MEMORY OF ORBITAL ANGULAR MOMENTUM IN MULTIPLE SCATTERING OF LIGHT

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We explore the prediction capacities of OAM of Laguerre-Gaussian (LG) beams by analyzing their helical wavefront evolution along propagation through a turbid tissue-like scattering medium. The low and multiple scattering of light in a medium are characterized by optical depth (*OD*) as it provides a quantitative measure of the attenuation and scattering strength of light in the medium. A commonly used guideline is that if *OD* ~ 10 or larger the medium is considered as multiple scattering [1], whereas in low scattering regime *OD* is typically low (*OD* ~ 1-6) [2]. We found that the OAM of the LG beam propagated through the turbid scattering medium still remains preserved as presented in Figure 1, considered as a manifestation of the memory of OAM. In a low scattering medium (*OD* = 2), the LG beam propagates with minimal disruption, enabling it to maintain its initial OAM state and doughnut-like spatial intensity profile [3], as well as helical phase structure of LG beam (Fig.1-a). The multiple scattering (*OD* = 10) results in a diffusive spread of the LG beam's intensity profile and the disruption of the helical phase front, leading to creation of complex speckle pattern (see Fig.1-b).

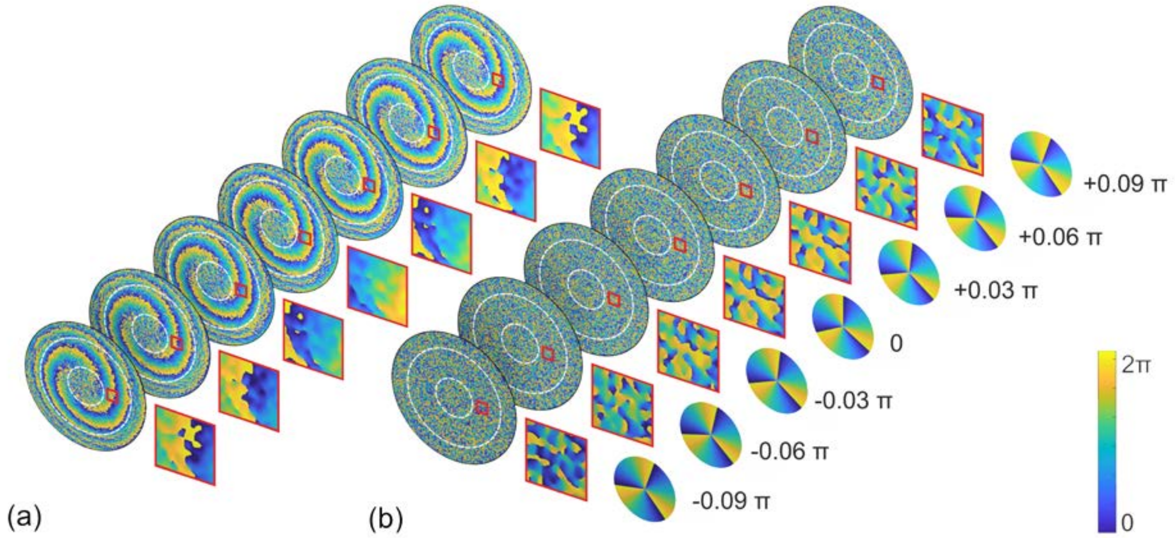

Fig.1: Memory of OAM in multiple scattering of light observed experimentally as the twist of the transverse phase of the LG^3_0 beam, propagated through (a) low (*OD* = 2) and (b) highly (*OD* = 10) scattering medium, versus the initial LG beam phase modulation in a range of – 9π to 9π (×10^{-2}).

The results, obtained both experimentally and computationally with the numerical simulation, agree well to each other, and suggest that influence of spatial dispersion on the retardation of OAM in a turbid tissue-like scattering medium depends on the refractive index of the medium, scattering properties, such as anisotropy of scattering and/or size distribution of scattering particles, as well as the initial OAM state of the LG beam. The results confirm fascinating opportunities of the exploiting OAM light in biomedical applications, e.g. such as non-invasive trans-cutaneous glucose diagnosis and optical communication through biological tissues and other optically dense media.

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