Interferometric measurement of the complex Orbital Angular Momentum spectrum and spatial mode decomposition of structured light beams

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In general, a paraxial light beam can be decomposed in a complete set of helical modes (for example Laguerre-Gauss modes), which are eigenstates of the orbital angular momentum of light (OAM). Thus, a full characterization of the beam can be achieved by reconstructing both the OAM power spectrum and the radial profile of amplitude and phase of the single helical modes.

Here we propose, and experimentally validate [1], a simple technique based on the analysis of interference patterns obtained superimposing the unknown structured light beam with a known reference field (such as a Gaussian beam) that allows the full reconstruction of a structured light field. The analysis consists into recording the interference pattern and performing, at different radial positions, Fourier transform with respect to the azimuthal variable. The result gives some complex functions of the radial coordinate. Integration of the absolute square along the latter returns the full OAM power spectrum.

Moreover, the radial structure of the Fourier transform allows the reconstruction of radial amplitude and phase of the helical modes that are contained in the OAM spectrum.

The remarkable feature of this technique is that all the information of the light field is contained in a few images (at most four). This, together with the minimal equipment required, makes this new approach a valid tool for structured light characterization experiments [2].

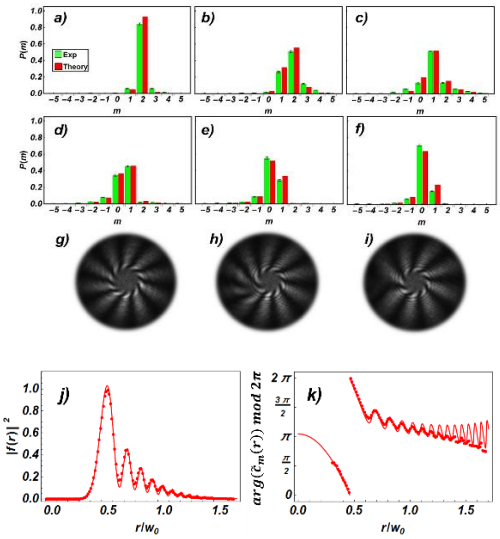

Figure 1: Characterization of a beam obtained displacing a q-plate with respect to an input plane wave. Panels a)-f) show the theoretical and experimental OAM distributions obtained from interference patterns as the ones shown in panels g)-i). Panels j) and k) are, respectively, the experimentally reconstructed amplitude and phase of an OAM eigenmode (red dots) compared with a Hypergeometric-Gaussian beam (red lines).

References

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[2] H. Rubinsztein-Dunlop, A. Forbes, M. Berry, M. Dennis, D. L. Andrews, M. Mansuripur, C. Denz, C. Alpmann, P. Banzer, and T. Bauer *et al.*, J. Opt. **19**, 013001 (2016).