TEXAS MATERIALS INSTITUTE
Materials Science & Engineering
THE UNIVERSITY OF TEXAS AT AUSTIN

TMI Seminar Series

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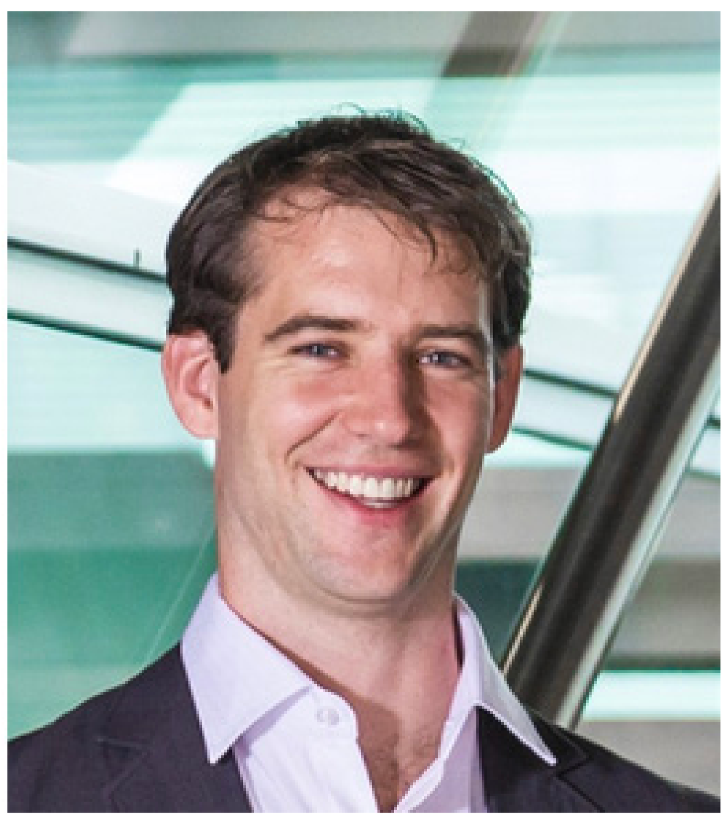
IRsweep AG
Switzerland

High-speed mid-infrared spectroscopy with quantum cascade laser frequency combs



Friday, February 28th
1:00 - 2:00 PM
ETC 2.114

Frequency comb spectroscopy is a promising development, allowing for higher resolutions, faster acquisitions, and higher throughput, especially when compared with non-laser based spectroscopic techniques. We have developed a spectrometer based on quantum cascade lasers, combining many advantages of dual comb spectroscopy with the relative affordability and ease of use of semiconductor lasers.

The method of dual-comb spectroscopy employs broadband lasers emitting hundreds of wavelengths simultaneously, enabling studies of the time evolution of multiple molecular absorption features. The recent advent of quantum cascade laser based mid-infrared frequency combs and the demonstration of their suitability for dual-comb spectroscopy led to the integration of the technique into a spectrometer. This spectrometer is based on two quantum cascade laser frequency comb sources that are overlaid to produce a heterodyne beating signal.

As the spectrometer contains no moving parts, a careful selection of the mode spacings allows for spectra to be acquired on a sub-microsecond timescale, and this can be done continuously for hundreds of milliseconds. The bright laser sources allow a combination of low noise (1 mOD at 100 μs) with high spectral resolution (< 0.0001 cm-1) to be achieved. Additionally, optically dense samples can be probed, for example affording measurements through highly absorbing water backgrounds. Validation of the method was done by comparing time-resolved dual comb spectroscopy measurements of a protein photocycle to an equivalent step-scan FTIR experiment. Closely matching spectral and kinetic behavior was found. In this presentation, we will give a technical introduction to the dual-comb technique and its implications for infrared spectroscopy. Then, we will present a range of applications such as high-resolution gas measurements, high-sensitivity detection in water matrix, and high-speed observation of chemical reaction kinetics.

About Dr. Mangold

Since 2015, Markus' main focus was the technical development of IRsweep's spectrometer. While co-founding IRsweep, he developed high-sensitivity trace gas sensors as a postdoc in the Air Pollution / Environmental Technology lab at Empa. For one of these sensors, he was awarded the best innovation award at the European Photonics Innovation Village 2014. He received his PhD in Physics from TU Munich and his Master of Science in Nanotechnology from the University of Basel.