Structured Light-Matter Interactions in Engineered Photonic Media

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Abstract: Structured light and structured matter are two fascinating branches of modern optics that recently started having a significant impact on each other. The synergy of complex beams, such as the beams carrying an orbital angular momentum (OAM), with nanostructured engineered media is likely to bring new dimensions to the science and applications of structured light, ranging from fundamentally new regimes of spin-orbit interaction to novel ways of information encoding for the future optical communication systems. We will discuss fundamental optical phenomena at the interface of singular and nonlinear optics in engineered optical media and show that the unique optical properties of optical nanostructures open unlimited prospects to "engineer" light itself. For example, by exploiting the emerging non-Hermitian photonics design at an exceptional point, we demonstrate a microring laser generating a single-mode OAM vortex lasing with the ability to precisely define the topological charge of the OAM mode. We show that the polarization associated with OAM lasing can be further manipulated on demand, creating a radially polarized vortex emission. Our OAM microlaser could find applications in the next generation of integrated optoelectronic devices for optical communications. Next, we discuss our recent experimental studies of nonlinear structured light propagation and necklace beam formation in soft-matter media, such as colloidal suspensions, that offer a promising platform for engineering polarizabilities as well as large and tunable nonlinearities. These results may be of interest for imaging and spectroscopic applications using light propagating in highly scattering biological and chemical media. Finally, we discuss other on-going projects and research directions in our group, including nonlinear topological photonics.

Bio: Natalia Litchinitser is a Professor of Electrical and Computer Engineering and a Professor of Physics at Duke University. Her research focuses on fundamental properties and applications structured light in engineered nanosctructures, metamaterials, topological photonics and nonlinear optics. Natalia M. Litchinitser earned her Ph.D. degree in Electrical Engineering from the Illinois Institute of Technology and a Master's degree in Physics from Moscow State University in Russia. She completed her postdoctoral training at the Institute of Optics, University of Rochester in 2000. Natalia Litchinitser previously was a Professor of Electrical Engineering at the University at Buffalo, The State University of New York, a Member of Technical Staff at Bell Laboratories, Lucent Technologies and of a Senior Member of Technical Staff at Tyco Submarine Systems. She authored 7 invited book chapters and over 200 journal and conference research papers. She is a Fellow of the Optical Society of America, Fellow of the American Physical Society, and a Senior Member of the IEEE.