Q 27: Precision Measurements and Metrology IV (joint session Q/A)

Time: Wednesday 10:30–12:30 Location: Q-H11

Invited Talk Q 27.1 Wed 10:30 Q-H11

Searching for physics beyond the Standard Model with isotope shift spectroscopy — •Elina Fuchs — CERN, Department for Theoretical Physics — Leibniz Universität Hannover — Physikalisch-Technische Bundesanstalt (PTB) Braunschweig

I will present searches for New Physics beyond the Standard Model using precision isotope shift spectroscopy with a focus on the King plot method and new avenues with Rydberg states.

Q 27.2 Wed 11:00 Q-H11

Metamirrors as platform for next-generation ultra-stable laser cavities — •Steffen Sauer[1,2], Johannes Dickmann[1,2], Liam Shelling Neto[1,2], and Stefanie Kroker[1,2,3] — [1]TU Braunschweig, Institute for Semiconductor Technology, Hans-Sommer-Str. 66, 38106 Braunschweig, Germany — [2]LENA Laboratory for Emergng Nanometrology, Langer Kamp 6a/b, 38106 Braunschweig — [3]Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig, Germany

The key ingredients of today′s most precise quantum optics experiments are laser cavities, e.g. in interferometric gravitational wave detectors and atomic clocks. These cavities are based on two highly reflective mirrors with required reflectivities of > 99.997 %. Additionally, cavities will play a key role in future dark matter research. The currently most stable laser cavities are limited by the mirror coating noise. A highly promising approach for the reduction of thermal noise is the implementation of metamirrors. Metamirrors are formed by laterally structured optical sub-wavelength nanostructures, which are designed to manipulate the near-field of the impinging light. Thus, the reflectivity can theoretically reach 100 % with only one structured layer. In this contribution, we present the current progress in the field of metamirrors for ultra-stable laser cavities, including thermal noise computation and reflectivity measurements.

Q 27.3 Wed 11:15 Q-H11

Precision Optical Techniques in the ALPS II Experiment — •Todd Kozlowski — University of Florida, Gainesville, USA

On behalf of the ALPS Collaboration. The Any Light Particle Search II (ALPS II) is a "light-shining-through-the-wall" experiment currently in commissioning at DESY. ALPS II will search for axion-like particles (ALPs), a family of hypothetical particles outside of the Standard Model which have a feeble coupling to the electromagnetic field, motivated by exciting astrophysical hints. The experiment aims to detect light which has undergone photon-ALP and subsequent ALP-photon conversion in the presence of a magnetic field. ALPS II utilizes a pair of 122-meter long high finesse Fabry-Perot optical resonators to improve detection sensitivity. One of the resonators will store 150 kW of circulating light to improve the amplitude of the generated axion field. The second resonator, located on the other side of a light-tight (but ALP transparent) barrier, will build up the regenerated laser field to gain a factor >10,000 in signal enhancement. The resulting signal, on the order of 1 photon/day, can then either be counted by a cryogenic photon counter or detected as modulation of a reference field. The experiment requires a control scheme to allow for the two cavities to both be held simultaneously on resonance with the same frequency of light, without any light from the first resonator entering the second. I will discuss the optical technologies utilized in this experiment, including nested optical offset phase locking, heterodyne interferometric readout of ultra-low optical fields, and alignment sensing and control. I will also present updates from the in-progress experimental commissioning.

Q 27.4 Wed 11:30 Q-H11

Tailoring narrower phase-matching bandwidth with resonant quantum pulse gate — •Dana Echeverria-Oviedo, Michael Stefszky, Jano Gil-Lopez, Benjamin Brecht, and Christine Silberhorn — Paderborn University, Integrated Quantum Optics, Warburguer Str. 100, 33098, Paderborn, Germany.

Time-frequency quantum metrology has been shown to saturate the quantum Cramér-Rao lower bound -the ultimate precision limit imposed by quantum mechanics- if temporal-mode selective measurements can be implemented. These can be realized with a so-called quantum pulse gate, a dispersion engineered sum-frequency generation between shaped pulses. In practice, the achievable resolution of such measurements is limited by the finite phase-matching bandwidth of the quantum pulse gate. It is of paramount importance to tailor narrower phase-matching bandwidths to alleviate this limitation and push technology further towards practical applications. We propose a resonant quantum pulse gate, which is comprised of two coupled waveguide cavities that reduce the phase-matching bandwidth, one of them the nonlinear cavity in which the interaction takes place, the other an additional linear cavity which helps to select only one single resonance. Our design facilitates a reduction in phase-matching bandwidth by several orders of magnitude compared to existing devices. In this talk, we report on the current progress in which our team is working with great effort.

Q 27.5 Wed 11:45 Q-H11

Integrated broadband PDC source for quantum metrology — •René Pollmann, Franz Roeder, Matteo Santandrea, Tim Wörmann, Victor Quiring, Raimund Ricken, Christof Eigner, Benjamin Brecht, and Christine Silberhorn — Paderborn University, Integrated Quantum Optics, Institute for Photonic Quantum Systems (PhoQS), Warburger Straße 100, 33098 Paderborn, Germany

Broadband quantum light is a vital resource for quantum metrology applications such as quantum spectroscopy, quantum optical coherence tomography or entangled two photon absorption. To produce light suitable for these applications we implemented a broadband (10 THz) non-degenerate type-II parametric down conversion source in a 40 mm long periodically poled $LiNbO_3$ waveguide. The broadband nature of the created photon pairs yields a very short correlation time (100 fs), while the narrowband CW pump ensures strict frequency anticorrelations. This high degree of time frequency entanglement makes the created state ideal for driving two photon absorption.

Furthermore, the bandwidth of the produced biphotons can be tuned from 1 THz to 10 THz by adjusting the operating temperature of the source.

A broadband, bright source of quantum light also enables its use as an active element of so-called SU(1,1)-interferometers for applications in spectroscopy with undetected photons.

Q 27.6 Wed 12:00 Q-H11

Influence of Spontaneous Brillouin Scattering in Cascaded Fiber Brillouin Amplification for Fiber-Based Optical Frequency Dissemination — •Jaffar Kadum and Sebastian Koke — Physikalisch-Technische Bundesanstalt, Braunschweig, Germany

The roadmap towards the redefinition of the SI Second in terms of an optical atomic clock transition demands a comparison between remote optical clocks. Ultra-stable coherent frequency dissemination via interferometric fiber links (IFLs) is currently the only available method to compare the best optical clocks at the level of their uncertainty over continental scales. Fiber Brillouin amplifiers (FBAs) are an attractive alternative to conventional Erbium-doped fiber amplifiers due to high gain and greatly reduced back-reflection sensitivity [1]. FBA exploits the stimulated Brillouin scattering (SBS) effect initiated by the nonlinear interactions of signal and counterpropagating pump wave. However, the spontaneous Brillouin scattering (SpBS) resulting from thermally excited acoustic waves [2] degrades the signal-to-noise ratio, which may become limiting for IFLs longer than currently demonstrated. To gain deeper insight into the properties of amplified SpBS in cascaded FBA and to optimize future longer FBA-based IFLs, we developed a simulation model, which will be introduced and discussed in this contribution. 1.O. Terra et al. , *Brillouin amplification in phase coherent transfer of optical frequencies over 480 km fiber,* Opt. Express 18, (2010). 2.R.W. Boyd et al., *Noise initiation of stimulated Brillouin scattering,* Phys. Rev. A, 42, (1990).

Q 27.7 Wed 12:15 Q-H11

Pertubation of trapping standards — •Martin Kernbach[1,2], Paul Oskar Sund[1], and Andreas W. Schell[1,2] — [1]Leibniz Universtity Hannover — [2]Physikalisch-Technische Bundesanstalt Braunschweig

Levitation platforms like quadrupole traps or optical tweezers are established tools for various experiments. Trapped particles are strongly isolated from their environment. This makes for example single ions accessible as individual quantum systems. Also particles up to the micrometer regime are trappable, which gives access to their even more complex properties, like internal degrees of freedom, chemical composition, or chemical reactions under well defined artificial environmental conditions.

As a first step toward a nanoparticle levitation platform we have set up a quadrupole trap with electro spray injection and in combination with a confocal microscope. The parameter range allows for trapping of nanometer to micrometer sized particles. The optical fingerprint of these particles are taken by Raman spectroscopy. As a second step we simulate trapping with respect to the driving field, atmospheric conditions or cooling. The experimental setup is designed to enable driving potentials of arbitrary waveform for particles on the micrometer scale. With these prerequisites experimental testing of promising exotic drivings can be realized. Effects on trapping speed and equilibrium temperature are expected to be confirmed.