Lasing with Propagation Invariant Shaped Beams

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Control of the propagation properties of complex beams is desired for many applications. Here we present a novel method to generate propagation invariant shaped beams. Our method is based on a modified degenerate cavity (MDC) [1], [2], which has a huge number of degrees of freedom (300,000 modes in our system), that can be coupled and controlled. Specifically, the MDC allows direct access to both the x-space and k-space components of the laser beam. Accordingly, placing two amplitude masks, one in x-space and one in k-space, enables control of the output beam. Varying the geometric properties of the mask in x-space changes the shape of the output beam, and varying the geometric properties of the mask in k-space breaks the degeneracy between modes and forms spatial correlations (partial spatial coherence) in the output beam [1].

Here we generate propagation invariant shaped beams by placing different amplitude masks in x-space (applied by a spatial light modulator) and an annular ring in k-space. In this way we place a constraint on the lasing modes: all k-vectors must lie on a cone of k-vectors of equal norm. This constraint is equivalent to demanding that the lasing mode must be a superposition of Bessel beams, and therefore the lasing mode is propagation invariant [3]. Since such a superposition of Bessel beams of a single k-vector is not a complete set, the laser finds an approximated solution that fits the shape of the x-space amplitude mask. Details of our experimental arrangement and results will be presented.

References