SAOT erlangen graduate school in advanced optical technologies

International Conference on Advanced Optical Technologies
University of Erlangen-Nürnberg, March 13th – 15th 2019

Wavefront Control in Linear and Nonlinear Multimode Fibers

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Light control in complex media has lately attracted significant interest. Recent progress in wavefront shaping and the physics of light scattering are opening new application opportunities. In particular, multimode fibers are important to deliver information in communications and to shape power in laser technologies. In the linear regime, control of light propagation has recently enabled ultrathin fiber endoscopy. In the nonlinear regime, light propagation in multimode fibers is enabling the discovery of new phenomena and the development of novel nonlinear systems. In effect, pulse propagation in multimode fibers expands the possibilities of linear mode control through different intermodal interactions and spatio-temporal dynamics.

In this talk we will present recent advances in multimode fiber mode control using wavefront shaping, including interesting physical phenomena resulting from linear and nonlinear interactions. We control the fiber output light using spatial light modulators at the input and real-time optimization. For example, we shape a Raman scattering cascade, manipulating the spectrum, shifting, enhancing or depleting spectral peaks [1].

Application of multimode fibers in thin endoscopes is of major interest to monitor the neural activity deep in the brain of model animals. Even though coherent light propagating inside multimode fibers is randomized, wavefront shaping enables projection of a focal spot onto the sample, while the fluorescent emission signal is detected at the proximal tip of the fiber to form an image point by point [2].

In order to accelerate data acquisition, we further present a compressive random sampling approach utilizing the speckle patterns generated by fiber [3]. Furthermore, spatial light modulation speed is critical for real-time and in-vivo imaging applications. Existing devices present limited modulation speeds that have precluded advances in the field. We will present novel strategies for phase control that are faster than any other prior approaches by more than one order of magnitude [4].

References

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