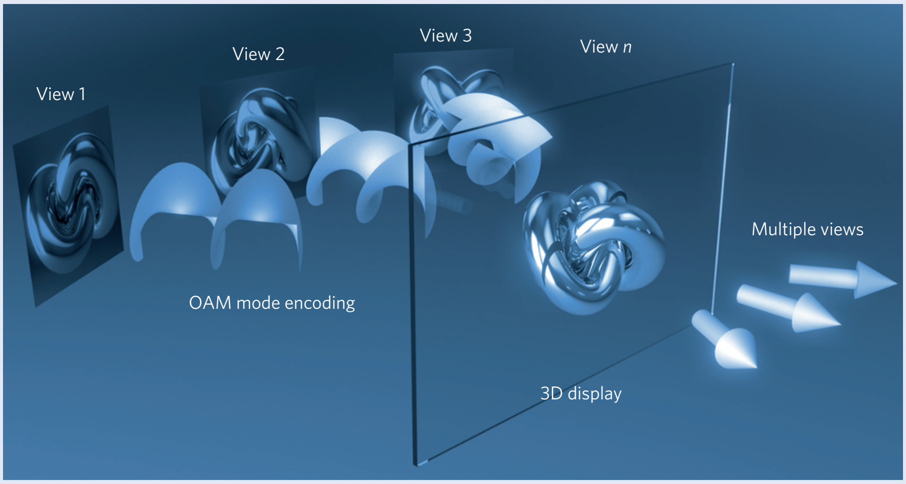
3D DISPLAYS

Momentum multiplexing

Disney, the famous US film studios, may be the last organization that you would expect to be interested in the orbital angular momentum (OAM) of light. However, Disney Research in California has teamed up with the Photonics and Sensors Group at the University of Cambridge, UK to investigate the prospect of constructing future 3D displays based on OAM multiplexing (*J. Opt.* **18,** 085608; 2016).

Research into beams of light with a twisted wavefront that carry OAM has been very active in recent years, largely due to the fact that such beams form a set of an unlimited number of orthogonal modes, each uniquely defined by the amount of twist. This characteristic has already been proven to be useful as a new multiplexing methodology for increasing the data capacity of both free-space and fibre-based optical communication. OAM multiplexing is attractive as it is a new degree of freedom that is potentially compatible with existing common multiplexing schemes based on wavelength, polarization and time.

Now Daping Chu and co-workers are exploring the opportunities for using OAM modes to carry different views of an object, which can then be demultiplexed to create a multi-view 3D display. To date, the researchers have demonstrated a three-view display based on the approach, whereby three different image patterns can be encoded into arrays of OAM beams and then spatially separated for the viewer.



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"There is no problem to scale it up to a much larger number, a few tens of views, at least, in terms of coding the information into a large number of modes," explained Chu. "However, it is technically challenging to multiplex many images as well as separate them in space."

The team create a 9 × 9 square lattice of identical OAM beams by first using a spiral phase plate to create the desired OAM state and then performing a beam copying function using a liquid crystal on silicon spatial light modulator encoded with a Dammann grating. Three such OAM beam arrays each carrying different amounts of topological charge (twist) were then directed onto three image masks that represent distinct views of the object. The beams encoded with the different views were then combined by a beam splitter to create a single multiplexed output.

This output was then demultiplexed into separate beams by an OAM sorter that converts the azimuthal phase gradient of each OAM beam (that is, the amount of twist) into a tilted plane wave that propagates at a distinct angle of propagation. At present, due to the design of the sorter, the angle between each view is very small (approximately 0.015°) compared with a conventional multi-view display (typically 0.7° or more), however, the team says that fabrication of sorters that address this issue should be possible.

As for future work in the area, Chu says that the team is now developing a method to code 2D images with OAM beams directly without a pixelated approach.

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