Generation of broad-band Bessel Beams with an SLM

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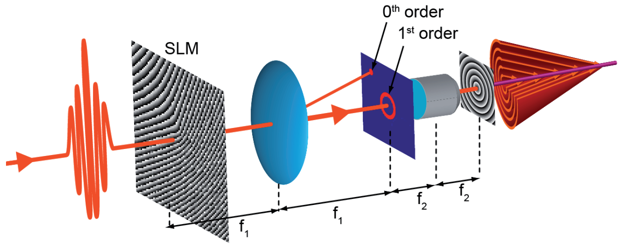
Bessel beams are a class of non-diffracting solution to the propagation equation. They exhibit a constant size of their main lobe over propagation distances that are much longer than the Rayleigh range of Gaussian beams with identical lobe size [1]. Such beam have been widely used for, femto-laser ablation [2], microscopy and optical coherence tomography [3-5].



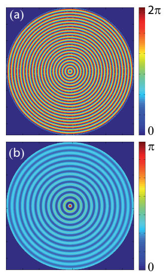


Fig. 1 Schematic of principle showing how to create a Bessel beam. **Fig. 2** Phase mask encoding (a) Conical; (b) Bessel

Experimentally, Bessel beams are mainly generated through the application of a conic phase upon an incident wavefront. Such a conical phase may be generated with an axicon lens or a Spatial Light Modulator (SLM). In the case of a SLM generated Bessel beam a linear phase term is generally added to the conical one to separate diffraction orders (Figure 1).

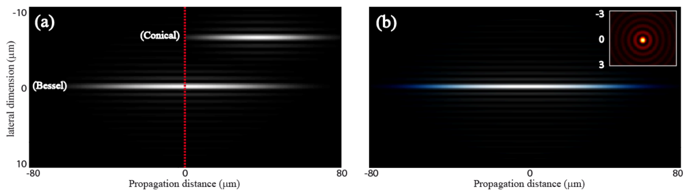


Fig. 3 Results: (a) Bessel beam generated with a conical and a Bessel phase; (b) Bessel beam obtained with the superposition of three wavelength (false color encoding): 0.6-0.7-0.8 μm. The inset is the beam cross section for the propagation distance=0.

Here, we report the generation of micrometric broadband (200nm bandwidth) Bessel Beams with an aspect ratio of more than 100 by a different phase encoding. Although the main configuration remains similar to that of Fig.1, a rotationnaly symmetrical Bessel phase function instead of a conical one is applied (Fig.2). This has the effect to double the Bessel beam propagation distance (Fig.3 (a)) with respect to that of a conical phase encoding. Furthermore, when illuminated with broad band light source, the sub-micrometer Bessel beam propagates achromatically on more than 100 μm (Fig.3 (b)). A similar result, with a much more complex approach, was recently shown that uses a phase masked numerically computed thanks to an iterative phase retrieval algorithm [6]. Although the authors did not proposed an analytical model for the phase mask that was obtained we think, thanks to our own approach, that this must be very close from a Bessel function. We anticipate this configuration may be an interesting alternative for imaging applications that need both resolution, bandwidth and depth imaging (Optical Coherence Tomography, Spectroscopic confocal microscopy).

References

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