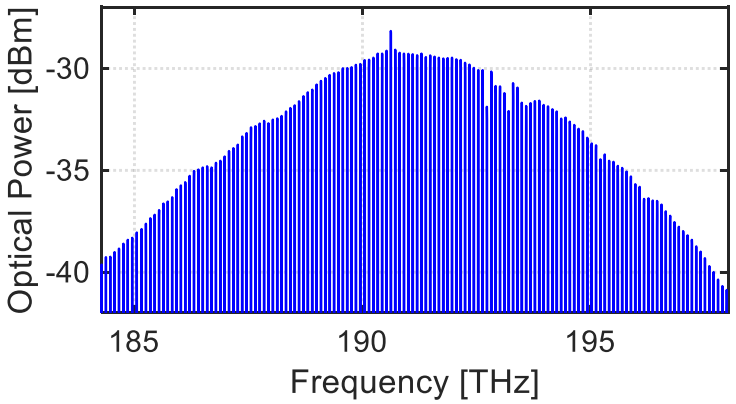
Master Thesis: Fast and high resolution spectroscopy using Kerr Soliton frequency combs

Karlsruhe Institute of Technology

Spectroscopy is a fundamental method for probe analysis in science and industry. Typical methods deploy either a broadband light source or a swept-laser source to analyze the transmittance of the respective sample. While the first approach can reach short duty cycles, it lacks spectral resolution and vice versa for the other one.
We implement an approach based on dissipative Kerr soliton (DKS) frequency combs [1], that may achieve both a high resolution and a short duty cycle, which has not been possible yet. DKS are ultrashort optical pulses, generated in nonlinear optical microcavities, that feature a large optical bandwidth (~ 10 THz) as well as a large free spectral range (~100 GHz). In 2016, these unique features were used at the IPQ for data transmission [2] as well as a distance metrology [3], receiving considerable attention and at the same time demonstrating the DKS vast potential for practical applications.

Your tasks:

- Conceptual work: In discussion with your supervisor, you elaborate an optimized setup scheme as well as the desired system operation point in terms of resolution and acquisition time
- Lab work: You build up and run a complex optical-fiber based setup including high-power optical devices and high speed RF-electronics. You perform actual measurements on gas samples.
- Data evaluation and interpretation: Digital signal processing is a considerable part of this experiment. You learn how to process large amounts of raw data into results via Matlab.



Kerr soliton frequency combs – optical rulers

Interested? More detailed information here:

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[1] Herr et al.: **Soliton mode-locking in optical microresonators**, *Nature Photonics*, *8*(2), 145–152, (2013).
[2] Marin-Palomo et al.: **Microresonator solitons for massively parallel coherent optical communications**. *Nature Publishing Group*, *546*(7657), 274–279, (2016).
[3] Ganin et al.: **Ultrafast Dual-Comb Distance Metrology Using Dissipative Kerr Solitons**. *Conference on Lasers and Electro-Optics*, (Optical Society of America, 2017) p. STh4L.6.