Q 54: Laser Applications: Optical Measurement Technology I

Time: Thursday 14:00–16:15 Location: F 342

Q 54.1 Th 14:00 F 342

Measurement of submicrometer diameters of tapered optical fibres using harmonic generation — •Ulrich Wiedemann, Konstantin Karapetyan, Dimitri Pritzkau, Cristian Dan, Wolfgang Alt, and Dieter Meschede — Institut für Angewandte Physik, Wegelerstr. 8, 53115 Bonn

For applications of subwavelength-diameter optical fibres in nonlinear optics it is important to know the submicrometer fibre diameter precisely. We demonstrate a new technique for optical measurement of the diameter based on second- and third-harmonic generation with an accuracy of a few percent. In order to obtain the harmonic light, inter-modal phase matching has to be fulfilled. We find that the phase-matching condition allows us to unambiguously deduce the fibre diameter from the wavelength of the harmonic light.

Q 54.2 Th 14:15 F 342

Demonstration of sub-picometer length measurements and sub-nanoradian angular read-out in the millihertz-frequency range — •Christian Diekmann, Michael Tröbs, Frank Steier, Iouri Bykov, Gerhard Heinzel, and Karsten Danzmann — Albert-Einstein-Institut Hannover, Max-Planck-Institut für Gravitationsphysik und Leibniz Universität Hannover

The space-based interferometric gravitational-wave detector Laser Interferometer Space Antenna (LISA) requires interferometry with sub-picometer and nanoradian sensitivity in the frequency range between 3 mHz and 1 Hz. Currently, a first prototype of the optical bench for LISA is being designed. We report on a pre-experiment with the aim to demonstrate the required sensitivities and to thoroughly characterise the equipment. For this purpose, a quasi-monolithic optical setup has been built with two Mach-Zehnder interferometers (MZI) on an optical bench made of zerodur. In a first step the relative length change between these two MZI will be measured with a heterodyne modulation scheme in the kHz-range and the angle between two laser beams will be read out via quadrant photodiodes and a technique called differential wavefront sensing. These techniques have already been used for the LISA predecessor mission LISA Pathfinder and their sensitivity needs to be further improved to fulfill the requirements of the LISA mission. We describe the experiment and the characterization of the basic components. First measurements of the length and angular noise will be presented.

Q 54.3 Th 14:30 F 342

Verification of Optical Diameter Measurement of Subwavelength-Diameter Optical Fibres using Scanning Electron Microscopy — •Dimitri Pritzkau, Konstantin Karapetyan, Ulrich Wiedemann, Cristian Dan, Wolfgang Alt, and Dieter Meschede — Institut für Angewandte Physik, Wegelerstr. 8, 53115 Bonn

Subwavelength-diameter optical fibres (SDOF) are widely used in linear optics and they are a promising tool for nonlinear optical applications. The diameter of an SDOF (300 - 1000 nm) is a main parameter in controlling nonlinear effects. Several optical measurement techniques exist, which are usually verified by scanning electron microscopy (SEM). For submicrometer metrology SEM is a convenient method but typically limited to 10 % uncertainty. We developed a new optical measurement method with improved accuracy. To validate this method, a precision of about 2 % is needed. In this talk we discuss the SEM measurement requirements (including fibre preparation, electron-fibre interaction and advanced analysis software) to achieve this goal.

Q 54.4 Th 14:45 F 342

Measuring small absorptions using the thermal Kerr effect — •Nico Lastzka, Jessica Dück, Sebastian Steinlechner, and Roman Schnabel — Institut für Gravitationsphysik, Leibniz Universität Hannover und Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut) Callinstrasse 38 D-30167 Hannover

The precise measurement of small absorption in optical materials is a challenging task. To measure absorption coefficients of some ppm/cm or smaller it is necessary to use indirect methods, which do not measure the power losses but the effect of the absorbed power in the substrate. These are for example calorimetric measurements or methods using the thermal lens effect. The sensitivities of these methods scale with the substrate length and with the input power, and typically high input power is necessary.

We present an absorption measurement scheme based on the shape of the airy peaks of a scanned optical resonator. Due to the heating of the intra-cavity material, the transmitted as well as the reflected airy peaks show a hysteresis depending on the scan direction. A time domain simulation based on the theory of Hello and Vinet is used to fit the measured data. In order to prove the quantitative results of this method the absorption coefficient of a lithium niobate was measured and compared to literature values. An estimation of the lower limit of the measurable absorption coefficient and corresponding error bars is given.

Q 54.5 Th 15:00 F 342

Measurement of complex optical third-order nonlinearities in waveguides and bulk samples — •Anatoly Sherman, Erik Benkler, and Harald R. Telle — Physikalisch-Technische Bundesanstalt (PTB), Braunschweig, Germany

We demonstrate a novel method for measuring real and imaginary parts of the third-order nonlinear optical susceptibility ($\chi(3)$) in waveguides and bulk samples. Here, the unknown nonlinearity of the device under test is compared, under nearly identical experimental circumstances, with the known value of a reference sample. In order to gain information about both amplitude and phase of $\chi(3)$, a four-wave mixing set-up is combined with a phase-sensitive heterodyne detection scheme. The overall phase is calibrated during such measurements using reference sample with negligible two-photon absorption (i. e. fused silica at telecommunication wavelength). From the ratio of both quadrature components of $\chi(3)$, one directly deduces the so-called nonlinear figure of merit, which is an important parameter of all-optical circuits. As a source of error, spurious mixing signals generated from the photodiode are eliminated by all-optical methods.

Q 54.6 Th 15:15 F 342

Online Laser-Raman-Spektroskopie an Tritium für KATRIN — •Magnus Schlösser[1], Michael Sturm[1], Sebastian Fischer[1], Beate Bornschein[2], Richard Lewis[3] und Helmut Telle[3] — [1]Karlsruher Institut für Technologie (KIT), Zentrum Elementarteilchen und Astroteilchenphysik, GER — [2]KIT, Tritiumlabor Karlsruhe, GER — [3]Dep. of Phys., Swansea University, UK

Das KArlsruher TRItium Neutrino-Experiment KATRIN untersucht das Elektronenspektrum des Tritiumzerfalls nahe dem kinematische Endpunkt von 18,6 keV. Mit einer fensterlosen molekularen gasförmigen Tritiumquelle hoher Luminosität und einem hochauflösenden elektrostatischen Filter wird KATRIN eine modellunabhängige Bestimmung der Neutrinomasse mit einer erwarteten Sensitivität von 0,2 eV (90% CL) ermöglichen. Um diese Präzision zu erreichen, ist die präzise Kenntnis der Zusammensetzung des in die Quelle eingespeisten Gases erforderlich. Zur Bestimmung und Überwachung der Anteile der verschiedenen Wasserstoffisotopologe (T2, D2, H2, DT, HT, HD) wird ein Laser-Raman-System verwendet. In diesem Vortrag werden der Aufbau des Laser-Raman-Systems im Tritiumlabor Karlsruhe sowie aktuelle Ergebnisse vorgestellt. Dabei wird gezeigt, dass alle sechs Isotopologe simultan gemessen werden können [1] und eine Präzision von 0.1% in 250 s erreicht werden kann. Gefördert vom BMBF unter 05A08VK2 und von der DFG im SFB/TR27 "Neutrinos and Beyond".
[1] Sturm et al., Monitoring of All Hydrogen Isotopologues at Tritium Laboratory Karlsruhe Using Raman Spectroscopy, Laser Physics, 2010, Vol. 20, No. 2

Q 54.7 Th 15:30 F 342

New Spectroscopic Techniques for Rydberg Atoms — •Thomas Becker, Pierre Thoumany, Linas Urbonas, and Theodor Hänsch — Max Planck Institute for Quantum Optics, Garching

In this talk, recent experiments about purely optical, Doppler-free spectroscopy of Rydberg atoms in gas cells will be reviewed. All experiments are based on a realization of electron-shelving techniques and allow a non-destructive detection of Rydberg transitions. Two different laser schemes, one single-step Rydberg excitation in he UV and a three-step Rydberg excitation with IR diode lasers will be pre-