PROPAGATION OF OAM AND POLARIZATION THROUGH RED BLOOD CELL SUSPENSION

Anna BEZRYADINA*,[1] Nicolas PEREZ,[1,2] Daryl PREECE,[2,3] Robert WILSON[3,4]

[1] Department of Physics and Astronomy, California State University Northridge, 18111 Nordhoff St., Northridge, CA, USA
[2] Department of Biomedical Engineering, University of California, Irvine, 3120 Natural Sciences II, Irvine, CA, USA
[3] Beckman Laser Institute, University of California, Irvine, 1002 Health Sciences Rd., Irvine, CA, USA
[4] Department of Medicine, University of California, 1001 Health Sciences Rd., Irvine, Irvine, CA, USA
**anna.bezryadina@csun.edu*

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The study of nonlinear processes and scattering in biological systems is critical for the development of photonic sensors and innovative low-loss transmission methods for deep-tissue imaging. In this work, we show how biological waveguides can conserve photonic states of light, allowing for the transmission of high bandwidth information through scattering media. We utilized the nonlinear self-trapping and self-guiding of a laser beam to create several centimeters long optically self-arranged biological waveguides in suspensions of sheep red blood cells. According to the forward-scattering theoretical model, cells in suspensions are drawn to the beam center by the optical gradient force and propelled along it by the scattering force [1]. Because live cells have a slightly higher index of refraction than the surrounding medium, optical force-induced nonlinearity causes self-lensing along the beam path and the formation of biological waveguides. In this study, we demonstrate the conservation of polarization state and orbital angular momentum (OAM) of the transmitted light through these RBC waveguides [2]. The ability to create waveguides and preserve optical properties after multiple scattering events may enhance communication bandwidth with minimal loss through scattering medium. Finally, a pump/probe-type nonlinear coupling has been used to broaden the range of transmitted wavelength through the scattering media, where the self-formed waveguide conducts weaker light at different wavelengths [2,3]. We anticipate that these investigations will aid in the development of alternative techniques for transmitting energy and information through scattering media, as required in communications, deep-tissue imaging, therapy, and diagnostics.

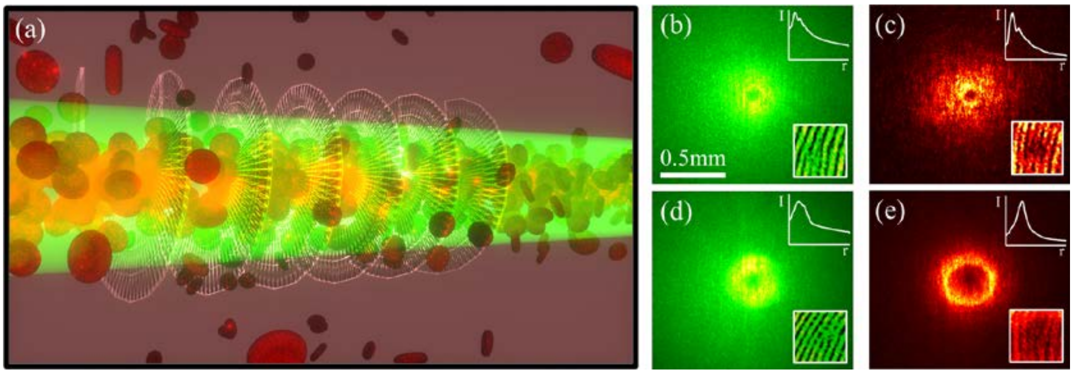

Fig. 1: OAM propagation within RBC waveguide. (a) Illustration of RBCs forming a waveguide of light and OAM propagates within the waveguide. (b,c) Linear diffraction and scattering of 532 nm and 780 nm vortex beams at low laser power through RBC suspensions. (d,e) Nonlinear self-trapping and self-focusing of the vortex beams at high power. The inserts are normalized azimuthally radial intensity profiles and interferograms.

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