TECHDAYS aveiro

conftele 2015

# Generation of Orbital Angular Momentum Beams

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## Introduction & Motivation

The internet data traffic capacity is rapidly reaching the limits imposed by optical fiber nonlinear effects, having almost exhausted the available degrees of freedom needed to orthogonally multiplex data [4-5]. In this regard, the orbital angular momentum (OAM) of photons may be used as an additional degree of freedom, with potentially unlimited number of achievable orthogonal states which is gathering significant attention within the scientific community [1-3].

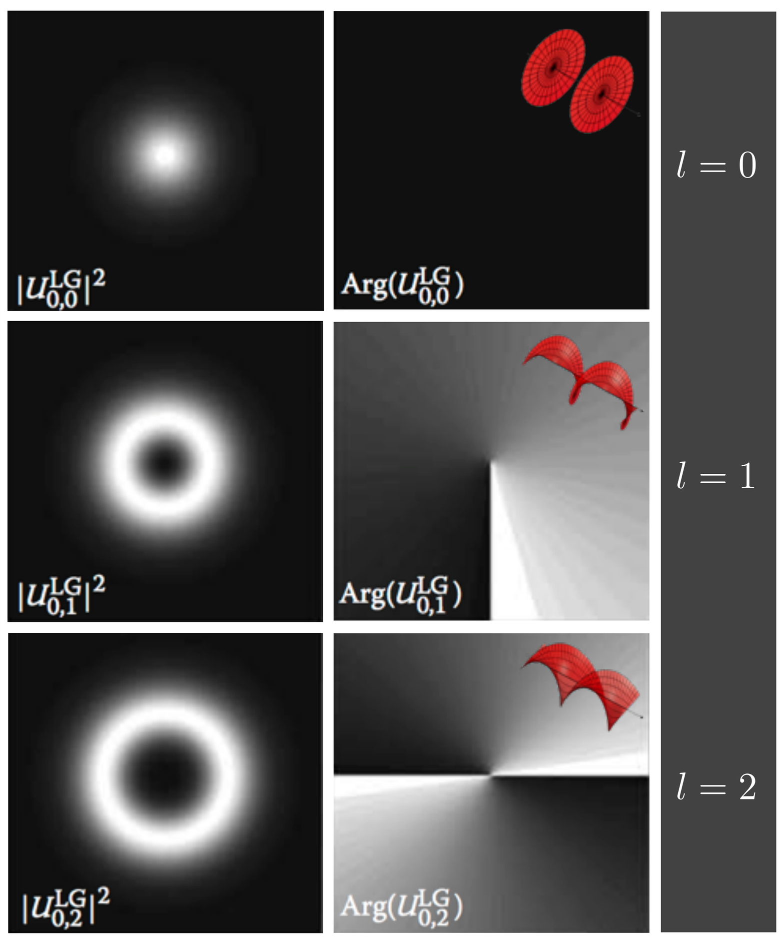
We propose the generation of two types of OAM carrying beams: vortex phased and Laguerre-Gaussian (LG) beams.

## Laguerre-Gaussian beams

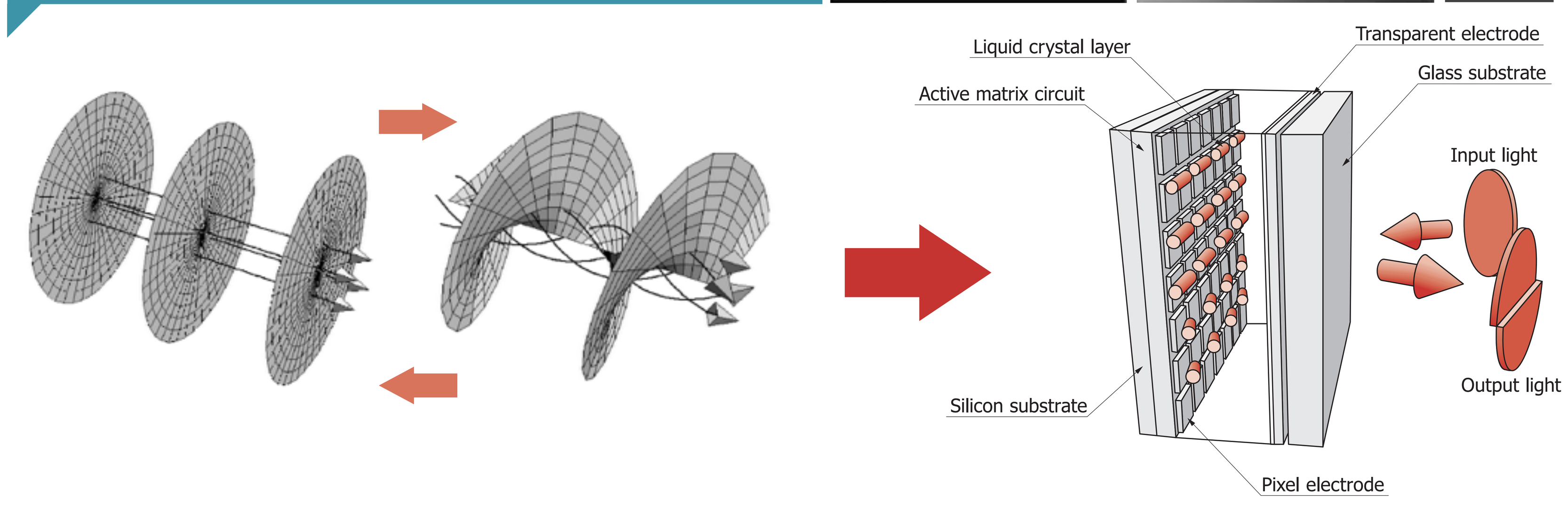
$$u_{pl}(r,\phi,z)=\frac{C}{(1+z^2/z_R^2)^{1/2}}\left(\frac{r\sqrt{2}}{w(z)}\right)^l L_p^l\left(\frac{2r^2}{w^2(z)}\right)$$
$$\times\exp\left(\frac{-r^2}{w^2(z)}\right)\exp\frac{-ikr^2z}{2(z^2+z_R^2)}$$
$$\times\exp\left(i(2p+l+1)\arctan\left(\frac{z}{z_R}\right)\right)$$
$$\times\exp(-il\phi)$$

$$\downarrow$$

$$\exp(il\phi)$$



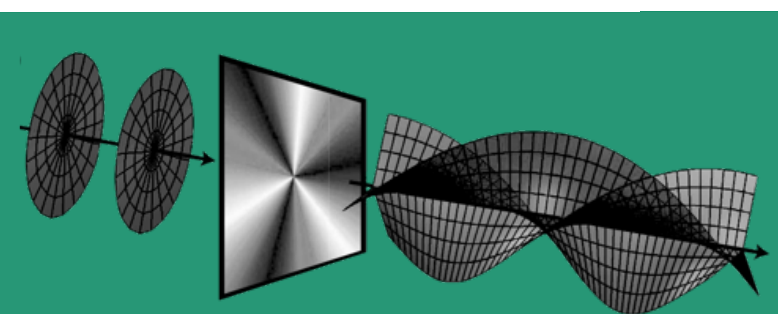

## Helical Phasefronts




## LCoS Spatial Light Modulators → Phase Modulation

By incising a collimated Gaussian beam in the surface of the LCoS SLM loaded with a certain phase pattern, we can shape the beam with an appropriate phase front [4-5].

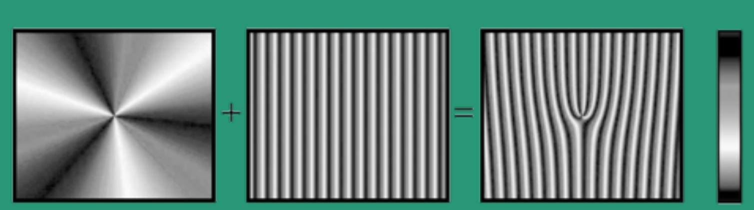
### Vortex



$$T(m,n)=\mathrm{mod}(l\theta,2\pi)$$

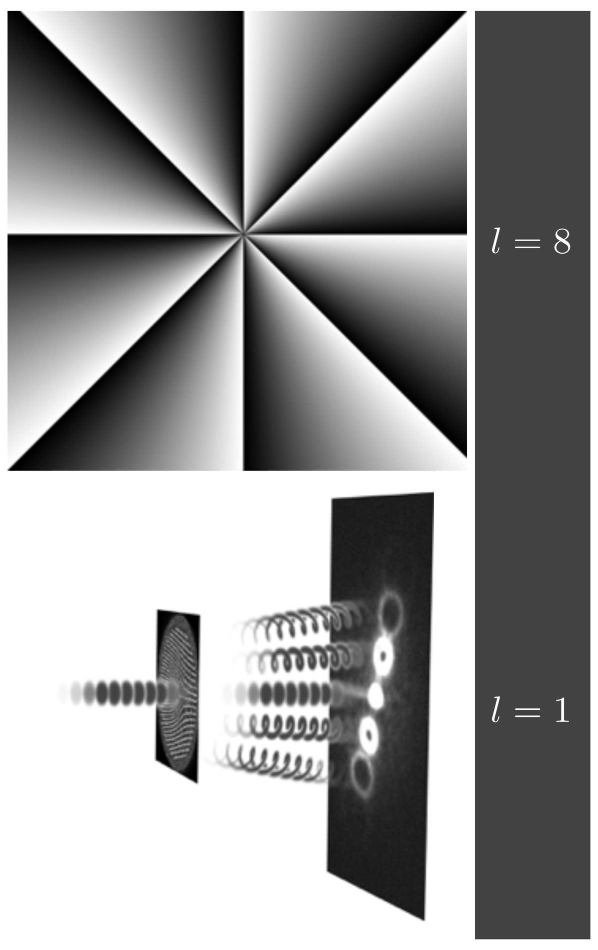
$$l=3$$

### Fork (LG)

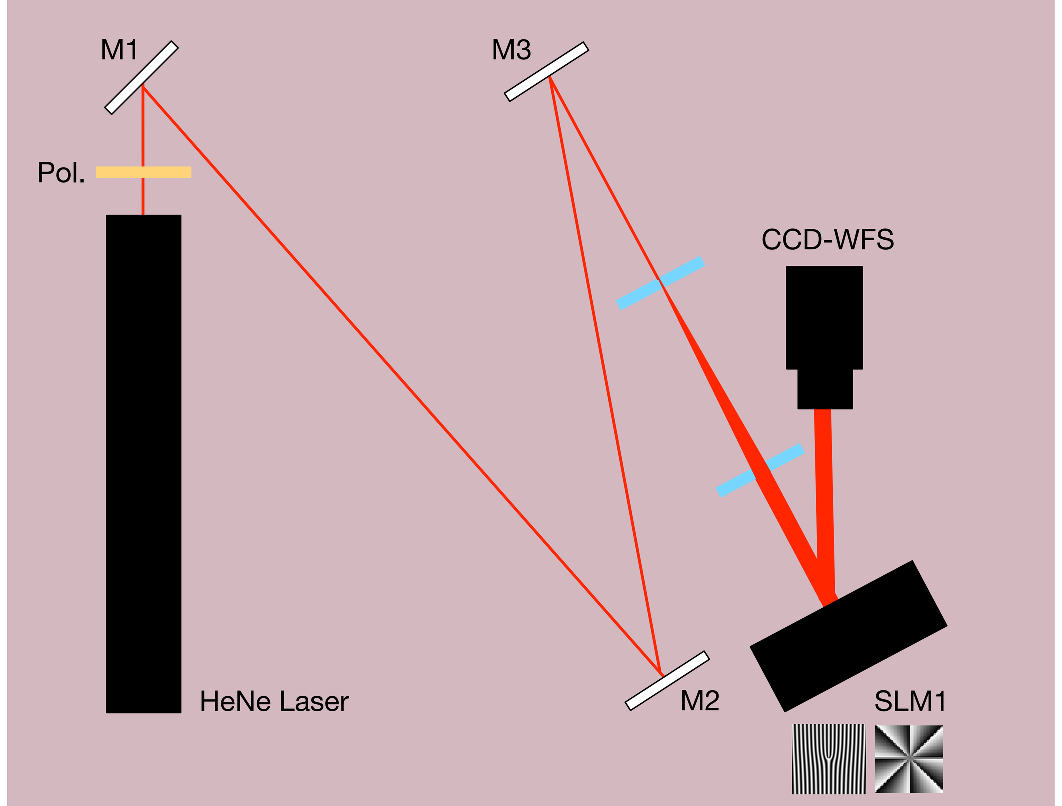


$$T(m,n)=T_0\exp\left[ia\cos\left(l\theta-2\pi\cos\left(l\theta-\frac{2\pi r\cos\theta}{G}\right)\right)\right]$$

$$l=3$$

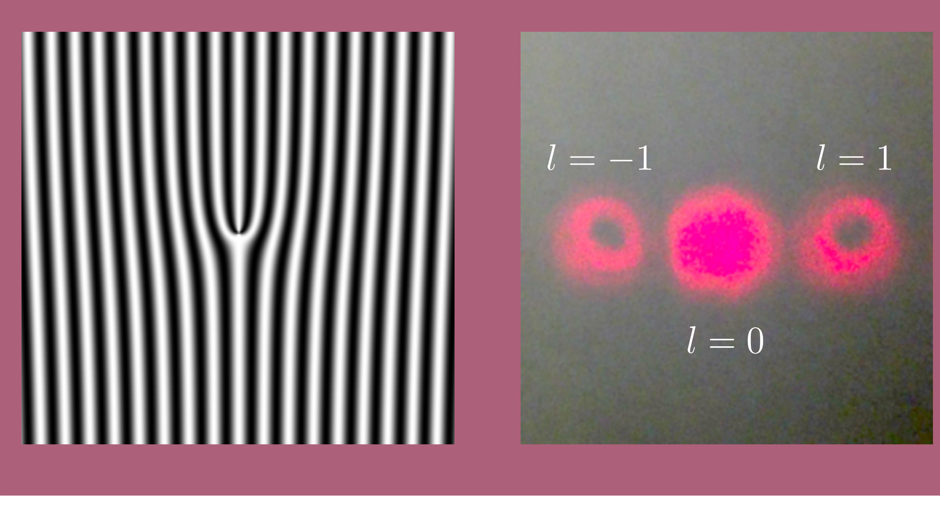



## Experimental Setup




## Forked Diffraction Intensity

A forked diffraction phase pattern decomposes a Gaussian beam into LG components according to the value of the topological charge [5-7].



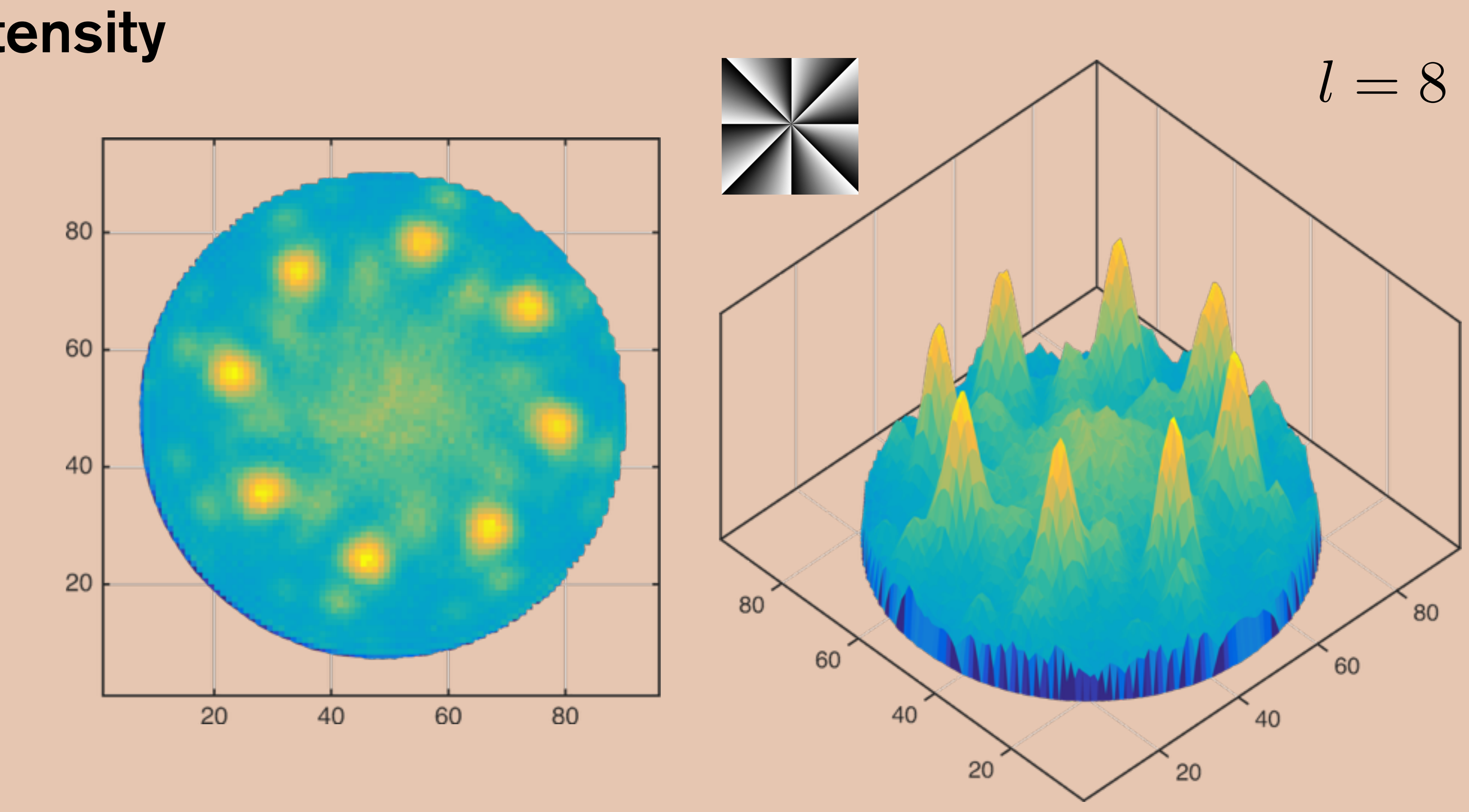

## OAM MUX Signal

$$U(r,\theta,t)=A(r)S(t)\exp(il\theta)$$

These beams can be used as orthogonal signals by using different values for the topological charge [4]. The radius of the intensity ring depends on the topological charge [7] which facilitates multiplexing [4].

## Optical Vortex Intensity

A vortex beam is obtained by imposing a helical phase directly into a Gaussian beam [4], resulting in a ring shaped intensity similar to LG modes since the center singularity relates to the helical phase.

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