(P23) Long range quasi-nondiffracting beams carrying orbital angular momentum

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High order Bessel-Gauss (BG) beams have been produced previously through the illumination of an axicon with a Laguerre-Gauss (LG_{pl}) beam with a non-zero azimuthal order (and usually a zero radial order, $p = 0$) [1]. The resulting BG beam is known to carry orbital angular momentum (OAM). In general, the non-diffracting nature of these beams changes abruptly at the boundary of the non-diffracting region from a Bessel function (near-field profile) into a conical field with the characteristic ring-shaped intensity distribution (far-field profile). The significant difference between the near-field and the far-field intensity pattern can be considered a disadvantage of such beams, in contrast to Gaussian beams which preserve their profile while propagating in free space. This change in profile can be overcome (at the expense of the non-diffracting nature of the fields) by a design comprising an axicon and a lens, with deliberately introduced spherical aberration, to produce BG beams with a z-dependent cone angle [2]. Such set ups are costly and difficult to implement.
In this paper we outline an optical design for producing high order Bessel-like beams with a z-dependent cone angle through the use of conventional optical elements, without the need for deliberate aberrations to be included. The design concept is shown graphically in figure 1, and consists of two axicons, Ax_1 and Ax_2, and a spherical lens of focal length f.

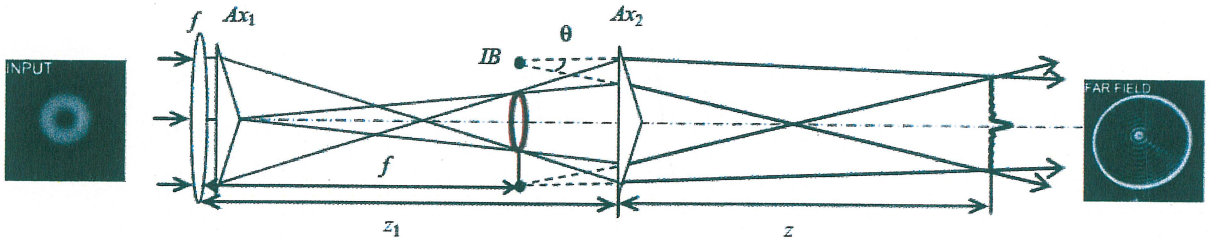

Figure 1: Schematic of the concept, together with the experimentally generated far field intensity (insets).

The pertinent property of this scheme is that the crossing angle of a light ray on the optical axis decreases with increasing distance z, yet remains the same at any distance r from the optical axis for a given z. As a consequence, if the input field is a LG_{0l} beam, the output field is a high order Bessel-Gauss beam carrying OAM, with the property that the far-field profile remains enveloped by a J_l function, and not the conventional annular ring. The fact that aspheric elements with custom aberrations are not required in this design makes the practical implementation of the set-up less complex and less costly.

[1] Arlt J and Dholakia K 2000 Generation of high-order Bessel beams by use of an axicon *Opt. Commun.* 177 297-301.
[2] Goncharov A V, Burvall A and Dainty C 2007 Systematic design of an anastigmatic lens axicon *Appl. Opt.* 46 6076-6080.