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].

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).

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