use a ray-optics formalism based on a ray family forming a hyperbolic caustic [3] to understand that the shape and the amount of OAM carried by a STOV depends on the framework used to study the propagation of this type of wavepacket. More precisely, we consider a set of "particles'", each traveling along a ray at the same speed. One particle along a ray presents coordinates $\overrightarrow{r(\xi,t)} = \big(X(\xi,t), Z(\xi,t)\big)$ involving functions allowing setting the initial conditions, and thus, the general shape of the set of particles. We found that STOVs are selectively elliptical either in three-dimensional space or in spacetime, but not in both frameworks simultaneously. We also computed the OAM of the particles running along ray bundles and compare our results with previous studies as regards the breakdown of the total STOV OAM into intrinsic and extrinsic contributions, either in 3D-space or in spacetime.

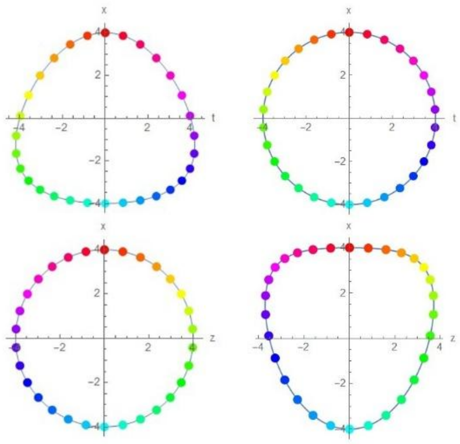

Fig. 1: Ray bundles cross-sections at *z=0* and *t=0* (left: *xz*-STOVs, right: *xt*-STOVs)

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