Controlling light with spatial light modulators

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Purpose

Adaptive optics is dead: long live spatial light modulators! But is this so? Phase-only spatial light modulators have become a ubiquitous tool in most modern optics laboratories, allowing the simple control of light through complex amplitude modulation in the form of digital holograms. The ease of use and the seemingly unlimited applications make such devices appear invincible. In this talk I will outline complex light modulation with spatial light modulators, highlighting the advantages and disadvantages of such devices. In the process, I will touch on applications ranging from generating non-diffracting beam, to controlling the orbital angular momentum of light. Finally, I will highlight the use of an SLM to control light inside a laser cavity, an application for which the SLM is not suitable, and make a comparison of adaptive mirrors and SLMs for this application.

Methods and Results

In this paper we give an overview of the research undertaken in the Mathematical Optics Group at the CSIR National Laser Centre. We focus in particular on the use of phase-only spatial light modulators (SLMs) for laser beam shaping, and the applications of this in optical trapping and tweezing, controlling the orbital angular momentum of light, generation of non-diffracting fields, simulating aberrations and turbulence in the laboratory, and modal decomposition of multimode laser beams. We also consider briefly the comparison of spatial light modulators and adaptive mirrors for intra-cavity control of the fundamental laser mode. Some of the results for orbital angular momentum fields (Fig. 1), non-diffracting beams (Fig. 2) and general phase control with a SLM (Fig. 3) are shown below.

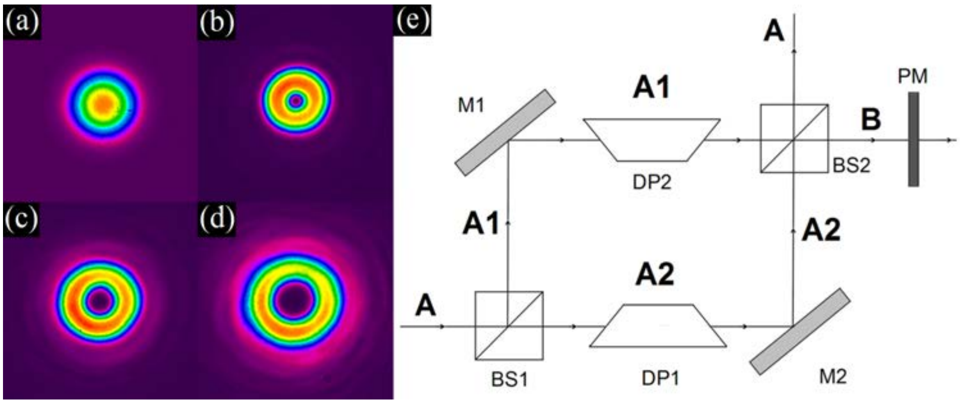

Fig. 1. Gaussian beam (a), converted into single mode Laguerre-Gaussian beams (b)-(d), created by azimuthal phase patterns on a SLM; (e) shows a sorting device for these modes. (from ref. [1])

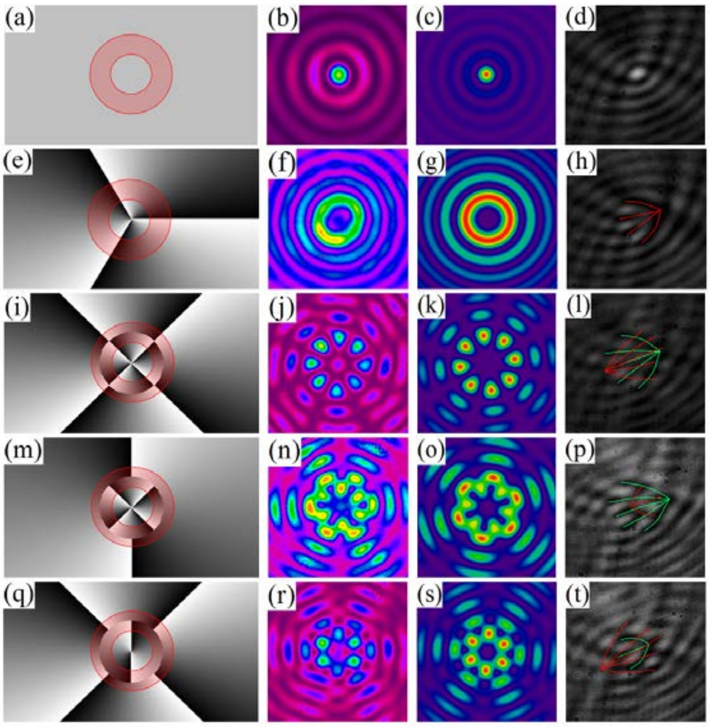

Fig. 2. Multiple phase screens on one SLM can create superpositions of modes, as shown here for superpositions of higher order Bessel beams. The columns from left to right represent the implemented phase screen, the experimentally measured beam, the theoretically predicted beam, and the interference of the superposition with a reference wave. (from ref. [2])

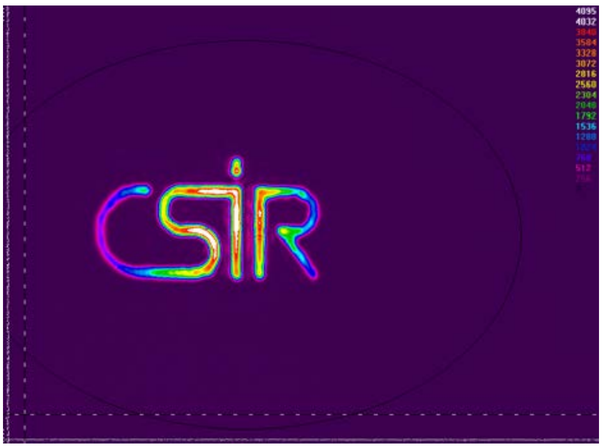

Fig. 3. SLMs have the advantage that arbitrary complex amplitude modulation can be executed even with a phase-only device.

References

1. R. Vasilyeu, A. Dudley, N. Khilo and A. Forbes, “Generating superpositions of higher-order Bessel beams,” Opt. Express **17**, 23389-23395 (2009).

2. Dudley, M. Nock, T. Konrad, F.S. Roux and A. Forbes, “Amplitude damping of Laguerre-Gaussian modes,” Opt. Express **18**, 22789-222795 (2010).