Q 68 Laserspektroskopie II

Zeit: Mittwoch 11:00–12:15 Raum: HU 2014a

Q 68.1 Mi 11:00 HU 2014a

Ultrasensitive NICE-OHMS Detection of Molecular Oxygen at Cryogenic Temperatures — •Dennis Weise[1] and Achim Peters[2] — [1]Universität Konstanz — [2]Humboldt-Universität zu Berlin

Dilute samples of cold or ultracold molecules with special properties are appealing systems for precision studies towards the establishment of new frequency standards or tests of fundamental principles in physics, such as the symmetrization postulate or CP violation. However, suitable transitions are usually quite weak and attainable number densities inherently low, so that extremely high sensitivity is required for spectroscopy. This is provided in the NICE-OHMS scheme (Noise-Immune Cavity-Enhanced Optical Heterodyne Molecular Spectroscopy) by combining the respective benefits of cavity-enhanced and lock-in detection.

In the work presented here, NICE-OHMS has for the first time been implemented in a cryogenic environment, which serves to cool the species of interests to liquid nitrogen or liquid helium temperatures. Introduction from room-temperature into the cryogenic cell is accomplished via capillary injection. Using a scanned linear resonator with a finesse of $\sim 90\,000$ and a length of 86 mm, several lines in the R branch spectrum of the atmospheric A band of molecular oxygen have been recorded at 77 K. An integrated detection sensitivity of $8.8 \times 10^{-9}/\sqrt{\mathrm{Hz}}$ is achieved, corresponding to a minimum detectable absorption coefficient of 1.02×10^{-8}/cm at 10 ms integration time. It is limited by etalon effects from windows and rf interferences at the modulation frequency of 1.734 GHz.

Q 68.2 Mi 11:15 HU 2014a

A Room-Temperature Distributed-Feedback cw Quantum Cascade Laser for Nitric Monoxide sensing — •Markus Horstjann[1], Sven Thelen[1], Dmitri Yarekha[2], Jerome Faist[2], Peter Hering[1], and Manfred Mürtz[1] — [1]Institut für Lasermedizin, Universität Düsseldorf, *www.ilm.uni-duesseldorf.de/tracegas.* — [2]University of Neuchatel, Ch-2000 Neuchatel, Switzerland.

Since the first successful demonstration of quantum cascade lasers (QCLs) in 1994, much work has been done in order to reduce the cooling requirement down to peltier-cooled operation. First cw, room-temperature operation of a $\lambda = 9$ μm QCL was shown from Beck et al in 2002, and one year later QCLs at $\lambda = 5$ μm with these properties became available [1]. This wavelength region can be used for high sensitive detection of nitric monoxide (NO), e.g. by using Faraday Modulation Spectroscopy (FAMOS). Utilizing the magnetic moment of NO, this method is free from any cross interferences, which enables the detection of NO released from liquids without any gas-pretreatment. This is especially interesting for biomedical and immunobiology purposes [2]. We present first experimental results achieved with a new $\lambda = 5{,}4$ μm distributed-feedback (DFB) cw QCL which can be operated up to 20°C.

[1] D.A. Yarekha, M. Beck, S. Blaser, T. Aellen, E. Gini, D. Hofstetter, and J. Faist: *Continuous-wave operation of quantum cascade laser emitting near 5.6 μm*, Electronics Letters 39, 1123-1125 (2003).
[2] H. Ganser, M. Horstjann, C.V. Suschek, P. Hering, and M. Mürtz: *Online monitoring of biogenic nitric oxide with a QC laser-based Faraday modulation technique*, Appl. Phys. B 8, 513-517 (2004).

Q 68.3 Mi 11:30 HU 2014a

Höchstempfindliche Spurengasanalytik mittels Cavity-Leak-Out-Spektroskopie bei 5 μm Wellenlänge — •Daniel Halmer, Peter Hering und Manfred Mürtz — Universität Düsseldorf, Institut für Lasermedizin, *www.ilm.uni-duesseldorf.de/tracegas*

Die Analyse von Spurengasen findet heutzutage Anwendung in vielen Bereichen, z.B. in der Umwelt- oder Medizinanalytik. Dabei müssen Konzentrationen im ppb-Berreich (parts per billion) oder darunter quantitativ bestimmt werden.

Die Cavity-Leak-Out-Spektroskopie ist sehr gut geeignet für die höchstempfindliche und schnelle Analyse von Spurengasen im sub-ppb Bereich. Wir benutzen einen verstimmbaren CO-Seitenband-Laser (λ=5μm) um einen Resonator hoher Güte anzuregen, wodurch effektive optische Weglängen von bis zu 10 km erreicht werden. Nach der Anregung der Resonators wird der Laser abgeschaltet und aus der exponentiell abklingenden Strahlung die Absorption bestimmt.

Wir erreichen so minimal nachweisbare Absorptionskoeffizienten von $7 \cdot 10^{-11}\mathrm{cm}^{-1}/\sqrt{\mathrm{Hz}}$. Für OCS, welches für die Umwelt- und Medizinanalytik interessant ist, entspricht dies einer Nachweisgrenze von 10 ppt. Weiterhin zeigen wir Ergebnisse von gleichzeitiger und zeitaufgelöster Messung der Hauptisotopomere von NO.

Q 68.4 Mi 11:45 HU 2014a

Investigation of excitation dynamics in *Acaryochloris marina* by picosecond fluorescence spectroscopy — •Franz-Josef Schmitt[1], Joachim Huyer[1], Hans Joachim Eichler[1], and Hann-Jörg Eckert[2] — [1]Optisches Institut - P 1-1, Technische Universität Berlin, Strasse des 17. Juni 135, D-10623 Berlin — [2]Max-Volmer-Laboratorium, Technische Universität Berlin, Strasse des 17. Juni 135, D-10623 Berlin

The primary processes of photosynthesis in higher plants and cyanobacteria start with the generation of excited states by light absorption within pigment-protein complexes forming the antenna system. The electronic excitation then migrates via singlet-singlet energy transfer to the reaction center where it induces a primary charge separation leading to a primary radical pair (P+A-). Up to quite recently it was assumed that the chlorophyll-antennae of oxygenic photosynthetic organisms contain mainly Chl b and Chl a. Therefore the discovery of the cyanobacterium *Acaryochloris marina* attracted much attention in the scientific community because its antenna system contains mainly Chl d and phycobiliproteins and only small amounts of Chl a. The nature of the primary donor of PS II of *A. marina* (Chl a or Chl d) is still a matter of discussion. The Qy absorption band of Chl d is shifted towards longer wavelengths with respect to Chl a. This spectroscopic property raises important questions about the mechanism of excitation energy transfer. In this report we study the excitation energy transfer within the antenna of *Acaryochloris marina* by measuring the ps-fluorescence dynamics after excitation of whole cells with laser pulses of various wavelengths.

Q 68.5 Mi 12:00 HU 2014a

Precision spectroscopy of Al^+ using quantum logic. — •Piet O. Schmidt, Till Rosenband, Jeroen Koelemeij, Yohei Kobayashi, Scott A. Diddams, Wayne M. Itano, James C. Bergquist, and D.J. Wineland — National Institute of Standards and Technology, 325 Broadway, Boulder, CO 80305, USA

We report on progress towards an optical frequency standard based on the narrow ($\Delta\nu_{\mathrm{nat}}/\nu \approx 10^{-17}$) $^1\mathrm{S}_0 \longrightarrow {}^3\mathrm{P}_0$ transition of a trapped aluminum ion. The lack of an accessible cycling transition for laser cooling and detection in Al^+ is overcome using quantum information techniques [1]. Al^+ is sympathetically cooled by a simultaneously-trapped, laser-cooled beryllium ion. Be^+ also serves to read out the internal state of Al^+ by applying an internal state-to-motional state mapping operation on each ion that results in a coherent transfer of the aluminum ion's internal state onto the beryllium ion, where it is then measured with high efficiency [1]. The coherence of this transfer scheme is demonstrated in a Ramsey experiment involving $\pi/2$ pulses on both ions. Using this two-ion technique, we measured the absolute frequencies of several Al^+ optical transitions including the clock transition via a femto-second frequency comb referenced to the NIST Cs fountain.

This general technique extends high precision optical spectroscopy to previously inaccessible ion species that may be potential candidates for extremely stable and accurate optical clocks [2].

[1] D. Wineland *et.al.*, in Proc. 6th Symposium on Frequency Standards and Metrology, St. Andrews, Scotland, Sept. 9-14, 2001
[2] H.G. Dehmelt, IEEE Trans. Instr. Meas. **IM-31**, 83 (1982)