Dynamics of Stimulated Raman Scattering process in an all-normal-dispersion fiber lasers

Today lasers are everywhere. Everyday each one of us takes benefits from the unique properties of the laser light, for example during shopping when we use laser scanners or when we put CD in its pocket. What is more lasers are used in many industrial applications and in the scientific laboratories enormous number of experiments is based on the laser sources. Now fiber lasers are becoming more and more popular. In this kind of lasers light is maintain inside the optical fiber, which makes the laser very environmentally stable. In addition, fiber laser setups can be very compact and cost-efficient. In proposed project we want to investigate some aspects of ultra-short laser pulse dynamics in the all-fiber laser cavity.

When the ultra-short laser pulse with high intensity is propagating inside the optical fiber core (with a diameter ten times smaller than the human hair) nonlinear optical phenomena are affecting pulse propagation. The main research objective of the project is to investigate the influence of nonlinear effects on the pulse propagation inside the all-fiber cavity. Especially we will be focused on the influence of stimulated Raman scattering process which affects pulse spectrum during propagation in nonlinear media. In the project we will investigate the all-fiber all-normal dispersion laser. In case of measurements of ultra-short laser pulses with pulse duration million times shorter than the flash of digital camera lamp special techniques have to be incorporated. Standard spectrometers or spectrum analyzers are not enough. We will develop diagnostic setup which will enable to register sequence of spectra generated from the laser. By inducing large group delay dispersion between different spectral components of the pulse we will achieve pulses stretched up to the nanosecond time scale. The spectrum of the pulse will be mapped on the time waveform. Because of that we will be able to measure real-time shot-to-shot stability of the spectra by means of ultra-fast photodiode and wide-bandwidth oscilloscope. The experiments will be supported by extensive numerical simulations of pulse propagation inside the all-fiber cavity.

Fiber lasers are becoming more and more popular not only from their excellent performance, which is now comparable with solid state lasers but also because complicated and fascinating nonlinear dynamics that take place within the cavity. The simultaneous observation of stable laser pulses and spectral components generated in the stimulated Raman scattering process is an excellent opportunity to investigate how stochastic process which has its start in every roundtrip is affecting pulse parameters and pulse train stability. Thorough investigation of the proposed phenomena can stimulate innovative all-fiber cavity designs and improve work of current configurations.