Q 18: Laser development and applications III

Time: Tuesday 10:30–12:15 Location: DO26 207

Q 18.1 Tue 10:30 DO26 207

Enhanced sensitivity of Raman spectroscopy for tritium gas analysis using a metal-lined hollow glass fiber — •Simone Rupp[1], Timothy M. James[2], Helmut H. Telle[2], Magnus Schlösser[1], and Beate Bornschein[1] — [1]Institute of Technical Physics, Karlsruhe Institute of Technology, Germany — [2]Department of Physics, Swansea University, United Kingdom

Raman spectroscopy is emerging as an advantageous tool for the compositional analysis of tritium-containing gases. Allowing for inline and real-time monitoring of flowing gases, it is of high interest for process control and tritium accountancy in, for example, the fuel cycle of fusion power plants, or neutrino mass experiments using tritium beta decay. Several Raman systems have been set up by our group over the past years and were successfully developed towards a high measurement precision and sensitivity. However, due to the sensitivity limits of conventional Raman spectroscopy, further improvements require new technologies. One promising approach is the use of a hollow glass fiber (capillary) acting as the Raman gas cell. The elongated scattering volume and the large light collection angle lead to a significant enhancement of the Raman signal compared to conventional setups. Such a Raman system has been constructed by our group and tested with tritiated hydrogen gases, yielding a sensitivity enhancement of at least one order of magnitude. In this contribution, a comparison of conventional and capillary Raman systems is given, and it is demonstrated that the use of a metal-lined hollow glass fiber as the Raman cell enables highly sensitive compositional analyses of tritium-containing gas.

Q 18.2 Tue 10:45 DO26 207

Single particle interferometry in the generalized Lorenz-Mie framework — •Markus Selmke, Irene Neugebauer, and Frank Cichos — Universität Leipzig, Linnéstr. 5, 04103 Leipzig

The change in laser transmission due to spherical particles under tightly-focused illumination is probably the most conveniently measurable quantity in optical microscopy setups. Sensitive techniques such as the spatial modulation spectroscopy for extinction spectroscopy, molecular sensors applications and photothermal single particle microscopy for absorption-based imaging have been put forward. The incidence beam interferes with the scattered field provides a contrast which contains detailed information about the scatterer itself and the illuminating focused field point-spread-function. However, a convenient framework for the description of such transmission signals for large particles, e.g. thermal lenses, was missing so far. Here, we present an extension of the generalized Lorenz-Mie theory which delivers such transmission signals for nanoparticle characterization and robust PSF mapping, alongside the commonly computed radiation forces and total cross-sections.

Q 18.3 Tue 11:00 DO26 207

Frequency stabilized laser systems for sounding rockets and future space missions — •Vladimir Schkolnik[1], Max Schiemangk[1,2], Markus Krutzik[1], Achim Peters[1,2], The LASUS Team[1,2,3,5], and The KALEXUS Team[1,2,4,5] — [1]Institut für Physik, HU Berlin — [2]Ferdinand-Braun-Institut, Leibniz-Institut für Höchstfrequenztechnik, Berlin — [3]Institut für Laserphysik, U Hamburg — [4]Institut für Physik, Johannes Gutenberg-Universität, Mainz — [5]Institut für Quantenoptik, LU Hannover

Laser systems with precise and accurate frequency are a key elements in high precision experiments such as atom interferometers and atomic clocks. Future space missions including quantum based tests of the equivalence principle or the detection of gravitational waves will need robust and compact lasers with high mechanical and frequency stability. We present two laser systems that fulfill these requirements. First, a micro-integrated distributed feedback laser (DFB) and a rubidium spectroscopy that will operate together with a rocket-borne frequency comb on the TEXUS 51 mission in May 2014.The second laser system contains two narrow linewidth extended cavity diode lasers (ECDLs) for potassium spectroscopy including a redundancy architecture for reliable operation. The system will be integrated with control and driver electronics within a pressurized payload and operate stand-alone on the TEXUS 53 mission.

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Q 18.4 Tue 11:15 DO26 207

Investigation of the intensity behavior of beta radioluminescence in tritium helium mixtures — •Oskari Pakari and Magnus Schlösser — Tritium Laboratory Karlsruhe, Institute for Technical Physics, Karlsruhe Institute of Technology

In future fusion reactors tritium and deuterium will be employed as fusion fuels. The fuel cycle of these reactors require accurate gas mixture analysis and monitoring systems. Raman spectroscopy is a promising candidate for this task.

However, Raman scattering is insensitive to mono-atomic helium, which is i) the fusion product and ii) used as important auxiliary gas in the fuel cycle processes. In order to detect helium in the gas streams the limited capabilities of Raman spectroscopy need to be extended. Therefore the following concept is considered. Tritium is a beta radiator which is present at every stage of the fuel cycle. The emitted beta electrons can excite helium atoms via collision. Subsequently, excited helium atoms de-excite under emission of a photon. This effect is called beta radioluminescence effect and the emission light could measured be as an option to monitor the tritium/helium ratio within the process gas in the fuel cycle.

This talk presents simultaneous Raman and beta radioluminescence spectroscopy of tritium helium gas mixtures. Furthermore, measured spectra under variation of the parameters i) pressure and ii) tritium-helium ratio will be discussed. Finally, a model to describe the intensity behavior will be introduced, as the experimental results do not suggest a linear correlation of intensity to the aforementioned parameters.

Q 18.5 Tue 11:30 DO26 207

Photoluminescence excitation and spectral hole burning spectroscopy of silicon-vacancy centers in diamond — •Carsten Arend, Christian Hepp, Jonas Becker, and Christoph Becher — Universität des Saarlandes, Experimentalphysik, D-66123 Saarbrücken

Silicon-vacancy (SiV) centers in diamond are promising sources for single photons because they provide narrow zero-phonon-lines (ZPLs) in the near infrared (738 nm), high photostability, weak phonon coupling and high brightness [1]. At cryogenic temperatures, the ZPL shows a four line fine structure due to the doubly split ground and excited states. Using photoluminescence excitation (PLE) spectroscopy where we scan a narrow-band laser across the fine structure lines and detect fluorescence on the phonon sidebands, we can measure linewidths and splittings of the SiV centers. We here report on the results using this technique on different samples containing ensembles of and single SiV-centers. Due to inhomogeneous broadening of the transitions caused by spectral diffusion, the measured linewidths commonly are in the order of several GHz, whereas the lifetime limit is in the order of 0.1 GHz. We therefore employ spectral hole burning spectroscopy which allows us to measure the homogeneous linewidth.

[1] E. Neu et al., New. J. Phys. 13, 025012 (2011)

Q 18.6 Tue 11:45 DO26 207

Absolute Photoluminescence Quantum Yield of Hexagonal β-NaYF4:Tm3+, Yb3+ Upconversion Nanoparticles — •Marco Kraft[1], Martin Kaiser[1], Christian Würth[1], Ute Resch-Genger[1], and Tero Soukka[2] — [1]BAM Bundesanstalt für Materialforschung und -prüfung, Richard-Willstätter-Str. 11, 12489 Berlin — [2]Department of Biotechnology, University of Turku, Tykistökatu 6A, FI-20520 Turku, Finland

Hexagonal β-NaYF4 doped with Yb3+ and Tm3+ is an efficient upconversion (UC) phosphor to convert 976 nm to 800 nm and 480 nm light. The rational design of nm-sized UC particles and their performance evaluation as well as the comparison of different materials require reliable spectroscopic tools for the characterization of the signal-relevant optical properties of these materials like the absolute quantum yield (QY). The QY of these particles in the solid state or in dispersion can be measured with high precision only absolutely.

This absolute measurement of UC QY still presents a considerable challenge due to the low absorption coefficient of these materials and the power density dependence of QY. In this respect, we present a custom-designed integration sphere setup equipped with a power-stabilized 976 nm-laser diode for spectrally resolved and power density-dependent measurements of absolute fluorescence. The UC QY and the photonic nature of the different UC emission bands are studied by varying the excitation power density. Furthermore, time-resolved measurements are performed to correlate the UC QY with the luminescence lifetimes of the different emission bands.

Q 18.7 Tue 12:00 DO26 207

Frequency-doubling in fs-laser-written waveguides in periodically poled KTP — •Sebastian Müller[1], Thomas Calmano[1], Fredrik Laurell[2], Carlota Canalias[2], Christian Kränkel[1,3], and Günter Huber[1,3] — [1]Institut für Laser-Physik, Universität Hamburg, Germany — [2]Department of Applied Physics, KTH, Stockholm, Sweden — [3]The Hamburg Centre for Ultrafast Imaging, Universität Hamburg, Germany

Efficient second harmonic generation requires high light intensity and a long interaction length between the fundamental wavelength and the generated signal. In waveguides, both conditions are combined. Here we report on fs-laser written waveguides in periodically poled $KTiOPO_4$ (PPKTP) crystals. KTP is a suitable and well established material for frequency doubling of $1\,\mu$m radiation and suitable for the inscription of low-loss waveguiding structures using intense fs-laser pulses. We inscribed the waveguides into a 9.5 mm long, x-propagating, periodically poled $KTiOPO_4$ for frequency doubling a wavelength of 943 nm. Waveguiding was achieved parallel to the z-axis between two parallel fs-laser written tracks of modified material with spacings of $17\,\mu$m to $19\,\mu$m. At a distance of $18\,\mu$m the guided IR mode had an elliptically shape with diameters of $12.8\,\mu\text{m} \times 22.3\,\mu$m and losses below 2 dB/cm. Under 1.6 W of incident IR radiation at 943 nm we obtained 76 mW of blue output at 472 nm, corresponding to a single-pass normalized conversion efficiency of 4.6 %/Wcm^2.