Project 3.12 Study of spatiotemporal dynamics of ultrafast fiber lasers

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Background:

Fiber lasers have been under study for around six decades and yet continue to garner significant research attention. Recently, they have achieved remarkable advancements in energy output, beam quality, and operational stability, becoming a key enabling technology in the contemporary world. Although ultrafast fiber lasers are now well-established alternatives to solid-state lasers, conventional single-mode fiber-based laser technology still faces limitations on wavelength coverage and energy enhancement. Consequently, ongoing research efforts are focused on leveraging existing technologies to develop innovative fiber laser systems.

Multimode fibers (MMFs) have seen a resurgence of interest in recent years as a potential solution for wavelength conversion, beam reshaping and in upscaling the power of ultrafast fiber lasers. Noteworthy nonlinear phenomena observed in MMFs include Kerr beam self- cleaning, the generation of parametric waves via Geometric Parametric Instabilities, multimode solitons, and spatiotemporal mode-locking. The dynamics of spatiotemporal nonlinear waves still lack comprehensive understanding and present numerous fundamental questions. Specifically, the nascent field of multimode fiber lasers remains largely unexplored, offering promising prospects for new physics and further energy scaling. However, controlling the dynamics of multimode fiber lasers poses significant challenges, necessitating extensive further studies for practical deployment.

Aim:

To develop multimode fiber oscillators and to explore their intricate dynamics. The aim is to advance current understanding of the physics underlying spatiotemporal mode-locking, to gain deeper insights into the advantages and limitations of this novel laser technology. We will study the role of polarization and the modal content of the output beam. Artificial intelligence will be employed to analyze to which extend various ultrafast multimode dynamics can be accessible in controllable way.

Requirements:

- Master's degree in Physics or related field;
- knowledge in the field of fiber laser, optics, nonlinear optics, fiber optics, or related;
- scientific curiosity;
- strong motivation for research work, in particular for experimental work (experience in laboratory work will be appreciated);
- strong ability to work independently and in a team;
- strong communication skills;
- fluent English.