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Collinear optical vortices with tailored topological charge generated by angular momentum transfer

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Special light beams exhibiting a structured field and carrying orbital angular momentum (OAM) appear as interesting tools in different fields such as particle manipulation, telecommunications or in several areas of light-matter interaction, including materials processing and nonlinear optics, among others. The coupling of spatially varying linear polarization fields (*i.e.*, radial or azimuthal) with spin and orbital angular momenta can be exploited to obtain optical vortices exhibiting different topological charges [1]. We propose a versatile in-line method suitable to obtain collinear optical vortices from focused or collimated beams, being continuous wave or pulsed. We consider a radial input mode of the form $R_m^{l_0}$ where l_0 and m denote the corresponding OAM and polarization azimuthal index respectively (m defined as the number of times that the orientation of the local linear polarization distribution is rotating 2π radians for a variation of 2π radians in the azimuthal coordinate) and demonstrate theoretically that there is a different OAM transfer to the final vortices depending on the m value of the input beam. Numerical simulations of the output vortices agree with the theoretical predictions, which are further confirmed by experimental measurements (see Fig. 1).

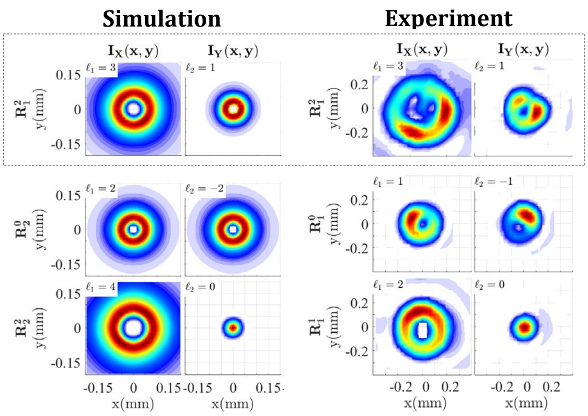

Figure 1. Representation of the x and y components of the spatial intensity profiles in focused beams for several simulated and experimental vortices [1]. For the R_1^2 case (top panels) a direct comparison between the simulated and experimental results can be made, illustrating the good agreement.

For the experiments, we used femtosecond laser pulses and combinations of special structured waveplates (s-waveplates) with standard retarders to generate radial modes with different additional OAMs that were used as input to produce the final optical vortices. Characterization of the obtained vortices was performed by a combination of the STARFISH technique and in-line interferometry [2-4]. Due to the perpendicular linear polarization of the obtained vortices, these can be separated and individually manipulated in potential applications. Thanks to its simplicity, the proposed method has been successfully applied for the generation of time varying optical vortices characterized by a novel technique [5].

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