Q 42: Precision Measurements and Metrology V

Time: Thursday 10:30–12:30 Location: A 310

Q 42.1 Th 10:30 A 310

NV color centers for magnetic field sensing at the nanoscale — •Friedemann Reinhard[1], Eike Oliver Schäfer-Nolte[1,2], Markus Ternes[2], Bernhard Grotz[1], Helmut Rathgen[1], Gopalakrishnan Balausbramanian[1], Julia Tisler[1], Klaus Kern[2], Fedor Jelezko[1], and Jörg Wrachtrup[1] — [1]Universität Stuttgart, 3. Physikalisches Institut — [2]Max-Planck-Institut für Festkörperforschung, Stuttgart

One of the most promising applications of the NV color center in diamond is to use it as a magnetic field sensor with sub-nanometer spatial resolution. This prospect arises from the fact that its spin sublevels are sensitive to magnetic fields, only ca. 1kHz wide and are accessible to pulsed optical-microwave precision spectroscopy. I present our work towards such a scanning probe diamond nano-magnetometer, focussing on two aspects: Firstly, the development of tailored atomic force microscopes with an efficient optical and microwave access. Secondly, the study of the surface properties of diamond, most notably of magnetic and electric noise, which presumably limits the coherence time of NV centers near the diamond surface and in nanodiamonds.

Q 42.2 Th 10:45 A 310

High-resolution laser spectroscopy of the $^2S_{1/2} - {}^2F_{7/2}$ octupole transition in ^{171}Yb$^+$ — •Nils Huntemann, Ivan Sherstov, Maxim Okhapkin, Burghard Lipphardt, Christian Tamm, and Ekkehard Peik — Fachbereich Zeit und Frequenz, Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig, Germany

We present our results on the spectroscopy of the electric octupole transition $^2S_{1/2}(F=0) \rightarrow {}^2F_{7/2}(F=3)$ of a single trapped laser-cooled ^{171}Yb$^+$ ion. This transition is of special interest as an optical frequency standard because the $^2F_{7/2}$ state has an extremely long natural lifetime of approximately 6 years. As a result, the stability of the frequency standard will not be limited by its natural linewidth, but by the laser system. The strong dependence of the transition frequency on the value of the fine structure constant α suggests long-term comparisons with other optical frequency standards, especially the $^2S_{1/2} - {}^2D_{3/2}$ electric quadrupole transition in ^{171}Yb$^+$, in order to test the constancy of α.

We developed a diode-laser system with a relative frequency stability better than 2×10^{-15} at 1 s and a very low nonlinear frequency drift to excite this transition. We obtain excitation spectra of the octupole transition with a resonant excitation probability of about 65 % and an essentially Fourier transform-limited resolution of 13 Hz. These results compare favourably with previous work [Hosaka *et al.*, Phys. Rev. A **79** 033403 (2009)].

Q 42.3 Th 11:00 A 310

Laser noise reduction by means of the optical Kerr Effect — •André Thüring, Alexander Khalaidovski, Nico Lastzka, Daniel Wahlmann, Benno Willke, Karsten Danzmann, and Roman Schnabel — Institut für Gravitationsphysik, Leibniz Universität Hannover und Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Callinstrasse 38, D-30167 Hannover

Conventional laser power stabilization techniques rely on the photo-electric detection of high light powers and on the filtering by means of linear optical resonators. These techniques are limited on the one hand by the intrinsic noise of the photo-detection, and on the other hand by the linewidth of the filter resonators being used. Here we present an alternative method for the noise reduction of high power lasers. It is based on the optical Kerr effect and can be used either for a pure optical passive noise reduction or as sensing device that does not require the photo-detection of high light powers. We report on the results of a first proof-of-principle experiment where a noise reduction of about 32 dB was achieved.

Q 42.4 Th 11:15 A 310

Präzise interferometrische Frequenzmessung und -stabilisierung für durchstimmbare Laser — •Thomas Kinder[1], Thomas Müller-Wirts[1], Johannes Brachmann[2] und Kai Dieckmann[2,3] — [1]TEM Messtechnik GmbH, Hannover — [2]Max-Planck-Institut für Quantenoptik, Garching — [3]Centre for Quantum Technologies - National University of Singapore

Laser mit veränderbarer optischer Frequenz finden Anwendung in vielen Bereichen., z.B. Spektroskopie, Abstandsmessung usw. Oft erfordert die Endanwendung eine hoch präzise Messung und Stabilisierung der Laserfrequenz. Wir stellen dazu ein Anordnung vor, deren Kern ein Interferometer als frequenzempfindlicher Detektor bildet. Dabei ist die Phase des erzeugten Quadratursignals ein Maß für die Laserfrequenz. In einer Rückkoppelschleife wird die Differenz der gemessenen Phase zu einem computergenerierten Sollwert auf den zu regelnden Laser zurückgegeben. Auf diese Weise kann die Frequenz auf beliebige, auch variable (!) Werte innerhalb des Durchstimmbereiches des Lasers stabilisiert werden, also auch während eines Scans. Das elektronische Auflösungsvermögen beträgt etwa 380kHz – bei einem beliebig großen Stimmbereich. Um die absolute Genauigkeit in dieselbe Großenordnung zu bringen, muss man zum einen die elektronische Phasenmessung auf 0,1mrad kalibrieren, und zum anderen muss man den Freien Spektralbereich des Interferometers mit einer relativen Unsicherheit von 10^{-9} bestimmen. Wir beschreiben die Methode am Beispiel eines Ti:Saphir-Ringlasers und zeigen Messergebnisse hinsichtlich Auflösung, Wiederholbarkeit, Langzeitstabilität und Absolutgenauigkeit.

Q 42.5 Th 11:30 A 310

Fixing a laser beam in space for hydroxide-catalysis bonding — •Martin Sommerfeld, Marina Dehne, Benjamin Sheard, Gerhard Heinzel, and Karsten Danzmann — Albert-Einstein-Institute Hannover, Max-Planck-Institute for gravitational physics and Leibniz University Hannover, Callinstr. 38, D-30167 Hannover

To build thermal and mechanical very stable interferometers for space-born missions, the technology of hydroxide-catalysis bonding is used. During assembly of the optical components, the position of laser beams in space must be controlled in four degrees of freedom. This is particularly important for the beam height and vertical slope which cannot be corrected by shifting components. To solve this problem a device to measure the position and the angle of the incoming beam is built and calibrated. The current status of ongoing development will be presented.

Q 42.6 Th 11:45 A 310

Systematic study of the hfs splitings for 3d elements by ABMR-LIRF method — •Przemysław Głowacki, Andrzej Krzykowski, Andrzej Jarosz, Danuta Stefańska, and Jerzy Dembczyński — Chair of Quantum Engineering and Metrology, Poznań University of Technology,
ul. Nieszawska 13B, 60-965 Poznań, Poland

The atomic beam apparatus was donated to our Chair by Prof. W. Ertmer from the Institute of Applied Physics of the University of Bonn, and further modernized and improved. With the use of ABMR-LIRF method (atomic beam magnetic resonance, detected by laser induced resonance fluorescence) and a new magnetic shield in the apparatus, it was possible to obtain the values of the hfs (hyperfine structure) intervals in investigated elements with an accuracy of about 1 kHz [1]. This allowed us to determine precisely the values of the hfs constants A and B (magnetic dipole and electric quadrupole interactions), as well as made the estimation of the values of the hfs constants C (magnetic octupole interaction) for the 3d elements possible.

This work was performed within the framework of DS63-029/10.

References

[1] A. Jarosz, D. Stefańska, M. Elantkowska, J. Ruczkowski, A. Buczek, B. Furman, P. Głowacki, A. Krzykowski, Ł. Piątkowski, E. Stachowska, J. Dembczyński, J. Phys. B: At. Mol. Opt. Phys. **40**, 2785-2797 (2007)

Q 42.7 Th 12:00 A 310

Demonstration of a squeezed zero-area Sagnac interferometer topology for future gravitational wave detectors — •Tobias Eberle, Sebastian Steinlechner, Jöran Bauchrowitz, Vitus Händchen, Karsten Danzmann, and Roman Schnabel — Institut für Gravitationsphysik, Leibniz Universität Hannover und Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut) Callinstrasse 38 D-30167 Hannover

The design study for the Einstein Telescope (ET), the future European laser-interferometric gravitational wave detector, is on going. An option for the interferometer topology is a zero-area Sagnac. The

Sagnac interferometer is a speed-meter and therefore a quantum non-demolition device that in principle can beat the standard quantum limit. The sensitivity of gravitational wave detectors can be further enhanced by the injection of squeezed light. In this talk we present the experimental demonstration of a table-top zero-area Sagnac interferometer at 1064nm whose sensitivity was increased with squeezed light.

Q 42.8 Th 12:15 A 310

Application of polarising optics in space interferometry — •Marina Dehne, Benjamin Sheard, Gerhard Heinzel, Michael Tröbs, and Karsten Danzmann — Albert- Einstein-Institut Hannover, Max-Planck-Institut für Gravitationsphysik und Universität Hannover, Callinstr. 38, D-30167 Hannover

Polarising optics will play a key role in future satellite projects like the LISA mission or a GRACE follow-on mission. In these missions it is foreseen to use polarising components in the laser interferometer for beam steering. It is therefore important to investigate the influence of these components on the interferometer sensitivity and to validate the length stability. The talk will describe the design and construction of a quasi-monolithic interferometer for comparing the interferometric performance of non-polarising and polarising optics. Preliminary results will be presented.