RD. MINI-SYMPOSIUM: PRECISION/FREQUENCY COMBS

THURSDAY, JUNE 24, 2010 – 8:30 am

Room: 1015 McPHERSON LAB

Chair: BEN McCALL, University of Illinois, Urbana, Illinois

RD01 *INVITED TALK* **30 min 8:30**

BROADBAND SPECTROSCOPY WITH DUAL COMBS AND CAVITY ENHANCEMENT

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Classical FTIRs handle the task of massively parallel spectroscopic probing by interferometric detection. In contrast a frequency comb Fourier transform spectrometer (FC-FTS) retains the principle of combining two interferometer beams but uses two inputs from two independent sources. Thus we can offset their frequencies to facilitate multifrequency heterodyne signal processing. The advantages of this spectrometer compared with the classical FTIR include ease of operation (no cumbersome moving delay lines), speed of acquisition (18 μs demonstrated), collimated long-distance propagation, possibly diffraction-limited microscopic probing, and mid infrared as well as THz operation if necessary.
In a recent proof of principle experiment we have dramatically improved the sensitivity by the implementation of an enhancement cavity around the probing volume[a]. We recorded, within 18 μs, spectra of the ammonia 1.0 μm overtone bands comprising 1500 spectral elements and spanning 20 nm with 4.5 GHz resolution and a noise-equivalent-absorption at one-second-averaging of 1 10^{-10}cm^{-1}Hz$^{-1/2}$, thus opening a route to time-resolved spectroscopy of rapidly-evolving single-events. Since FC-FTS only needs one detector that is easily available in practically all spectral regions, it can be envisioned that cavity-enhanced FC-FTS will assume a position of dominance for the measurements of real-time ultra-sensitive spectra in the molecular fingerprint region.

[a] B. Bernhardt et. al., *Nature Photonics* **4** (55), January 2010

RD02 **15 min 9:05**

TUNABLE LASER SPECTROSCOPY REFERENCED WITH DUAL FREQUENCY COMBS

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Frequency combs provide broadband spectroscopic measurements with high frequency accuracy and precision. However, because the comb power is distributed over a broad spectrum, the sensitivity can be low unless some form of multiplexed detection or cavity enhancement is used. In contrast, tunable laser spectroscopy can achieve much higher sensitivities because the full laser power is within the measured frequency window, but the frequency accuracy and precision of a rapidly tuned laser is challenging to characterize and control. We propose to combine the advantages of these two forms of spectroscopy by performing tunable cw laser spectroscopy in conjunction with a dual frequency comb setup. The cw laser would provide broadband high SNR measurements of a samples transmission spectrum on a single detector, while dual frequency combs would provide absolute instantaneous frequency measurements of the cw laser. Preliminary measurements characterizing a tunable laser have demonstrated Kilohertz frequency accuracy and resolution with a measurement time of a few milliseconds over a 25 nm band around 1550 nm.