Q 23: Photonics I

Time: Monday 16:15–17:45 Location: S Ex 04 E-Tech

Q 23.1 Mon 16:15 S Ex 04 E-Tech

Optomechanical saturable cavity output coupler — •Carol Bibiana Rojas Hurtado[1], Johannes Dickmann[1], Walter Dickmann[2], and Stefanie Kroker[1,2] — [1]Physikalisch-Technische Bundesanstalt — [2]Technische Universität Braunschweig

We present a concept for saturable output couplers based on a nonlinear mirror with optomechanical saturable response. The mirror consists of a nanostructured silicon surface with two layers of subwavelength gratings. The interaction between the optical forces induced by the incoming light field and the structural deformations lead to a nonlinear response of the mirror, whose reflectivity can be modulated passively directly inside a resonator. The nonlinear response shows a saturable behavior, the surface's reflectivity increases for high intensities meaning that the resonator losses decreases for high intensities. This approach is an alternative to current saturable absorbers made of quantum dots, graphene, dyes, semiconductors and devices based on Kerr lensing or nonlinear crystals. We investigate the requirements for the mirror to be used for passive pulse generation, especially Q-switching, as the bandwidth, modulation depth, saturation intensity and recovery time, and show that most of these properties can be designed at will depending on the application. Furthermore, the non-saturable losses can be totally minimized in contrast to the existing losses in saturable absorbers.

Q 23.2 Mon 16:30 S Ex 04 E-Tech

Homo-heterodyne detection of EIT in ^{167}Er:^{7}LiYF$_4$ at sub-Kelvin temperatures — •Nadezhda Kukharchyk[1], Dmitriy Sholokhov[2], Oleg Morozov[3], Stella L. Korableva[3], Jared H. Cole[4], Alexey A. Kalachev[5], and Pavel A. Bushev[1] — [1]Microwave Quantum Systems, Universität des Saarlandes, Saarbrücken, Germany — [2]Quantum Photonic Universität des Saarlandes, Saarbrücken, Germany — [3]Kazan Federal University, Kazan, Russian Federation — [4]Chemical and Quantum Physics, School of Science, RMIT University, Melbourne, Australia — [5]Zavoisky Physical-Technical Institute, Kazan, Russian Federation

We demonstrate the microwave approach in optical measurements. While typical application of Mach-Zehnder Modulator to control optical frequency requires filtering of a carrier and negative side-band, we do the heterodyne detection with unfiltered carrier in a perfect phase matching regime. This implies a particular data processing scheme, which allows an accurate determining of amplitude, phase, and absorption coefficient. We demonstrate application of this method in spectroscopic measurements[1], as well as for EIT in isotopically purified ^{166}Er:^{7}LiYF$_4$ and ^{167}Er:^{7}LiYF$_4$.

[1] N. Kukharchyk, D. Sholokhov, O. Morozov, S. L. Korableva, J. H. Cole, A. A. Kalachev, and P. A. Bushev, "Optical vector network analysis of ultranarrow transitions in ^{166}Er^{3+}:^{7}LiYF$_4$ crystal", Opt. Lett. 43, 935-938 (2018)

Q 23.3 Mon 16:45 S Ex 04 E-Tech

The impact of a new approach for the Kerr nonlinearity parameter on four wave mixing — •Izzatjon Allayarov[1], Swaathi Upendar[1], Markus A. Schmidt[2,3], and Thomas Weiss[1] — [1]4th Physics Institute and Research Center SCoPE, University of Stuttgart, Germany — [2]Leibniz Institute of Photonic Technology, Germany — [3]Otto Schott Institute of Material Research, Friedrich Schiller University of Jena, Germany

Nowadays, hollow-core photonic crystal fibers are widely used in optics, since their linear and nonlinear optical properties are highly tunable [1]. However, a thorough theoretical formulation for the pulse propagation in such fibers has been missing so far due to the leaky nature of the occurring modes. We have recently derived such a formulation that is capable of treating guided and leaky modes based on the so-called resonant-state expansion with analytical mode normalization [2]. For leaky modes, we find that the Kerr nonlinearity parameter has an imaginary part that provides either nonlinear gain or loss for overall attenuating pulse that can significantly influence the pulse dynamics with intense pulse compression and spectral broadening in the case of nonlinear gain. Our theory can be extended to parametric processes such as degenerate four-wave mixing.

[1] F. Benabid and P. J. Roberts, J. Mod. Opt. **58**, 87 (2011).
[2] I. Allayarov et al., Phys. Rev. Lett. **121**, 213905 (2018).

Q 23.4 Mon 17:00 S Ex 04 E-Tech

Sub-cycle 2D spectroscopy of terahertz intersubband saturable absorbers — •Jürgen Raab[1], Christoph Lange[1], Jessica Boland[1], Enrico Dardanis[2], Nils Dessmann[2], Lianhe Li[3], Edmund Linfield[3], Giles Davies[3], Miriam Vitiello[2], and Rupert Huber[1] — [1]Department of Physics, University of Regensburg, 93040 Regensburg, Germany — [2]NEST, CNR-Istituto Nanoscienze and Scuola Normale Superiore, Piazza San Silvestro 12, Pisa I- 56127, Italy — [3]School of Electronic and Electrical Engineering, University of Leeds, Leeds LS2 9JT, UK

Intersubband transitions are promising candidates for terahertz (THz) saturable absorbers, a key ingredient for future passively mode-locked quantum cascade lasers. Here we investigate the saturation dynamics of semiconductor quantum well structures by field resolved 2D THz spectroscopy, which allows us to distinguish between incoherent pump-probe and coherent four-wave mixing signals, on a sub-cycle time scale. These nonlinearities peak at a THz field amplitude of 11 kV/cm and decrease for higher fields, due to THz-driven carrier-wave Rabi flopping. With a microscopic model based on a numerical solution of the Maxwell-Bloch equations, we can quantitatively reproduce our experimental findings and trace the trajectory of the Bloch vector. This theory allows us to design tailored semiconductor structures with optimized dynamical properties for saturable absorbers that could be used in future compact semiconductor-based single-cycle THz sources.

Q 23.5 Mon 17:15 S Ex 04 E-Tech

Characterization of a VUV plasma lamp for the production of metastable krypton for a MOT — •Svenja Sonder, Carsten Sieveke, Ergin Simsek, and Pablo Woelk — Carl Friedrich von Weizsäcker Centre for Science and Peace Research, University of Hamburg, Beim Schlump 83, 20144 Hamburg, Germany

Krypton is an excellent tracer for the detection of clandestine reprocessing of plutonium and groundwater dating. For the effective measurement of its concentration in the atmosphere small sample sizes and large sample throughput rates are required. In our ATTA (Atom Trap Trace Analysis) experiment we want to use a magneto-optical trap to measure the concentration of Krypton in air samples. This method allows to capture specific isotopes and is sensitive to the parts-per-trillion level.

As it is not possible to capture krypton atoms in the ground state, we need to excite them to a metastable state. To avoid cross contamination, we do not use RF-driven excitation, but an all-optical one with self-build VUV plasma lamps. The properties of the VUV lamps are a key factor for the performance of the whole apparatus.

We present a comprehensive characterization of our VUV lamps with a VUV gold detector. Of key interest are VUV photon flux, spatial emission profile, lamp lifetime and long-term stability.

Q 23.6 Mon 17:30 S Ex 04 E-Tech

Raman spectroscopy of homonuclear gases by means of a photonic crystal fiber — •Christian Niklas, Fabian Müller, Hainer Wackerbarth, and Georgios Ctistis — Laser-Laboratorium Göttingen e.V., Hans-Adolf-Krebs-Weg 1 , 37075 Göttingen, Deutschland

Global climate change has brought the detection of hazardous gases to the focus of public. Industrial processes have to fulfil strict regulations nowadays, which makes the detection of gases more and more important. Optical detection of gases applies mainly IR-based absorption techniques. However, homo-nuclear gases, such as H_2 and O_2, are not accessible by these approaches. Raman spectroscopy is suitable for detecting these gases. Yet, due to a low scattering cross section of these gases, the signal has to be enhanced. Hollow-core photonic crystal fibers provide an ideal platform for such studies because of the enhancement of the scattering signal due to long absorption length and an intensity enhancement of the excitation.

In this work, we present our experiments with a hollow-core photonic crystal fiber and oxygen as sample gas. It is evaluated, whether the photonic bandgap of the fiber is suitable to sufficiently guide the Stokes-shifted Raman signal. Furthermore, the influence of the gas flow rate is examined and the detection limit is determined.