Monday, 30.06.2014, Room D 230

Time	ID	ATOMIC PHYSICS AND QUANTUM OPTICS & TASK COMBINED SESSION *Chair: Antoine Weis, Uni Fribourg*
16:30	501	**Systematic effects in the neutron electric dipole moment (nEDM) experiment at Paul Scherrer Institute (PSI).** *Prashanth Pataguppi, UCN, Paul Scherrer Institute, Villigen and Department of Physics, K U Leuven, 5232 Villigen, on behalf of the nEDM collaboration* An experiment to search for the nEDM using ultra-cold neutrons has started to take data at the PSI. A possible nEDM would be observed via a tiny electric-field dependent shift of the neutron-precession-frequency in a simultaneously applied magnetic field. The experiment employs the Ramsey-technique of separated oscillatory fields. Our collaboration aims at reaching a sensitivity for the nEDM of $5 \cdot 10^{-27}$ e·cm (95% C.L.) with the current apparatus. Understanding of all systematic-effects on a corresponding level is crucial to reach this goal. Here, we present specific analysis techniques,the current status of important systematic-effects, and the implications on the sensitivity of the experiment. This work has been supported by the FWO Flanders and the GOA10/10 project of Kath. Univ. Leuven.
17:00	502	**A laser based mercury magnetometer for the nEDM experiment at PSI** *Sybille Komposch, Paul Scherrer Institute, 5232 Villigen, on behalf of the nEDM collaboration* At the Paul Scherrer Institute an international collaboration searches for a permanent electric dipole moment of the neutron, which is a sensitive probe for physics beyond the Standard Model. The experiment uses Ramsey's method of separated oscillating fields to detect an electric field dependent shift in the Lamor frequency of stored ultra-cold neutrons. The experiment requires very sensitive magnetometers to correct for systematic errors related to magnetic field fluctuations. We present progress on a laser based magnetometer which detects the spin precession frequency of ^{199}Hg atoms in the same volume as the neutrons. This work is supported by the SNF under grant 200020_144473.
17:15	503	**Atomic magnetometer array in the nEDM experiment** *Malgorzata Kasprzak, University of Fribourg, Chemin du Musee 3, 1700 Fribourg, for the nEDM collaboration* In this contribution we explain the operation principle of the array of atomic magnetometers mounted in a high precision particle physics experiment measuring the electric dipole moment of a neutron (nEDM). Sixteen scalar cesium magnetometers measure the magnetic field and its gradients in the nEDM setup with the precision of 10^{-7}. The magnetic field is measured by means of magnetic resonance using either continuous or pulsed radio frequency signal. We give the overview of the magnetic field measurements and discuss the results.
17:30	504	**High precision and accurate Cs magnetometer for the nEDM experiment** *Samer Afach, Georg Bison, Paul Scherrer Institute, 5232 Villigen* We have developed a vector magnetometer based on optical pumping of cesium atoms to assess the magnetic field distribution in the neutron Electric Dipole Moment (nEDM) experiment at the Paul Scherrer Institute. The system measures deviations from homogeneous magnetic field conditions, which are an important source of systematic errors in nEDM. We will report on progress with a new magnetometer module, which is expected to achieve better precision and accuracy of the magnetic field measurement.

17:45	**505**	**An accurate fT-magnetometer based on the optically detected free-induction decay (FID) of atomic spin polarization** *Peter Koss, Zoran Grujic, Antoine Weis* *Department of Physics, University of Fribourg, Chemin du Musée 3, 1700 Fribourg* We present an atomic magnetometer recording the free-induction decay of polarized Cs atoms prepared by amplitude-modulated laser light in a paraffin-coated vapor cell exposed to a transverse magnetic field. After pumping the laser power is reduced and the transmitted power shows a decaying modulation at the Larmor frequency. Under optimized conditions the value of a 1 μT field can be extracted with 45 fT sensitivity in 1 second. The FID magnetometer avoids systematic errors occurring in feedback-controlled magnetometers. We currently investigate systematic errors associated with quadratic Zeeman shifts. Arrays of FID-magnetometers will be deployed in the neutron EDM experiment at PSI.
18:00	**506**	**A ^{3}He-Cs magnetometer for absolute measurements of magnetic fields** *Hans-Christian Koch [1], Zoran Grujic [1], Malgorzata Kasprzak [1], Antoine Weis [1], Andreas Kraft [2], Anatoly Pazgalev [2], Werner Heil [2], Georg Bison [3], Jens Voigt [4], Allard Schnabel [4]* *[1] Department of Physics, University of Fribourg, Chemin du musee 3, 1700 Fribourg* *[2] Institute of Physics, University of Mainz, Staudingerweg 7, DE-55128 Mainz* *[3] Paul Scherrer Institute, PSI, 5232 Villigen* *[4] Physikalisch Technische Bundesanstalt, Berlin, Abbestraße 2-12, DE-10587 Berlin* Many fundamental physics experiments, such as the search for the neutron electric dipole moment (nEDM) at PSI, Switzerland, demand precise and accurate measurement of applied magnetic fields. We report on the development and tests of a combined ^{3}He-Cs magnetometer for the high precision absolute measurement of a 1 μT magnetic field. The precession frequency of nuclear spin polarized ^{3}He gas is detected by optically pumped double-resonance Mx-Cesium magnetometers. Measurements in the magnetically shielded room of PTB, Berlin, show that our device has an accuracy better than 100 fT for a 100 second integration time.
18:15		***Postersession and Apéro***
20:15		***Public Lecture***

Tuesday, 01.07.2014, Room F 130

Time	**ID**	**Atomic Physics and Quantum Optics I** *Chair: Joanna Hoszowska, Uni Fribourg*
14:00	**511**	**Quantized Conductance in Neutral Matter** *Dominik Husmann, Sebastian Krinner, Martin Lebrat, David Stadler, Charles Grenier, Jean-Phillippe Brantut, Tilman Esslinger* *Institute for Quantum Electronics, ETH Zürich, Otto-Stern-Weg 1, 8093 Zürich* A fundamental regime of quantum transport is manifested in the emergence of quantized conductance, where changes in the conductance only appear in integer steps of 1/h, with the Planck constant h. Here we present the observation of quantized conductance through a Quantum Point Contact (QPC) realized in a two-terminal setup of ultracold fermionic Lithium-6 atoms. We shape our system with laser light using an ultra-high resolution imaging system to project potentials structures onto the atoms. We observe distinct plateaus in the conductance when tuning either a gate potential or the confinement of the QPC.

14:30	**512**	**Imaging plasmons in an ultrafast Transmission electron microscope** *Fabrizio Carbone, EPFL, Station 6, 1015 Lausanne* The dual wave-particle nature of microscopic systems has been investigated through numerous experiments; by looking at characteristic interference effects, the granular distribution of photons in a beam, or the exchange of quanta of energy. While duality has been observed for electrons in the double-slit experiment, its unambiguous observation for photons has proven more challenging due to the hidden variable conundrum, which has been addressed only recently through delayed-choice experiments. Here, we show that by femtosecond (fs) transmission electron microscopy (TEM), it is possible to capture simultaneously the quantization and the interference pattern of a plasmonic field.
15:00	**513**	**In situ imaging of the microwave field of a vapor cell atomic clock** *Guan-Xiang Du [1], Andrew Horsley [1], Philipp Treutlein [1], Matthieu Pellaton [2], Thejesh Bandi [2], Christoph Affolderbach [2], Gaetano Mileti [2]* *[1] University of Basel, Klingelbergstrasse 82, 4056 Basel* *[2] University of Neuchatel, Avenue de Bellevaux 51, 2000 Neuchatel* We present a new characterisation technique for atomic vapor cells, combining time-domain measurements with absorption imaging to obtain spatially resolved information on decay times, atomic diffusion and coherent dynamics. The technique has been used to characterise both a microfabricated Rb vapor cell placed inside a microwave cavity, and a larger, high-performance vapor cell atomic clock. We obtain high resolution images of the population (T1) and coherence (T2) lifetimes in the cell, and of the individual polarisation components of the applied microwave magnetic field. Our technique is useful for vapor cell characterisation in atomic clocks, atomic sensors, and quantum information experiments.
15:15	**514**	**Thin-disk laser for proton and alpha-particle radii measurements** *Karsten Schuhmann [1], Thomas Graf [2], Aldo Antognini [1], Klaus Kirch [1], Birgit Weichelt [2], Marwan A. Ahmed [2], Andreas Voß [2], Randolf Pohl [3]* *[1] Institute for Particle Physics, ETH Zurich, Otto-Stern-Weg 5, 8093 Zürich* *[2] Institut für Strahlwerkzeuge, Universität Stuttgart, Pfaffenwaldring 43, DE-70569 Stuttgart* *[3] Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Str. 1, DE-85748 Garching* The proton charge radius determined by spectroscopy of the 2S-2P transition in μH is 20 times more precise than from other determinations but seven standard deviations away from the world average. To shed light onto the "proton radius puzzle" we have performed spectroscopy of μ^4He^+. We report on a thin-disk laser composed of a Q-switched oscillator and a multi-pass amplifier delivering pulses of 150 mJ. Its peculiar requirements are stochastic trigger and short delay time (< 500 ns) between trigger and optical output. The laser showed months of stable operation. This work was supported by the SNF_200021L-138175 and DFG_GR_3172/9-1.
15:30	**515**	**Tomography of squeezed and over squeezed states of mesoscopic atomic ensembles** *Matteo Fadel, Roman Schmied, Baptiste Allard, Caspar Ockeloen, Philipp Treutlein* *Department Physik, Universität Basel, Klingelbergstrasse 82, 4056 Basel* The experimental characterization of the quantum state of a mesoscopic ensemble of particles is a major challenge in quantum physics, especially when multi-particle entanglement is present. We experimentally demonstrate tomographic reconstruction of non-classical manybody (pseudo-)spin states. The system consists of a two-component ^{87}Rb Bose-Einstein condensate created on an atom-chip. A state-selective potential gives rise to a S_z^2 interaction term in the Hamiltonian in the collective spin representation. Using this one-axis twisting dynamics, we prepare non-classical spin states. We perform a Stern-Gerlach-type analysis to characterize the many-body quantum states, and from the results of measurements along many quantization axes, we determine the most likely positive-semidefinite density matrix.
15:45		
16:30		***Coffee Break***

Time	ID	**Atomic Physics and Quantum Optics II** *Chair: Jean-Claude Dousse, Uni Fribourg*
17:00	**521**	**Multiphoton inner-shell ionization with high-fluence x-ray free-electron laser femtosecond pulses** *Joanna Hoszowska [1], Jakub Szlachetko [2], Christopher J. Milne [2], Wojciech Blachucki [1], Jean-Claude Dousse [1], Rafael Abela [2], Christian David [2], Yves Kayser [2], Maarten Nachtegaal [2], Bruce D. Patterson [2], Jacinto Sà [2], Grigory Smolentsev [2], Sébastien Boutet [3], Marc Messerschmidt [3], Garth Williams [3], Marek Pajek [4], Christopher T. Chantler [5]* *[1] Department of Physics, University of Fribourg, Chemin du Musée 3, 1700 Fribourg* *[2] Paul Scherrer Institut, 5232 Villigen PSI* *[3] Linac Coherent Light Source (LCLS), SLAC National Accelerator Laboratory, Menlo Parc, 94025 California, USA* *[4] Institute of Physics,Jan Kochanowski University, Świętokrzyska 15, PL-25406 Kielce* *[5] School of Physics, University of Melbourne, Parkville, AU-3010 Victoria* We report on multiphoton ionization of solid Fe with very intense and ultra-short hard x-ray free-electron laser (XFEL) pulses from the Linac Coherent Light Source (LCLS) in Stanford, USA. The experiment was carried out at the CXI end-station by means of high-resolution x-ray emission spectroscopy. The Fe Kα x-ray emission spectra were collected with the von Hamos x-ray spectrometer of PSI. The ultra-focused x-ray beam provided an extreme fluence (~10^4 - 10^5 photons/Å^2). Sequential photon ionization leading to multiple vacancy configuration states and to K-shell hollow atom formation was investigated as a function of the XFEL beam fluence.
17:30	**522**	**An optical polarimeter for measuring the DC and AC magnetic susceptibilities of superparamagnetic fluids and films** *Philipp Aebischer, Victor Lebedev, Antoine Weis* *Departement of Physics, University of Fribourg, Chemin du Musée 3, 1700 Fribourg* We present a simple optical experiment for measuring DC and AC magnetic susceptibilities of superparamagnetic fluids and films. Superparamagnetic iron oxide nanoparticles (SPIONs) have a single magnetic domain. An applied external magnetic field orients the associated magnetic moments, thereby inducing an optical anisotropy that can be detected by optical polarimetry. We demonstrate the technique by measuring the B(H) dependence in static fields, from which we deduce the harmonic response to AC field excitation. The predicted AC response is confirmed by AC susceptibility measurements using the same apparatus. The susceptibilities' frequency dependences allow us to infer particle size distributions.
17:45	**523**	**Magnetorelaxation of superparamagnetic iron oxide nanoparticles (SPIONs) by spatially-resolved atomic magnetometry** *Simone Colombo, Vladimir Dolgovskiy, Victor Lebedev, Antoine Weis* *Physics Department, University of Fribourg, Chemin du Musée 3, 1700 Fribourg* We present two-dimensional maps of the magnetic field prodcued by magnetized SPIONs. A CCD-camera detects laser-induced fluorescence from a 1 mm thick sheet of spin-polarized Cs atoms in a cubic buffer gas cell, the fluorescence yield depending on the magnitude and orientation of the local magnetic field with respect to the spin polarization. The imaging plane of 22x22 mm is located a few mm from the sample, yielding maps with sub-mm spatial and 600 pT magnetic resolution and a current detection limit of 10-20 µg Fe. In view of biomedical applications we have studied SPION relaxation following a magnetizing pulse.

18:00	**524**	**A novel actuator for frequency comb self-referencing based on an optically-pumped SESAM** *Stephane Schilt, Martin Hoffmann, Thomas Südmeyer* *Université de Neuchatel, Av. de Bellevaux 51, 2000 Neuchatel* We present a novel method for carrier envelop offset (CEO) control in an optical frequency comb that combines high bandwidth with low loss, low nonlinearity, low dispersion, and power scalability. It uses intra-cavity opto-optical modulation realized by optically pumping the intra-cavity SESAM used for modelocking the laser. We implemented this new method in a diode-pumped solid-state laser and compared it with the standard method of pump-current modulation. We show an improvement by one order of magnitude of the CEO modulation bandwidth and of the residual integrated phase noise and by a factor of 4 of the relative frequency stability.
18:15	**525**	**Toward the generation of phonon Fock state and on-demand single photons in optomechanical cavities** *Nicolas Piro [1], Christophe Galland [1], Nicolas Sangouard [2], Nicolas Gisin [2], Tobias Kippenberg [1]* *[1] EPFL, SB-LPQM, station 3, 1015 Lausanne* *[2] Uni Genève, Chemin de Pinchat 22, 1211 Genève* Creating non-classical states of macroscopic systems will enable to test quantum mechanics in unexplored regimes, leading to new fundamental insights as well as practical outcomes for quantum information processing and communication. Here we show how to use the radiation pressure interaction in recently developed optomechanical cavities to generate a single-phonon Fock state in a macroscopic oscillator. Our scheme relies on projective measurement upon single-photon detection and is realizable with state-of-art experimental setups. A single quantum of mechanical motion is generated in a heralded way and released, on-demand, as a single photon. Potential applications include long-distance quantum key distribution.
18:30		***END***
19:45		***Conference Dinner***

ID	**Atomic Physics and Quantum Optics Poster**
531	**Imaging of Relaxation and Microwave Field Strength in Vapor Cells** *Andrew Horsley [1], Guan-Xiang Du [1], Matthieu Pellaton [2], Christoph Affolderbach [2], Gaetano Mileti [2], Philipp Treutlein [1]* *[1] Departement Physik, Universität Basel, 82 Klingelbergstrasse, 4056 Basel* *[2] Lab. Temps-Fréquence, Inst. de Physique, Université de Neuchâtel, Avenue de Bellevaux 51, 2009 Neuchâtel* We present a new characterisation technique for atomic vapor cells, combining time-domain measurements with absorption imaging to obtain spatially resolved information on decay times, atomic diffusion and coherent dynamics. The technique has been used to characterise both a microfabricated Rb vapor cell placed inside a microwave cavity, and a larger, high-performance vapor cell atomic clock. We obtain high resolution images of the population (T1) and coherence (T2) lifetimes in the cell, and of the individual polarisation components of the applied microwave magnetic field. Our technique is useful for vapor cell characterisation in atomic clocks, atomic sensors, and quantum information experiments.

532	**A quantitative study of particle size effects in the magnetorelaxometry of superparamagnetic iron oxide nanoparticles (SPIONs) using atomic magnetometry** *Vladimir Dolgovskiy [1], Victor Lebedev [1], Simone Colombo [1], Antoine Weis [1], Benjamin Michen [2], Liliane Ackermann Hirschi [2], Alke Fink [2]* *[1] Department of Physics, University of Fribourg, Chemin du Musée 3, 1700 Fribourg* *[2] Adolphe Merkle Institute, University of Fribourg, Rte de l'Ancienne Papeterie, CP209, 1723 Marly 1* The time-dependent decay of the remanent magnetization of SPIONs (magnetorelaxometry, MRX) plays a role of growing importance in biomedical imaging. The nanoparticle size distribution determines the characteristic timescale of the relaxation process and therefore imposes limitations on the MRX measurement device. MRX signals from oleic acid coated SPIONs of different concentrations and sizes were systematically studied using an atomic gradiometer. By fitting standard MRX model predictions to our data, we infer the samples' anisotropy constant and magnetization, thereby determining the effective particle size range that contributes to the induced magnetic field.
533	**Evaluation of microwave leakage and magnetic field inhomogeneity in the primary frequency standard FoCS-2** *Antoine Jallageas [1], Laurent Devenoges [2], Michael Petersen [1], Jacques Morel [2], Thomas Südmeyer [1]* *[1] Time and frequency laboratory, Neuchâtel university, Av. de Bellevaux 51, 2000 Neuchâtel* *[2] Federal institute of Metrology METAS, Lindenweg 50, 3003 Bern-Wabern* The latest results on the evaluation process of the Swiss primary frequency standard FoCS-2 will be presented. Recently, we have been focusing on electromagnetic fields effects. A careful investigation of microwave leakages originating from both inside and outside the fountain has been made to avoid uncontrolled frequency shifts. The magnetic field inside the fountain has also been investigated, since its homogeneity is important to guarantee the efficiency of the state preparation and to avoid Majorana transitions. Finite element simulations of the magnetic field have shown good agreement with in-situ probe measurements and have allowed for the prediction of the magnetic field.
534	**XAS measurements of 3d, 4d and 5d transition metals using a laboratory-based setup** *Faisal Zeeshan, Joanna Hoszowska, Jean-Claude Dousse, Lucie Loperetti* *Physics Department, University of Fribourg, Chemin du Musée 3, 1700 Fribourg* We report on X-Ray Absorption Spectroscopy (XAS) measurements of several 3d, 4d and 5d transition elements. The measurements were performed in-house by means of a laboratory-based setup using a von Hamos curved crystal spectrometer and a side-window x-ray tube. The K-edges of Ti and Fe, the L_3-edges of Mo, Ta and Pt as well as the L_1-, L_2- and L_3-edges of Ag were measured. Precise edge energies could be determined and compared to existing experimental and theoretical values. A further aim of this work was to investigate the effect of the sample thicknesses on the experimental edge energies.
535	**High energy resolution off-resonant spectroscopy for self-absorption-free XAS study of Ta L_3-edge** *Wojciech Blachucki [1], Jakub Szlachetko [2], Joanna Hoszowska [1], Jean-Claude Dousse [1], Yves Kayser [2], Jacinto Sá [2], Maarten Nachtegaal [2]* *[1] Department of Physics, University of Fribourg, Chemin du Musée 3, 1700 Fribourg* *[2] Swiss Light Source, Paul Scherrer Institut, 5232 Villigen PSI* X-ray absorption spectra measured in the fluorescence-mode are affected by self-absorption effects which results in intensity reduction of the near-edge x-ray absorption fine structure. High energy resolution off-resonant spectroscopy is a technique allowing to convert an off-resonant x-ray emission spectrum into an x-ray absorption one by means of the Kramers-Heisenberg formula modified by Tulkki and Åberg [1]. We demonstrate that the L_3-edge x-ray absorption spectrum of Ta measured with this method is free of self-absorption effects and is obtained in a single shot. [1] J. Tulkki and T. Åberg, J. Phys. B: At. Mol. Phys. 15 (1982), L435

536	**Compact Rubidium-Stabilized Optical Frequency Comb as Source of Reference Frequencies in the 1.55-micrometer Region** *Renaud Matthey, Florian Gruet, Stéphane Schilt, Gaetano Mileti* *Laboratoire Temps-Fréquence, Université de Neuchâtel, Avenue de Bellevaux 51, 2000 Neuchâtel* Applying light modulation and frequency conversion techniques, a frequency stabilized optical frequency comb spanning over 35 nm in the 1.55-micrometer wavelength region has been generated, which benefits from the high frequency stability achievable from rubidium atomic transitions at 780 nm. Frequency stability better than 2 kHz has been demonstrated on time scales between 20 minutes and 2 days, at twice the rubidium wavelength, 1560 nm, and at 1557 nm. The developed compact setup could be of use to applications requiring accurate and stable reference frequencies around 1.55 micrometer, like remote sensing – in particular C02 lidar detection –, spectroscopy and optical communications.
537	**Frequency noise investigation in mid-infrared quantum cascade lasers** *Stephane Schilt [1], Lionel Tombez [1], Stéphane Blaser [2], Romain Terazzi [2], Camille Tardy [2], Richard Maulini [2], Alfredo Bismuto [2], Tobias Gresch [2], Michel Rochat [2], Antoine Muller [2], Thomas Südmeyer [1]* *[1] Université de Neuchatel, Av. de Bellevaux 51, 2000 Neuchatel* *[2] Alpes Lasers SA, 1-3 Pass. Max-Meuron, 2000 Neuchatel* A detailed investigation of flicker frequency noise in more than 20 different quantum cascade lasers emitting at 7-8 µm is presented. We investigated both frequency noise and electrical noise measured on the voltage across the laser, showing a strong correlation between them. The substantial noise difference observed among the different devices indicates the probable existence of various noise sources. The significantly lower noise observed in ridge waveguide lasers compared to buried-heterostructures is explained by extra-noise contributions arising from electrons injection through lateral surfaces. An influence of the width of the laser active region is also shown, with a lower noise observed in larger lasers.
538	**Broadband UV-VIS transient absorption spectroscopy from femtosecond to microsecond time domain** *Sandra Mosquera-Vázquez, Bernhard Lang, Arnulf Rosspeintner, Eric Vauthey* *Université de Genève, 30, quai Ernest Ansermet, 1211 Genève 4* A combination of sub-nanosecond photo excitation and femtosecond supercontinuum probing is used to extend femtosecond transient absorption spectroscopy into the nanosecond and microsecond time domain. The set-up permits to cover time scales from the ultrafast domain up to time ranges traditionally looked at with laser flash photolysis, with the added benefit of a broadband detection. Thereby, photochemical reactions can be followed in real-time from photo-excitation over intra-molecular processes to bond breaking and eventually bond formation within a single experiment. Due to the broadband detection, determination of unexpected reaction pathways is much easier than with conventional flash photolysis.
539	**1914-2014: Electron collisions 100 years after Franck & Hertz** *Michael Allan, Khrystyna Regeta* *Département de chimie, Université de Fribourg, Chemin du Musée 9, 1700 Fribourg* The poster will first remind the visitor of the historical experiments of James Franck and Gustav Hertz on electronic excitation of mercury, and will then sketch the current goals and motivations of the electron-scattering community. Finally it will present an example of current research in Fribourg – measuring the absolute cross sections for electronic excitation of the molecules furane and pyrimidine, motivated by the desire to understand electron-driven chemistry and to support efforts to develop theory for electronic excitation of polyatomic molecules by electron impact.