LABORATORY FOR LIGHTWAVE METROLOGY

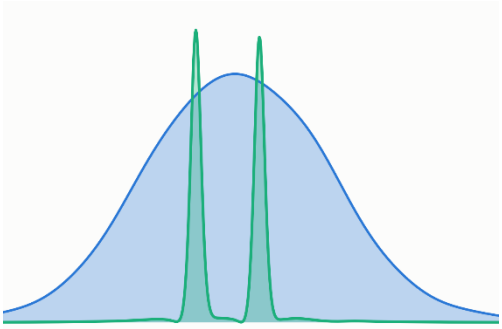
RPTU Rheinland-Pfälzische Technische Universität Kaiserslautern Landau

MSc Thesis at the Laboratory of Lightwave Metrology, Prof. Ioachim Pupeza

Temporal Solitons in Nonlinear Enhancement Cavities

Temporal solitons are ultrashort optical pulses that maintain a stable shape through a balance between nonlinear and dispersive effects. In a coherently driven enhancement cavity, this balance additionally involves optical losses, external driving, and laser–cavity detuning. Introducing a Kerr nonlinear medium into a femtosecond enhancement cavity can therefore create stable temporal cavity solitons with properties that differ substantially from those of the incident laser pulses. Such states offer the possibility of simultaneously enhancing the intracavity peak power, compressing the pulse duration, and stabilizing the circulating waveform, making them promising for high-field nonlinear optics and cavity-enhanced frequency conversion. Beyond individual solitons, these cavities can support multi-soliton configurations and more complex dynamical states.

This MSc thesis will combine numerical simulations with experimental work on a nonlinear femtosecond enhancement cavity. The numerical part may include the implementation of a nonlinear cavity model based on pulse propagation over successive cavity round trips or a field description. The student will investigate how dispersion, Kerr nonlinearity, cavity losses, input power, and laser–cavity detuning determine the formation, stability, and properties of single and multi-soliton states. The experimental part can include the integration of a nonlinear medium into an enhancement cavity, cavity alignment and stabilization, controlled scanning of relevant operating parameters, and measurements of the intracavity power, optical spectrum, pulse duration, and stability. Numerical and experimental results will be compared to identify the parameter ranges for soliton formation and to explore soliton interactions, multi-soliton configurations, and transitions to more complex nonlinear states. The project is intended as an MSc thesis and will provide experience in ultrafast optics, nonlinear dynamics, numerical modelling, laser stabilization, and experimental data analysis.



Lilienfein, N., Hofer, C., Högner, M. et al. Temporal solitons in free-space femtosecond enhancement cavities. Nature Photon 13, 214–218 (2019)

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