Laser Pulse Shaping and Coherent Control of Molecules, *Brijuni, Croatia, August 26th - 31st, 2007.*

Frequency Comb spectroscopy from IR to XUV

C. Gohle[1], A. Renault[1], D.Z. Kandula[1], A.L. Wolf[1], W. Ubachs[1], K.S.E. Eikema[1],

A. Ozawa[2], B. Bernhardt[2], B. Stein[2], A. Schliesser[2], Th. Udem[2], T.W. Hänsch[2]

[1]*Laser Centre, Vrije Universiteit Amsterdam, DeBoelelaan 1081, 1081 HV Amsterdam*

[2]*Max-Planck-Institut für Quantenoptik, Hans-Kopfermannstraße 1, 85748 Garching*

cgohle@few.vu.nl

Femtosecond frequency combs provide a unique combination of hundreds of terahertz bandwidth and high temporal coherence of up to a second. This has been exploited for optical frequency metrology (the driving power of the invention) and direct electric field control in attosecond physics. Using the output from a frequency comb for direct spectroscopic applications is especially appealing. The large bandwidth allows massively parallel probing while the high coherence simultaneously can provide continuous laser resolution. In addition, the extremely high peak power available in femtosecond pulses makes coherent harmonic upconversion very efficient, so that high precision experiments in the extreme ultraviolet (XUV) and soft X-ray spectral range could become reality.

Here we report on cavity enhanced methods for harmonic upconversion of frequency combs into the XUV spectral range [1,2] as well as a large bandwidth high resolution and high sensitivity rapid molecular detection technique that we call optical vernier spectroscopy [3].

A different route to high resolution spectroscopy in the XUV range is optical Ramsey type spectroscopy using amplified high energy pulses as a starting point. This type of spectroscopy is usually hampered by the difficulty of accurately calibrating the phase between pulses. The frequency comb is the key technology for solving this problem. In this context we will present a high power amplified laser system [4], that will be used for future XUV ultra high resolution spectroscopy experiments with phase stable pulse pairs.

References:
[1] C. Gohle et al., Nature, **436**, 234 (2005)
[2] R. J. Jones et al., PRL, 94, 193201 (2005)
[3] C. Gohle et al., arXiv:0706.1582v1
[4] A. Renault et al., Optics Letters (accepted)