STRUCTURED VORTEX BEAMS IN COMPLEX MEDIA: CONICAL REFRACTION AND OAM MEMORY

Fatima KHANOM,*[,1] Nawal MOHAMED,[1] Diana GALIAKHMETOVA,[1]
Ivan LOPUSHENKO,[2] Anton SDOBNOV,[2] Alexander BYKOV,[2]
Edik RAFAILOV,[1] and Igor MEGLINSKI[1]

[1]*Aston University, Address, Birmingham, UK;*
[2]*Oulu University, Oulu, Finland*
* *Correspondence:* 190013699@aston.ac.uk *and/or i.meglinski@aston.ac.uk*

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Orbital Angular Momentum (OAM) is a fundamental property of light arising from its helical phase structure and spatial field distribution. Once considered primarily a tool for optical communications, OAM has now emerged as a powerful modality for photonics and biomedical imaging, offering unique advantages for information encoding, tissue diagnostics, and label-free sensing. Recent advances reveal that OAM beams exhibit exceptional resilience in turbid, highly scattering media, retaining their phase structure and topological charge where conventional optical modalities fail. In this work, we systematically investigate the propagation of OAM beams through tissue-like scattering environments, demonstrating their robustness for high-precision detection of disease-related structural and refractive index variations in biological tissues [1,2]. We further compare Laguerre–Gaussian OAM beams with vortex beams generated via conical refraction (CR), introducing a framework for exploiting their distinct spatial evolution and phase memory in complex media. These results establish the foundation for integrating structured vortex beams into next-generation optical diagnostic platforms, unlocking new opportunities for deep-tissue imaging, refractive index mapping, and biomedical sensing in challenging optical environments.

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