PSAS'2018 - International Conference on Precision Physics of Simple Atomic Systems

Report of Contributions

https://indico.cern.ch/e/psas2018

Contribution ID: **4** Type: **oral without proceeding**

Precision spectroscopy of the 2S-4P transition in atomic hydrogen

Tuesday, 15 May 2018 16:00 (30 minutes)

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print service

Primary author: MAISENBACHER, Lothar (Max Planck Institute of Quantum Optics)

Presenter: MAISENBACHER, Lothar (Max Planck Institute of Quantum Optics)

Session Classification: Hydrogen

Contribution ID: **5** Type: **oral without proceeding**

Tests of the theory of Quantum-Electrodynamics

Monday, 14 May 2018 16:05 (30 minutes)

We describe recent developments in tests of quantum-electrodynamics (QED),
the theory of the interactions of matter with electro-magnetic fields and forces. The tests focus on consistency in the determination of parameters or constants within QED obtained via multiple independent means and, in particular, by comparisons of precision measurements with, equivalently accurate, theoretical calculations. The most-precise tests rely on a combination of the spectroscopy of atomic hydrogen, g-factor measurements of a free electron as well as that of an electron bound in a hydrogen-like ion, and finally the mass determination of the ions through atom recoil experiments and mass spectroscopy. These experiments determine the dimensionless finestructure constant and the mass of the electron to about ten significant digits, orders of magnitude better than any other description of nature. We also show that an international system of units (SI) based on fixed values of the Planck constant and the charge of the electron (in addition to the fixed value of the speed of light in vacuum) modifies the interpretation of some of these tests.

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Primary authors: Dr TIESINGA, Eite (NIST); Dr MOHR, Peter (NIST)

Presenter: Dr TIESINGA, Eite (NIST)

Session Classification: QED, g-factors #1

Contribution ID: **7** Type: **oral without proceeding**

Towards high-precision spectroscopy of the 1S-2S transition in He+

Tuesday, 15 May 2018 15:10 (20 minutes)

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Primary author: SCHMID, Fabian (Max Planck Institute of Quantum Optics)

Presenter: SCHMID, Fabian (Max Planck Institute of Quantum Optics)

Session Classification: Hydrogen

Contribution ID: **8** Type: **poster contribution**

Nuclear-anapole-moment Effects in Diatomic Molecules

Tuesday, 15 May 2018 18:00 (5 minutes)

In diatomic systems, the rich and varied spectra and nearly degenerate energy levels provide huge enhancements for tiny physical effects, making it possible to look for new physics beyond the Standard Model in a single experiment. Nuclear-spin dependent parity-violating interactions and nuclear-anapole-moment effects in diatomic molecules in particular provide precise test of the electroweak Theory of the Standard Model. For instance, the weak interaction coefficient WA can be used to extract helpful information, which determines nuclear-spin dependent parity-violating interactions, from experiments. It, specifically, depends on electronic structure and can be obtained from evaluating the matrix elements of the $\alpha\rho(r)$ operator in the molecular spinor basis. In this work, the WA coefficients for the selected alkaline earth metal fluorides are reported with relativistic Coupled Cluster methods and their properties are also discussed.

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Primary author: HAO, Y.

Co-authors: BORSCHEVSKY, A. (University of Groningen); ILIAS, M. (Matej Bel University)

Presenter: HAO, Y.

Session Classification: Poster Session, Tuesday

Contribution ID: **9** Type: **poster contribution**

Relativistic corrections for the ground state of hydrogen molecule

Monday, 14 May 2018 17:50 (5 minutes)

for abstract see the attached pdf-file

print service

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Primary author: Dr WANG, Liming (Henan Normal University)

Presenter: Dr WANG, Liming (Henan Normal University)

Session Classification: Poster Session, Monday

Contribution ID: **10** Type: **oral without proceeding**

Accurate spectroscopy of deuterium molecule

Friday, 18 May 2018 09:25 (25 minutes)

The accuracy of the molecular spectroscopy on weak transitions (too weak to saturate) in molecules which cannot be cooled and trapped, is presently limited to the sub-megahertz level, without clear perspectives for further substantial improvements. We demonstrate a new method with the potential to achieve kilohertz-level accuracy. We bring the Doppler-regime measurements into the high-pressure region, where the signal-to-noise-ratio is much higher. The expected deterioration of accuracy by collision-induced systematics [Wcislo2016] is mitigated with ab initio line-shape and quantum scattering calculations [Thibault2017]. We test our approach on a case of weak quadrupole transition in D_2, which is a benchmark system for testing quantum electrodynamics in molecules. We validate our methodology at the 400˜kHz level by comparing our results with the best previous determination [Mondelain2016]. We demonstrate that our approach achieves higher accuracy despite much milder experimental requirements (in Ref.[Mondelain2016], the effective optical path was 20 times longer). For the same experimental apparatus, the accuracy of our approach will be at least one order of magnitude better. For the first time, we applied ab initio quantum scattering calculations to address the collisional line-shape effects [Blackmore1989,May2013] in ultra-accurate spectra analysis collected at high pressures. The experimental and theoretical values of the 2-0 S(2) line position in D_2 reported here constitute the most precise comparison of the experimental and theoretical ab initio determinations of rovibrational splitting for any neutral molecule. We observe a 3.4σ discrepancy, which, together with previously reported discrepancies [Puchalski2017], indicates that the theoretical accuracy is underestimated because of the uncalculated terms.

[Wcislo2016] P. Wcislo, I. E. Gordon, C.-F. Cheng, S.-M. Hu, and R. Ciurylo, Phys. Rev. A 93 (2016) 022501.
[Thibault2017] F. Thibault, K. Patkowski, P. S. Zuchowski, H. Jozwiak, R. Ciurylo, P. Wcislo, J. Quant. Spectrosc. Radiat. Transf. 202 (2017) 308.
[Mondelain2016] D. Mondelain, S. Kassi, T. Sala, D. Romanini, D. Gatti, and A. Campargue, J. Mol. Spectrosc. 326 (2016) 5.
[Blackmore1989] R. Blackmore, S. Green, and L. Monchick, J. Chem. Phys. 91 (1989) 3846.
[May2013] A. D. May, W.-K. Liu, F. R. W. McCourt, R. Ciurylo, J. Sanchez-Fortn Stoker, D. Shapiro, and R. Wehr, Can. J. Phys. 91 (2013) 879.
[Puchalski2017] M. Puchalski, J. Komasa, and K. Pachucki, Phys. Rev. A 95 (2017) 052506.

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Primary authors: WCISLO, Piotr (Nicolaus Copernicus University in Torun); Dr THIBAULT, Franck; Mr ZABOROWSKI, Mikolaj; Dr WOJTEWICZ, Szymon; Dr CYGAN, Agata; Mr KOWZAN, Grzegorz; Dr MASLOWSKI, Piotr; Prof. KOMASA, Jacek (Adam Mickiewicz University); Dr PUCHALSKI, Mariusz; Prof. PACHUCKI, Krzysztof; Prof. CIURYLO, Roman; Prof. LISAK, Daniel

Presenter: WCISLO, Piotr (Nicolaus Copernicus University in Torun)

Session Classification: Molecules #2

Contribution ID: **11** Type: **any type**

New Atomic Probes for Dark Matter and Neutrino-Mediated Forces

Thursday, 17 May 2018 17:15 (20 minutes)

abstract provided as attached pdf-file

print service

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Primary author: STADNIK, Yevgeny (University of New South Wales)

Presenter: STADNIK, Yevgeny (University of New South Wales)

Session Classification: Casimir & Cosmology

Contribution ID: **13** Type: **oral with proceeding**

Constraints for fundamental short-range forces from the neutron whispering gallery, and extention of this method to atoms and antiatoms

Monday, 14 May 2018 15:10 (25 minutes)

Extra fundamental short-range interactions mediated by new bosons are predicted in many extentions of the Standard Model of particle physics. They are also predicted in theories with large extra spatial dimentions and theories involving the light dark matter hypothesis.

To search for such interactions at different charateristic distances, the experimentalists use many methods including measurements of gravitational interaction at short distances, the search for extra interactions on top of the van der Waals/Casimir-Polder interaction, the search for rare proceeses in neutrino detectors, precision measurements with atoms, molecules and neutrons. Comparison of the sensitivities of different experiments to extra short-range forces in the standard Yukawa parametrization is published, for example, in ref. [1].

A competitive method of searching at characteristic distances of about 10 nm is the precision measurement of the neutron whispering gallery [2]. This phenomenon is analogous to the well-known phenomenon of the whispering gallery of electromagnetic waves of a broad frequency range, as well as the sound wave. However, a material wave, for example a neutron wave, provides an additional possibility due to the existence of a nonzero neutron mass: for a neutron, the energy values of the whispering-gallery quantum states depend on the mass of the neutron and the interactions of this mass with the surface. Moreover, the neutron in such quantum states is localized at a distance from the surface of the order of tens of nanometers. Even a tiny extra force between the neutron and the surface at such distances would lead to a measurable shift in the energy of whispering-gallery quantum states.

We present the results of experiments performed with cold neutrons and estimate their sensitivity to extra short-range forces. We affirm that this method can also be extended to experiments with atoms and antiatoms [3]. The sensitivity of atomic experiments may be even higher than thus providing a similar, or even higher than the sensitivity of neutron experiments. More details could be found in [4].

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Primary authors: NESVIZHEVSKY, Valery (ILL); Prof. VORONIN, Alexei (Lebedev Institute)

Presenter: NESVIZHEVSKY, Valery (ILL)

Session Classification: Antihydrogen

Contribution ID: **14** Type: **oral without proceeding**

Sub-kHz measurement of the 2 3S −2 1S transition frequency in 4He

Thursday, 17 May 2018 14:25 (20 minutes)

for abstract see the attached pdf-file

print service

Primary author: Dr VASSEN, Wim (LaserLaB Vrije Universiteit Amsterdam)

Presenter: Dr VASSEN, Wim (LaserLaB Vrije Universiteit Amsterdam)

Session Classification: Helium, 3-Body-Systems

Contribution ID: **15** Type: **oral without proceeding**

Testing QED with precision spectroscopy of the helium atom

Thursday, 17 May 2018 14:00 (25 minutes)

Precision spectroscopy in few-body atomic systems, like hydrogen and helium, enables the testing of the quantum electrodynamics(QED) theory and determination of the fundamental physical constants, such as the Rydberg constant~\cite{2013H}, the proton charge radius~\cite{2009Biraben_HydrogenReview}, and the fine-structure constant~\cite{2010Pachucki,2017Zheng}. It also sets constraints on new physics beyond the standard Model(BSM). High-precision spectroscopy of atomic helium, combined with ongoing theoretical calculations for the point nucleus may allow an alternative determination of the helium nuclear charge radius, which could be more accurate than from the electron scattering. Moreover, the comparison of results from electronic and muonic helium will provide a sensitive test of universality in the electromagnetic interactions of leptons.

The 2^3S-2^3P transition of He is particularly suitable for this purpose, because it is relatively sensitive to the nuclear charge radius and can be calculated within the QED theory up to mα^7 order. These calculations will bring the theoretical accuracy to the 10-kHz level and may allow the determination of the helium nuclear charge radius with an accuracy of 10^{-3}.

Recently, We perform an laser spectroscopy measurement of the 2^3S-2^3P transition of ^4He in an atomic beam. The configuration of the experimental setup is shown in Fig.1. The new centroid frequency of the 2^3S-2^3P may lead to a determination of the nuclear charge radius of He(r_{He}) with a relative accuracy of 10^{-3},once the theoretical calculations for mα^7 corrections have been accomplished. This will enable a comparison of the r_{He} values obtained from electronic and from muonic helium in the future. Such a comparison will help to resolve the proton charge radius puzzle, while in the case of disagreement with muonic determination it will open a window for new physics beyond the standard Model by violation of the lepton universality in electro-magnetic interactions.
\end{multicols}

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Primary authors: Dr SUN, Yu (University of Science and Technology of China); ZHENG, Xin (University of Science and Technoloy of China); Prof. PACHUCKI, Krzysztof (University of Warsaw); Prof. HU, Shui-ming (University of Science and Technoloy of China)

Presenter: Dr SUN, Yu (University of Science and Technology of China)

Session Classification: Helium, 3-Body-Systems

Contribution ID: **16** Type: **poster contribution**

Towards a search for Dark Matter using atomic Dysprosium

Tuesday, 15 May 2018 17:55 (5 minutes)

Towards a search for Dark Matter using atomic Dysprosium
A. Sharma a,b, M. Leyser a,b, A. V. Viatkina a,b, L. Bougas a,b and D. Budker a,b

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Studies of rotation curves of galaxies, initiated by Oort & Zwicky (1930's) and later by Rubin (1970's) led to the Dark Matter (DM) hypothesis and the subsequent evidence for the existence of Dark Matter and Dark Energy. Search for the elusive dark matter candidates has been going on since the early 1970's. Oddly, the Standard Model (SM) with all its tremendous successes (most notably, in the recent past, being the discovery of the Higgs boson at the LHC, CERN) has so far failed to provide an insight into the candidates that may directly or indirectly relate to Dark Matter or Dark Energy.

Experimental efforts (including the ones at the LHC, CERN) initiated towards the search of axions and WIMPs (Weakly Interacting Massive Particles), both of which are potential Dark Matter candidates, have still not produced any definitive outcome related to the origin of Dark Matter and the still yet elusive, Dark Matter particles. In our group, we are trying to search for possible Dark Matter (DM) candidates through precision atomic spectroscopy on dysprosium (Dy) atoms. Dysprosium (Dy) is an atomic system that has in the past been used for searching for possible variations of fundamental constants [1] with the aim of constraining possible dark matter candidates and also exploited for the search of parity-violating effects mediated by cosmic fields that may be part of dark matter. This experiment was also used towards a search for ultralight dilatonic dark matter [2] (that was also used to improve constraints on possible quadratic interactions of scalar dark matter by 15 orders of magnitude), and most recently, a search for possible exotic interactions sourced by massive bodies and mediated by light scalar bosons [3].

We are proposing to use the same system for performing precision ISS (Isotope Shifts Spectroscopy) measurements with sub-Hz precision, with the aim of searching for New Physics (NP) beyond the Standard Model (BSM) through possible non-linearities that may arise on a King Plot (KP) [4]. The idea is based on isotope shifts spectroscopy (ISS) and establishing a King Plot (KP) through frequency measurements across multiple isotopes of dysprosium (Dy) in the RF (Radio Frequency) and the optical domain. In an ideal scenario, the King Plot (KP) is linear with mass and frequency ratio scaling measured for two different transitions across multiple isotopes. Non- linearities in the King Plot may arise from possible dark matter candidates that couple to the atomic nucleus and electrons through short range forces. I shall present our experimental efforts that have been initiated towards this end with an emphasis on the current status and possible experimental outcomes.

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[1] N. Leefer et al., Phys. Rev. Lett. 111 (2013) 060801.
[2] K. van Tilburg et al., Phys. Rev. Lett. 115 (2015) 011802. [3] N. Leefer et al., Phys. Rev. Lett. 117 (2016) 271601.
[4] J. C. Berengut et al., arXiv:1704.05068 [hep-ph]

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Primary author: Dr SHARMA, Arijit (Helmholtz Institut Mainz)

Presenter: Dr SHARMA, Arijit (Helmholtz Institut Mainz)

Session Classification: Poster Session, Tuesday

Contribution ID: **17** Type: **oral without proceeding**

Bound-electron g-factor and tetraquarks

Thursday, 17 May 2018 10:10 (20 minutes)

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Primary author: CZARNECKI, Andrzej

Presenter: CZARNECKI, Andrzej

Session Classification: QED, g-factors #3

Contribution ID: **18** Type: **oral without proceeding**

Nuclear Spin-Independent Effects of Parity NonConservation in Molecule of Hydrogen

Friday, 18 May 2018 10:10 (20 minutes)

for abstract see attached pdf file

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Primary author: Mr CHUBUKOV, Dmitrii (Saint Petersburg State University)

Presenter: Mr CHUBUKOV, Dmitrii (Saint Petersburg State University)

Session Classification: Molecules #2

Contribution ID: **19** Type: **poster contribution**

P,T -odd Faraday effect in heavy neutral atoms

Monday, 14 May 2018 17:40 (5 minutes)

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Primary author: CHUBUKOV, Dmitrii (Saint Petersburg State University)

Presenter: CHUBUKOV, Dmitrii (Saint Petersburg State University)

Session Classification: Poster Session, Monday

Contribution ID: **20** Type: **oral without proceeding**

Toward a determination of the proton-to-electron mass ratio from a Lamb-dip measurement of HD

Friday, 18 May 2018 09:00 (25 minutes)

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Primary author: HU, Shuiming (Univ Sci & Tech China)

Presenter: HU, Shuiming (Univ Sci & Tech China)

Session Classification: Molecules #2

Contribution ID: **21** Type: **oral without proceeding**

Leptonic and semi-leptonic decays of charmed mesons at BESIII

Friday, 18 May 2018 13:40 (15 minutes)

The BESIII experiment at BEPCII accumulated the world's largest e^+e^- collision samples at 3.773 and 4.178 GeV. We have studied the purely leptonic decays $D^+_{(s)} \to l^+v$, and the semi-leptonic decays of $D^0 \to K(\pi)^- e^+ v_e$, $K(\pi)^- \mu^+ v_\mu$, $D^+ \to \bar{K}^0(\pi^0) e^+ v_e$, $\bar{K}^0(\pi^0)\mu^+ v_\mu$ and $D_s^+ \to K^{(*)0} e^+ v_e$. We will report the improved measurements of the branching fractions of these decays and the CKM matrix elements $|V_{cs(d)}|$, the $D^+_{(s)}$ decay constants, the form factors of $D^+_{(s)}$ semi-leptonic decays. These results are important to calibrate the LQCD calculations of $D^+_{(s)}$ decay constants and form factors and to test the CKM unitarity.

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Primary author: COLLABORATION, BESIII

Presenter: COLLABORATION, BESIII

Session Classification: Hadrons

Contribution ID: **23** Type: **oral with proceeding**

The $\mu\mu$tron physics program

Friday, 18 May 2018 14:10 (20 minutes)

The construction of the low-energy e^+e^- collider ($\mu\mu$tron) operating near the muon-pair production threshold begins in 2018 at BINP (Novosibirsk). The collider parameters and configuration (a luminosity of 8×10^{31} cm^{-2}c^{-1}), an center-of-mass energy spread of 400 keV, and beams collision with a large crossing angle) allow to perform experiments on study of dimuonium properties. The dimuonium is the $\mu^+\mu^-$ bound state that has not yet been observed. At $\mu\mu$tron it will be possible to detect about 40 thousand dimuonium atoms per year (10^7 s). In this report we describe the physics program of $\mu\mu$tron.

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Primary authors: Mr GRIBANOV, Sergei (BINP (Novosibirsk)); Mr DRUZHININ, Vladimir (BINP (Novosibirsk)); Mr MILSTEIN, Alexander (BINP (Novosibirsk))

Presenter: Mr GRIBANOV, Sergei (BINP (Novosibirsk))

Session Classification: Hadrons

Contribution ID: **24** Type: **oral without proceeding**

High-Precision Measurement of the Proton's Atomic Mass

Tuesday, 15 May 2018 11:25 (25 minutes)

Abstract is provided as attached pdf-file.

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Primary author: HEISSE, Fabian (Max Planck Institute for Nuclear Physics)

Presenter: HEISSE, Fabian (Max Planck Institute for Nuclear Physics)

Session Classification: Electron and Proton Masses

Contribution ID: **25** Type: **oral with proceeding**

Collider experiment SND and Precision Physics with hadronic e^+e^- cross sections

Friday, 18 May 2018 14:50 (25 minutes)

Spherical neutral detector (SND) is an experiment for e^+e^- annihilation study at moderate energies 0.2-2 GeV. The light quark anti-quark bound states are main subject of study at these energies. The quark anti-quark states express themselves as resonances in the e+e- ->hadronic cross sections. The hadronic cross sections could be recalculated to hadronic vacuum polarization (HVP). The Standard Model predictions today are limited by HVP which is not calculable with modern Quantum chromo dynamics theory. In this talk we present the review of the hadronic cross sections measurements at SND and some new measurements: $e^+e^- \to \pi^+\pi^-, \pi^0\gamma, K^+K^-, \omega\pi^0, K^+K^-\eta, \pi^+\pi^-\eta, K_SK_L\pi^0, \pi^+\pi^-\pi^0\eta, \omega$ e.t.c.

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Primary authors: KHARLAMOV, Alexey (Budker Institute of Nuclear Physics (RU)); Prof. ACHASOV, M.N. (BINP); Prof. AULCHENKO, V.M.; BARNYAKOV, Alexey (Budker Institute of Nuclear Physics (RU)); BELOBORODOV, Konstantin (Budker Institute of Nuclear Physics (RU)); Dr BERDYUGIN, A.V. (BINP); Dr BERKAEV, D.E. (BINP); BOGDANCHIKOV, Alexander (Budker Institute of Nuclear Physics (RU)); Mr BOTOV, A.A. (BINP); DRUZHININ, Vladimir (BINP, Novosibirsk); GOLUBEV, Vladimir (Budker Institute of Nuclear Physics); KARDAPOLTSEV, Leonid (Novosibirsk State University (RU)); Mr KASAEV, A.S.; Mr KIRPOTIN, A.N. (BINP); KOOP, Ivan (BINP); Mr KORNEEV, L.A. (BINP); Dr KOROL, Aleksandr (Budker Institute of Nuclear Physics (RU)); Mr KOSHUBA, S.V. (BINP); Mr KOVRIZHIN, D.P. (BINP); KUPICH, Andrey (Budker Institute of Nuclear Physics (RU)); Mr LITVINOV, R.A. (BINP); Ms MARTIN, K.A. (BINP); MELNIKOVA, Natalya (Budker Institute of Nuclear Physics (RU)); MUCHNOI, Nickolai; OBRAZOVSKY, Alexandr (Budker Institute of Nuclear Physics, Novosibirsk, Russia); Prof. PAKHTUSOVA, E.V. (BINP); Mr PUGACHEV, K.V. (BINP); Mr ROGOVSKY, Yu.A. (BINP); ROGOZINA, Elizaveta (Novosibirsk State University (RU)); SEREDNYAKOV, Sergey; Mr SENCHENKO, A.I. (BINP); SHTOL, Dmitry (Novosibirsk State University (RU)); SHWARTZ, Dmitry (BINP); Dr SILAGADZE, Z.K. (BINP); Mr SURIN, I.K. (BINP); Mr USOV, Yu.V. (BINP); Dr VASILJEV, A.V. (BINP); ZHABIN, Viktor (CERN); Dr DIMOVA, Tatyana (Novosibirsk State University (RU))

Presenter: KHARLAMOV, Alexey (Budker Institute of Nuclear Physics (RU))

Session Classification: Hadrons

Contribution ID: **28** Type: **oral with proceeding**

Hadronic atoms spectroscopy: overview and perspectives

Thursday, 17 May 2018 11:00 (30 minutes)

I shall review the results obtained in recent years in the experimental studies of exotic atoms, in particular on hadronic atoms.
I shall mostly focus on the studies of kaonic atoms performed at the DAFNE collider of LNF-INFN and at J-PARC in Japan, which have produced a valuable wealth of data which are used by theoreticians to better understand the QCD in non-perturbative sector, with implications going from particle and nuclear physics to astrophysics.
I shall present future perspectives, including ongoing programs, as SIDDHARTA-2 at DAFNE and E57 and E62 at J-PARC, as well as plans to measure sigmonic atoms transitions and to perform dedicated measurements of kaonic atoms to solve the "charged kaon mass inconsistency".
Hadronic atoms studies represents a unique opportunity to unlock the secrets of the QCD in the low-energy regime and to disentangle the role of strangeness in the neutron stars (equation of state of neutron stars).

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Primary author: CURCEANU, Catalina Oana (INFN e Laboratori Nazionali di Frascati (IT))

Presenter: CURCEANU, Catalina Oana (INFN e Laboratori Nazionali di Frascati (IT))

Session Classification: Exotic Atoms

Contribution ID: **29** Type: **oral without proceeding**

Interleaved Matter-wave Gyroscope with 2x10^-10 rad/s Stability

Monday, 14 May 2018 11:30 (20 minutes)

for abstract see attached pdf-file

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Primary author: GEIGER, Remi (Observatoire de Paris)

Presenter: GEIGER, Remi (Observatoire de Paris)

Session Classification: Special Transitions

Contribution ID: **32** Type: **poster contribution**

Recent progresses in building a femtosecond extreme-ultraviolet (XUV) comb at WIPM

Tuesday, 15 May 2018 18:30 (5 minutes)

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Primary author: Dr HUA, LinQiang (wipm)

Co-authors: Mr ZHANG, Jin (wipm); Prof. LIU, XiaoJun (wipm)

Presenter: Dr HUA, LinQiang (wipm)

Session Classification: Poster Session, Tuesday

Contribution ID: **33** Type: **poster contribution**

The relativistic and radiative corrections to polarizability of hydrogen-like atoms

Monday, 14 May 2018 18:10 (5 minutes)

The polarizability in atomic physics is important to determining the frequency standard [1], magic wavelengths and the tune-out wavelengths [2,3] of the atom in the optical lattice clock. It is also used to calculating the long-range interactions between atoms [4], in the cold atom research. However the higher order corrections are still researched inadequately [1,5].

In this work, starting from the relativistic polarizability of the Hydrogen-like atoms, we derive the operators of the nonrelativistic leading term and first order perturbation term: relativistic corrections and radiative corrections by applying Nonrelativistic Quantum Electrodynamic approach [6,7]. These correction are the dynamical parts, which dependent on the electric field frequency. The Bethe-logarithm-like correction is also obtained. This study can be helpful in our next step research about blackbody radiation contribution in atomic system, which is based on our previous study [8].

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Primary authors: Dr ZHOU, Wanping (School of Physics and Technology, Wuhan University, china); Mr MEI, Xuesong (School of Physics and Technology, Wuhan University, china); Dr QIAO, Haoxue (School of Physics and Technology, Wuhan University, china)

Presenter: Dr ZHOU, Wanping (School of Physics and Technology, Wuhan University, china)

Session Classification: Poster Session, Monday

Contribution ID: **35** Type: **oral with proceeding**

Precision Spectroscopic applications of cold molecular ions

Monday, 14 May 2018 11:05 (25 minutes)

Cold molecular ions prepared by sympathetic cooling with laser-cooled atomic ions in an ion trap represent attractive systems for new spectroscopic experiments. The long trapping times (up to hours) and state lifetimes (up to minutes) [1,2] in an almost perturbation-free environment enable the long interaction times required for the study of "forbidden"spectroscopic transitions which have not been accessible before in molecular ions.
Here, we report the first direct observation of electric-dipole-forbidden, quadrupole- allowed infrared transitions in a molecular ion (N_2^+ in our case) [3], more than 60 years after such transitions have first been observed in a neutral molecule. The detection of these extremely weak transitions was enabled through a combination of the state-selective preparation of the molecular ions, their sympathetic cooling into the near-perturbation-free environment of a Coulomb crystal and the application of a highly sensitive charge-transfer detection scheme. The observed transitions in molecular ions can exhibit very small natural linewidths, rendering them ideal for spectroscopic precision experiments [4].

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Primary authors: Prof. TONG, Xin (Wuhan Institute of Physics and Mathematics, Chinese Academy of Sciences); Dr ZHONG, Zhen-Xiang (Wuhan Institute of Physics and Mathematics, Chinese Academy of Sciences); Prof. WILLITSCH, Stefan (Department of Chemistry, University of Basel)

Presenter: Prof. TONG, Xin (Wuhan Institute of Physics and Mathematics, Chinese Academy of Sciences)

Session Classification: Special Transitions

Contribution ID: **37** Type: **oral without proceeding**

Improved determination of the dissociation energy of H2

Friday, 18 May 2018 09:50 (20 minutes)

The dissociation energy (D_0) of H_2 is a benchmark value in quantum chemistry, with recent QED calculations now approaching accuracies achievable in simple atoms. Precise measurement of the GK-X molecular transition, in combination with other precision measurements, provides a determination of D_0. The GK-X transition is excited through Doppler-free two-photon spectroscopy using 179-nm radiation, based on frequency up-conversion using a special KBBF crystal. The optical frequency of the fundamental (716 nm), which is the output of a narrowband pulsed Ti:Sa laser system, is locked to a frequency comb. This enables accuracies of the GK-X transition to a few parts in 10^{10} or MHz level, leading to an order-of-magnitude improvement for D_0. The comparison of this accurate experimental result with the best calculations may provide a test of the Standard Model of Physics.

print service

Primary author: CHENG, Cunfeng (Vrije Universiteit Amsterdam)

Co-authors: HUSSELS, Joël; SALUMBIDES, Edcel (Vrije Universiteit Amsterdam); Dr BETHLEM, Hendrik; HU, Shuiming (Univ Sci & Tech China); EIKEMA, Kjeld; UBACHS, Wim (VU University Amsterdam)

Presenter: CHENG, Cunfeng (Vrije Universiteit Amsterdam)

Session Classification: Molecules #2

Contribution ID: **39** Type: **oral with proceeding**

The 413 nm tune-out wavelength for $2\,^3S_1$ state of helium as test of QED

Thursday, 17 May 2018 14:45 (25 minutes)

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Primary author: TANG, Li-Yan (Wuhan Institute of Physics and Mathematics, Chinese Academy of Sciences. China)

Presenter: TANG, Li-Yan (Wuhan Institute of Physics and Mathematics, Chinese Academy of Sciences. China)

Session Classification: Helium, 3-Body-Systems

Contribution ID: **41** Type: **oral with proceeding**

Precision spectroscopy of HD at 1.4 μm

Wednesday, 16 May 2018 12:05 (25 minutes)

Text provided in the uploaded pdf.

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Primary author: GRAVINA, Stefania (University of Campania "Luigi Vanvitelli")

Presenter: GRAVINA, Stefania (University of Campania "Luigi Vanvitelli")

Session Classification: Molecules #1

Contribution ID: **42** Type: **poster contribution**

High-accuracy ab-initio calculations of magic wavelengths for the $2\,^3S_1 \rightarrow 2\,^1S_0$ transition of helium

Tuesday, 15 May 2018 18:20 (5 minutes)

text provided in the uploaded pdf

print service

no, I'll bring my poster to the conference

Primary author: ZHANG, Yong-Hui (Wuhan Institute of Physics and Mathematics, Chinese Academy of Sciences)

Presenter: ZHANG, Yong-Hui (Wuhan Institute of Physics and Mathematics, Chinese Academy of Sciences)

Session Classification: Poster Session, Tuesday

Contribution ID: **43** Type: **poster contribution**

Hyperfine structure in heavy muonic atoms

Monday, 14 May 2018 18:30 (5 minutes)

We consider bound states between an atomic nucleus and a muon, so called muonic atoms. Especially for high charge numbers, the surrounding atomic electrons do not influence the muon and the system is essentially hydrogenlike. Just as in normal atoms, there is fine and hyperfine splitting, but the significance of the various contributions differs dramatically. In particular, nuclear structure effects are much bigger, and vacuum polarization effects are very important. We calculate the level structure in heavy muonic atoms, taking several QED and nuclear structure effects into account in first-order perturbation theory and beyond. Thereby, precise values of the hyperfine structure of muonic atoms are obtained [1] and the dependence of transition energies in muonic atoms on nuclear parameters is investigated.
[1]: Phys. Rev. **A** 96, 032510 (2017)

print service

no, I'll bring my poster to the conference

Primary author: Mr MICHEL, Niklas (Max-Planck-Institute for Nuclear Physics)

Co-authors: Dr ORESHKINA, Natalia S. (Max-Planck-Institute for Nuclear Physics); Prof. KEITEL, Christoph H. (Max-Planck-Institute for Nuclear Physics)

Presenter: Mr MICHEL, Niklas (Max-Planck-Institute for Nuclear Physics)

Session Classification: Poster Session, Monday

Contribution ID: **44** Type: **oral with proceeding**

Higher Order Corrections to Positronium Energy Levels

Wednesday, 16 May 2018 09:25 (25 minutes)

Positronium spectroscopy is of continuing interest as a high-precision test of our understanding of binding in QFT. Positronium represents the purest example of binding in QFT as the constituents are structureless and their interactions are dominated by QED with only negligible contributions from strong and weak effects. Positronium differs from other Coulombic bound systems such as hydrogen or muonium in having maximal recoil (the constituent mass ratio m/M is one) and being subject to real and virtual annihilation into photons. Spectroscopic studies of low-lying states ($n = 1$ hyperfine splitting, $n = 2$ fine structure, and the $2S - 1S$ interval) have reached a precision of order $1MHz$, and ongoing experimental efforts give the promise of improved results. Theoretical calculations of positronium energies at order $m\alpha^6 \sim 18.7MHz$ are complete, but only partial results are known at order $m\alpha^7 \sim 0.14MHz$. I will report on the status of the positronium energy calculations, give some details of the methods employed, and present the latest results for order $m\alpha^7$ contributions.

print service

Primary author: Dr ADKINS, Gregory (Franklin & Marshall College)

Presenter: Dr ADKINS, Gregory (Franklin & Marshall College)

Session Classification: Positronium & Muonium

Contribution ID: **45** Type: **oral with proceeding**

A New Experiment for the Measurement of the g-Factors of 3He+ and 3He2+

Tuesday, 15 May 2018 14:45 (25 minutes)

text provided in the uploaded pdf

print service

Primary author: Dr MOOSER, Andreas (RIKEN)

Presenter: Dr MOOSER, Andreas (RIKEN)

Session Classification: QED, g-factors #2

Contribution ID: **46** Type: **poster contribution**

Searching for the first excited nuclear state of 229Th

Tuesday, 15 May 2018 18:15 (5 minutes)

for abstract see attached pdf-file

print service

Primary author: HUA, Xia (Wuhan Institute of Physics and Mathmatics)

Presenter: HUA, Xia (Wuhan Institute of Physics and Mathmatics)

Session Classification: Poster Session, Tuesday

Contribution ID: **47** Type: **poster contribution**

Hylleraas-B-spline basis set and its application of energies, polarizability and Bethe-logarithm of helium

Tuesday, 15 May 2018 18:25 (5 minutes)

for abstract see attached pdf-file.

print service

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Primary author: SANJIANG, Yang (Wuhan Institute of Physics and Mathematics)

Presenter: SANJIANG, Yang (Wuhan Institute of Physics and Mathematics)

Session Classification: Poster Session, Tuesday

Contribution ID: **48** Type: **oral with proceeding**

Precision tests with molecular hydrogen and isotopes

Wednesday, 16 May 2018 11:35 (30 minutes)

Molecular hydrogen has emerged as a benchmark quantum test system for fundamental physics, where current high-precision measurements challenge the most accurate theoretical calculations that include relativistic and quantum electrodynamics (QED) contributions. Investigations on isotopic molecular species containing deuterium and tritium provide opportunities to expand such fundamental tests, that will aid in unravelling important higher-order mass-dependent corrections as well as nuclear size contributions to the level energy structure. In the context of the long-standing Amsterdam program on precision measurements in molecular hydrogen, recent measurements on HD and T_2 will be presented. Extremely weak transitions in the $(v = 0 \rightarrow 2)$ overtone band of the HD molecule were measured with sub-Doppler resolutions to obtain transition frequencies with three orders of magnitude improvement in accuracy. In a second study, precision measurements on the fundamental $(v = 0 \rightarrow 1)$ vibrational splittings of the radioactive T_2 molecule were also performed yielding transition energies that are 250 times more accurate than previous studies. These benchmark values provide a test of QED theory in the hydrogen molecule, open up another avenue to pursue a solution to the proton radius puzzle, and point towards precision studies of nuclear structure. With further progress in the first principles calculations, future comparisons between experiment and theory will yield stronger constraints on new physics such as hypothetical fifth forces and extra dimensions.

print service

Primary author: SALUMBIDES, Edcel (Vrije Universiteit Amsterdam)

Presenter: SALUMBIDES, Edcel (Vrije Universiteit Amsterdam)

Session Classification: Molecules #1

Contribution ID: **49** Type: **oral without proceeding**

Hydrogen molecular ions and fundamental constants

Tuesday, 15 May 2018 11:50 (20 minutes)

text provided in the uploaded pdf

print service

Primary author: Dr KARR, Jean-Philippe (Laboratoire Kastler Brossel)

Presenters: Dr KARR, Jean-Philippe (Laboratoire Kastler Brossel); KARR, Jean-Philippe (Laboratoire Kastler Brossel)

Session Classification: Electron and Proton Masses

Contribution ID: **50** Type: **oral with proceeding**

FAMU: studies of the energy dependent transfer rate $\Lambda_{\mu p \to \mu O}$

Thursday, 17 May 2018 11:30 (25 minutes)

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print service

Primary authors: VACCHI, Andrea (Universita e INFN, Trieste (IT)); Dr MOCCHIUTTI, Emiliano (INFN Trieste)

Presenter: Dr MOCCHIUTTI, Emiliano (INFN Trieste)

Session Classification: Exotic Atoms

Contribution ID: **51** Type: **poster contribution**

Nonadiabatic rotational states of H2, HD, and D2

Monday, 14 May 2018 17:45 (5 minutes)

abstract provided as attached pdf-file

print service

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Primary authors: Prof. PACHUCKI, Krzysztof; KOMASA, Jacek (Adam Mickiewicz University)

Presenter: KOMASA, Jacek (Adam Mickiewicz University)

Session Classification: Poster Session, Monday

Contribution ID: **52** Type: **any type**

Relativistic correlation and QED effects on the radiative decay of 1s2s3s configuration in Li-like ions

Thursday, 17 May 2018 09:00 (25 minutes)

Abstract attached

print service

Primary author: NATARAJAN, Lakshmi (University of Mumbai)

Presenter: NATARAJAN, Lakshmi (University of Mumbai)

Session Classification: QED, g-factors #3

Contribution ID: **54** Type: **oral with proceeding**

The construction of the low energy Li+ source and the preliminary spectroscopy for the 1s2s 3S - 1s2p 3P transitions

Thursday, 17 May 2018 15:10 (25 minutes)

As the simplest system, Li+ has significant application in verifying the quantum electrodynamics (QED) theory and determination of the fine-structure constant, because the spectrum of Li+ ion can be calculated accurately in theory. We constructed a low energy Li+ source by electron bombardment, and energy of the 7Li+ ions is 500 eV. The 1s2s 3S -1s2s 3P transitions of 7Li+ are investigated by laser saturation spectroscopy on a low-energy Li+ ion beam which radial Doppler broadening is optimized to 200 MHz, and the transition frequency is identified by Lamb dip (Linewidth ˜ 40 MHz). Meanwhile, the laser frequency is measured by an optical frequency comb (FC8004, Menlo Systems GmbH). Hyperfine and fine structure splits can be derived from these transitions, in which most of the systematic frequency shifts are canceled. We are optimizing the stability of the laser and ion beam. The uncertainty of the hyperfine and fine structure splits is promising to less than 100 kHz.

print service

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Primary author: GAO, Kelin (Wuhan Institute of Physics and Mathematics (WIPM) of Chinese Ac)

Presenter: GAO, Kelin (Wuhan Institute of Physics and Mathematics (WIPM) of Chinese Ac)

Session Classification: Helium, 3-Body-Systems

Contribution ID: **55** Type: **oral with proceeding**

Cw laser spectroscopy of the 1S-3S transition in hydrogen: new contribution to the proton radius puzzle

Tuesday, 15 May 2018 16:30 (25 minutes)

Text provided in the uploaded pdf.

print service

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Primary author: THOMAS, Simon (Kastler-Brossel Laboratory)

Presenter: THOMAS, Simon (Kastler-Brossel Laboratory)

Session Classification: Hydrogen

Contribution ID: **56** Type: **oral without proceeding**

The CODATA 2017 Special Adjustment of the Fundamental Constants and the New SI

Monday, 14 May 2018 09:25 (30 minutes)

abstract provided as attached pdf-file

print service

Primary author: Dr NEWELL, David (NIST)

Presenter: Dr NEWELL, David (NIST)

Session Classification: New SI System

Contribution ID: **57** Type: **any type**

Precision Measurement of the Isotope Shift in Neutral Boron

Friday, 18 May 2018 12:00 (20 minutes)

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print service

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Primary author: MAASS, Bernhard (Technische Universitaet Darmstadt (DE))

Presenter: MAASS, Bernhard (Technische Universitaet Darmstadt (DE))

Session Classification: Symmetry Violations & EDMs

Contribution ID: **59** Type: **oral without proceeding**

Precise study of heavy-atom compound electronic structure to extract fundamental properties of electron and nuclei

Friday, 18 May 2018 11:40 (20 minutes)

for abstract see attached pdf-file

print service

Primary author: Dr SKRIPNIKOV, Leonid (NRC «Kurchatov Institute» - PNPI, SPbU)

Presenter: Dr SKRIPNIKOV, Leonid (NRC «Kurchatov Institute» - PNPI, SPbU)

Session Classification: Symmetry Violations & EDMs

Contribution ID: **60** Type: **oral without proceeding**

Nuclear recoil effect on the g factor of lithiumlike ions

Monday, 14 May 2018 16:35 (30 minutes)

For abstract see attached pdf-file.

print service

Primary authors: Dr MALYSHEV, Aleksei (St. Petersburg State University); Prof. SHABAEV, Vladimir (St. Petersburg State University); Dr GLAZOV, Dmitry (St. Petersburg State University); Prof. TUPITSYN, Ilya (St. Petersburg State University)

Presenter: Dr MALYSHEV, Aleksei (St. Petersburg State University)

Session Classification: QED, g-factors #1

Contribution ID: **61** Type: **any type**

Muon (g-2) and measurement of hadronic cross-sections at CMD-3

Friday, 18 May 2018 14:30 (20 minutes)

text provided in the uploaded pdf

print service

Primary author: LOGASHENKO, Ivan (BINP)

Presenter: LOGASHENKO, Ivan (BINP)

Session Classification: Hadrons

Contribution ID: **62** Type: **poster contribution**

The next generation of laser spectroscopy experiments of light muonic atom

Monday, 14 May 2018 18:25 (5 minutes)

for abstract see attached pdf file

print service

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Primary author: Dr SCHMIDT, Stefan (Johannes Gutenberg-Universität Mainz)

Presenter: Dr SCHMIDT, Stefan (Johannes Gutenberg-Universität Mainz)

Session Classification: Poster Session, Monday

Contribution ID: **63** Type: **oral without proceeding**

The hyperfine-puzzle of strong-field bound-state QED

Thursday, 17 May 2018 09:50 (20 minutes)

for abstract please see the attached pdf file

print service

no, I'll bring my poster to the conference

Primary author: Dr SCHMIDT, Stefan (Johannes Gutenberg-Universität Mainz)

Presenter: Dr SCHMIDT, Stefan (Johannes Gutenberg-Universität Mainz)

Session Classification: QED, g-factors #3

Contribution ID: **64** Type: **poster contribution**

Towards precision spectroscopy of the 2S-6P transition in atomic hydrogen

Tuesday, 15 May 2018 18:35 (5 minutes)

The 1S-2S two-photon transition frequency in hydrogen can be measured most accurately compared to other transitions in hydrogen due to its narrow natural linewidth, and serves as a corner stone for fundamental constants. However, only a combination of the precisely known 1S-2S transition with additional measurements allows to extract specific constants such as the proton root mean square charge radius r_{p} as well as the Rydberg constant R_∞, and to test the consistency of Quantum Electrodynamics. More precise measurements of the 2S-nP transition frequencies (e.g. with $n = 4,\ 6$) can be used to overcome current limitations in the framework of determining fundamental constants.

The value of r_{p} has become particularly interesting since the discovery of the apparent discrepancy with muonic hydrogen. Important steps towards the solution of this so-called "proton radius puzzle"are more precise measurements of other transitions in hydrogen. Recently, the 2S-4P transition has been measured in our group with a relative uncertainty of 4 parts in 10^{12}. Combining this result with the 1S-2S transition frequency leads to the r_p value which is 3.3
combined standard deviations smaller than the value deduced from previous hydrogen world data, but in good
agreement with the value from muonic hydrogen. Since the origin of this discrepancy is currently unknown, more measurements with even higher precision are needed.

Using the same apparatus as for the 2S-4P data, we aim to measure the 2S-6P transition with an improved uncertainty. With a narrower natural linewidth of 3.8 MHz (as opposed to 12.9 MHz for 2S-4P), the 2S-6P transition has the potential to determine the line center more accurately. In addition to the known challenges from the previous experiment, the new transition requires to rebuild the system for 410 nm (2S-6P) as opposed to 486 nm (2S-4P) laser light. The shorter wavelength leads to difficulties such as a complete re-design of our collimator used for the active fiber-based retroreflector, and increased Rayleigh scattering in the optical fiber resulting in etalon-like effects. This poster reports on the current status of the 2S-6P hydrogen experiment, with a particular focus on the upgrade for shorter wavelength.

print service

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Primary author: ANDREEV, Vitaly (MPQ)

Presenter: ANDREEV, Vitaly (MPQ)

Session Classification: Poster Session, Tuesday

Contribution ID: **65** Type: **oral without proceeding**

Constraints on exotic spin-dependent interactions between matter and antimatter from antiprotonic helium spectroscopy

Tuesday, 15 May 2018 09:50 (20 minutes)

abstract provided as attached pdf-file

print service

Primary author: Mr FICEK, Filip (Jagiellonian University)

Co-authors: Mr FADEEV, Pavel; Prof. FLAMBAUM, Victor; Prof. JACKSON KIMBALL, Derek; Prof. KOZLOV, Mikhail; Dr STADNIK, Yevgeny; Prof. BUDKER, Dmitry

Presenter: Mr FICEK, Filip (Jagiellonian University)

Session Classification: Antihydrogen & Antiprotonic Helium

Contribution ID: **66** Type: **oral without proceeding**

Measurement of the Electric Dipole Moment of the Xe-129 Atom

Friday, 18 May 2018 11:00 (20 minutes)

text provided in the uploaded pdf

print service

Primary author: ALLMENDINGER, Fabian (Physikalisches Institut, Uni Heidelberg, Germany)

Presenter: ALLMENDINGER, Fabian (Physikalisches Institut, Uni Heidelberg, Germany)

Session Classification: Symmetry Violations & EDMs

Contribution ID: **67** Type: **poster contribution**

High-precision Ramsey-comb spectroscopy in the XUV spectral range for tests of bound-state QED and the proton radius

Monday, 14 May 2018 18:20 (5 minutes)

please see the attached file for abstract

print service

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Primary author: Ms DREISSEN, Laura (LaserLaB, Vrije Universiteit Amsterdan)

Presenter: Ms DREISSEN, Laura (LaserLaB, Vrije Universiteit Amsterdan)

Session Classification: Poster Session, Monday

Contribution ID: **68** Type: **oral with proceeding**

Four loop QED contributions to the electron g-2

Monday, 14 May 2018 17:05 (30 minutes)

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print service

Primary author: Dr LAPORTA, Stefano (University of Padova)

Presenter: Dr LAPORTA, Stefano (University of Padova)

Session Classification: QED, g-factors #1

Contribution ID: **69** Type: **oral with proceeding**

Measurement of the proton Zemach radius from the hyperfine splitting in muonic hydrogen atom

Thursday, 17 May 2018 11:55 (25 minutes)

The proton is a fundamental constituent of the matter. However, it has a complicated internal structure which is difficult to be fully understood. The internal structure of the proton is described by the electronic and magnetic form factors. The charge radius of the proton is defined by these form factors and has been determined experimentally. In recent years, a significant discrepancy between independent measurements of the proton charge radius was reported. This conflict is known as "proton radius puzzle". Even though various interpretations have been proposed, no definitive solution to the problem has been found yet. In order to shed some light on the puzzle, we proposed a new experiment to determine the proton Zemach radius which is defined as a convolution of the charge distribution with the magnetic moment distribution. The proton Zemach radius can be derived from the hyperfine splitting (HFS) in the muonic hydrogen atom. We aim to perform a laser spectroscopy of the muonic hydrogen HFS with the relative uncertainty of 1 ppm and obtain the proton Zemach radius with 1% precision.

print service

Primary author: KANDA, Sohtaro (RIKEN)

Presenter: KANDA, Sohtaro (RIKEN)

Session Classification: Exotic Atoms

Contribution ID: **70** Type: **oral with proceeding**

Accurate calculations with explicitly correlated functions for molecular hydrogen

Wednesday, 16 May 2018 11:05 (30 minutes)

Theoretical studies of hydrogen molecule is the cornerstone of the molecular quantum mechanics. Due to its simplicity, the achieved precision is the highest among all molecules and still has a potential of significant enhancement. This high precision of theoretical predictions for H_2 leads to improved tests of quantum electrodynamics (QED) and improved bounds on hypothetical interactions. Moreover, at the 10^{-7} cm^{-1} precision level the dissociation energy is sensitive to the proton charge radius, which may help to resolve the so called proton radius conundrum. This requires high accuracy calculations of not only nonrelativistic energies, but also leading relativistic and QED, as well as the higher order QED corrections. In fact, the nonrelativistic energies can already be calculated with the precision of 10^{-7} cm^{-1}. The the higher order QED contribution has very recently been calculated using explicitly correlated Gaussian (ECG) functions with $1 + r_{12}/2$ prefactor ({\it rECG}) that makes the interelectronic cusp condition to be exactly satisfied. We provided improved results for the dissociation and the fundamental vibrational energies. These results open the window for the high precision spectroscopy of H_2 and related accurate tests of fundamental interactions models. Recently, we also reported also highly accurate results for the leading relativistic correction using {\it rECG} functions and conclude that the compilation of previous results has underestimated uncertainties. We will also present the latest advances in the calculation of nuclear mass relativistic corrections, which are currently the main limitation of theoretical predictions.

print service

Primary author: Prof. PUCHALSKI, Mariusz (Faculty of Chemistry, Adam Mickiewicz University, Poland)

Presenter: Prof. PUCHALSKI, Mariusz (Faculty of Chemistry, Adam Mickiewicz University, Poland)

Session Classification: Molecules #1

Contribution ID: **71** Type: **oral without proceeding**

A measurement of the proton mass by rotational spectroscopy of HD+ molecular ions

Tuesday, 15 May 2018 11:00 (25 minutes)

see uploaded abstract file

print service

Primary author: Prof. SCHILLER, Stephan (Universität Düsseldorf)

Presenter: Prof. SCHILLER, Stephan (Universität Düsseldorf)

Session Classification: Electron and Proton Masses

Contribution ID: **72** Type: **poster contribution**

Towards Sympathetic Cooling of a Single (Anti)Proton in a Penning Trap for a High-Precision Measurement of the Particle's Magnetic Moment

Monday, 14 May 2018 18:35 (5 minutes)

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Primary author: WIESINGER, Markus (Max-Planck-Gesellschaft (DE))

Presenter: WIESINGER, Markus (Max-Planck-Gesellschaft (DE))

Session Classification: Poster Session, Monday

Contribution ID: **73** Type: **oral without proceeding**

CANNEX - A parallel plate approach to physics

Thursday, 17 May 2018 16:05 (25 minutes)

given as pdf

print service

Primary author: SEDMIK, Rene

Presenter: SEDMIK, Rene

Session Classification: Casimir & Cosmology

Contribution ID: **74** Type: **oral with proceeding**

Effects of spacetime topology and curvature on the resonance interatomic energy

Thursday, 17 May 2018 16:30 (20 minutes)

We study, using the formalism proposed by Dalibard, Dupont-Roc, and Cohen-Tannoudji, the resonance interatomic energy (RIE) of two identical two-level static atoms in a symmetric/antisymmetric entangled state, which are coupled to massless scalar fields, in a number of different spacetimes. We first show that the presence of a boundary in a flat Minkowski spacetime can dramatically modify the RIE of the two static atoms, resulting in an enhanced or weakened and even nullified RIE, as compared with that in the unbounded case; we then show that the RIE of the two atoms in the spacetime of a Schwarzschild black hole can be sharply affected by the spacetime curvature on one hand, but on the other hand it is surprisingly undisturbed by the Hawking radiation of the black hole; we finally show that the RIE of the two static atoms in the spacetime with an infinite and straight cosmic string (the so called cosmic string spacetime) is sensitive to the nontrivial topological structure of the spacetime, making the RIE of the two static atoms behaves in a manner very similar to that near a perfectly reflecting boundary in a flat Minkowski spacetime.

print service

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Primary authors: Prof. YU, Hongwei (Department of physics, Synergetic Innovation Center for Quantum Effects and Applications, Hunan Normal University, Changsha, Hunan 410081, China); Prof. ZHOU, Wenting (Center for Nonlinear Science and Department of Physics, Ningbo University, Ningbo, Zhejiang 315211, China)

Presenter: Prof. YU, Hongwei (Department of physics, Synergetic Innovation Center for Quantum Effects and Applications, Hunan Normal University, Changsha, Hunan 410081, China)

Session Classification: Casimir & Cosmology

Contribution ID: **75** Type: **oral with proceeding**

High precision measurement of muonium hyperfine structure

Wednesday, 16 May 2018 09:50 (25 minutes)

text provided in the uploaded pdf

print service

Primary author: TANAKA, Toya (University of Tokyo)

Presenter: TANAKA, Toya (University of Tokyo)

Session Classification: Positronium & Muonium

Contribution ID: **76** Type: **oral with proceeding**

A New Silicon Drift Detector System for Kaonic Atom Measurements

Monday, 14 May 2018 18:40 (15 minutes)

Abstract provided in the attachment.

print service

Primary author: Ms TRIPPL, Carina (Stefan Meyer Institute)

Presenter: Ms TRIPPL, Carina (Stefan Meyer Institute)

Session Classification: Poster Session, Monday

Contribution ID: **77** Type: **poster contribution**

First results of the VIP2 experiment

Tuesday, 15 May 2018 18:40 (5 minutes)

abstract provided as attached pdf-file

print service

Primary author: Mr PICHLER, Andreas (Stefan Meyer Institute)

Presenter: Mr PICHLER, Andreas (Stefan Meyer Institute)

Session Classification: Poster Session, Tuesday

Contribution ID: **78** Type: **poster contribution**

Charged particle veto detector for a kaonic deuterium measurement at DAFNE

Monday, 14 May 2018 18:55 (5 minutes)

For abstract see attached pdf-file.

print service

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Primary author: TÜCHLER, Marlene (Stefan Meyer Institute)

Presenter: TÜCHLER, Marlene (Stefan Meyer Institute)

Session Classification: Poster Session, Monday

Contribution ID: **79** Type: **poster contribution**

Tune-out wavelength calculation for helium

Tuesday, 15 May 2018 19:00 (5 minutes)

See attached pdf document

print service

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Primary authors: DRAKE, Gordon (University of Windsor); Mr MANALO, Jacob (University of Windsor)

Presenter: DRAKE, Gordon (University of Windsor)

Session Classification: Poster Session, Tuesday

Contribution ID: **80** Type: **poster contribution**

Spectral lines from C-like to Ca-like tungsten

Tuesday, 15 May 2018 18:55 (5 minutes)

text provided in the uploaded attachment

print service

Primary authors: Dr NATARAJAN, Anuradha (SIWS college, Mumbai); Prof. NATARAJAN, Lakshmi (University of Mumbai)

Presenter: Dr NATARAJAN, Anuradha (SIWS college, Mumbai)

Session Classification: Poster Session, Tuesday

Contribution ID: **81** Type: **oral with proceeding**

Direct Frequency Comb Spectroscopy on Hydrogen and Associated Systematic Frequency Shifts

Tuesday, 15 May 2018 17:15 (20 minutes)

\documentclass[11pt,a4paper]{article}
%\documentstyle[epsf,12pt]{article}
\usepackage{epsfig}
\usepackage{graphicx}
\usepackage{eurosym}
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\usepackage{caption}
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\begin{document}
\thispagestyle{empty}

%%

\begin{center}
{\Large \bf
% Title of your contribution:
Direct Frequency Comb Spectroscopy on Hydrogen and Associated Systematic Frequency Shifts
\bigskip\\}
% Author list, presenting author :
Alexey Grinin[a], Arthur Matveev[a,b], Lothar Maisenbacher[a], Vitaly Andreev[a], Dylan Yost[c], Randolf Pohl[a], Theodor W. H\”ansch[a,b], Thomas Udem[a]\\
% Affiliation(s), assignment needs to be done manually
[a] {\em Max-Planck Institut f\”ur Quantenoptik, 85748, Garching, Germany}\\
[b] {\em Ludwig-Maximilians-Universit\”at, M\”unchen, Fakult\”at f\”ur Physik, Schellingstrasse 4/III, 80799 ¨
M\”unchen, Germany}\\
[c] {\em Physics Department, Colorado State University, 1875 Campus Delivery, Fort Collins, CO, 80521}\\

\end{center}

% Your abstract text:
High precision spectroscopy has been always the driving force for new fundamental
theories in physics. The so called proton size problem is a so far unexplained disagreement of the value of the proton charge radius extracted from the muonic spectroscopy,

hydrogen spectroscopy and elastic electron-proton scattering by more than 5 sigma ~\cite{Antognini2013}. Recently two new experiments intensified this puzzle ~\cite{Bayer2017}, ~\cite{Fleurbaey2018}.
\newline
\newline
For the first time we present a high precision measurement in hydrogen on the 1s3s(F=1) performed with Direct Frequency Comb Spectroscopy (DFCS ~\cite{Baklanov1977}), with an uncertainty sufficient to contribute to the Proton Size Puzzle. Systematic frequency shifts observed with DFCS differ significantly from previous measurements which utilize CW lasers and in particular from the previous 1s3s (F=1) measurement, allowing for the first time comparison of two different groups on the same transition for the proton size puzzle.
\newline
\newline
In our experiment we excite a cryogenic hydrogen atomic beam with a picosecond frequency comb. The UV frequency comb at 205nm is produced by quadrupling a TiSa comb at 820nm by two subsequent frequency doubling stages. While two-photon transitions are in principle Doppler free in first order, residual Doppler shift associated with chirped pulses is observed and constitutes our leading systematic. Other significant systematics are Second Order Doppler Effect, collisional shift and AC/DC Stark Effects. We present experimental determination of these systematics and comparison with the theory.

%References (<10)
\begin{thebibliography}{9.}
%\frenchspacing
\setlength{\itemsep}{0em}
\setlength{\parskip}{0em}

\bibitem{Antognini2013} A. Antognini {\em et al}, Science {\bf 339}, (2013) 417
\bibitem{Bayer2017} Axel Bayer, Lothar Maisenbacher {\em et al}, Science Vol(358), (2017) Issue (6359)
\bibitem{Fleurbaey2018} H. Fleurbaey {\em et al}, https://arxiv.org/abs/1801.08816
\bibitem{Baklanov1977} Y. V. Baklanov and V. P. Chebotayev, Appl. Phys. 12, (1977) 97

\end{thebibliography}

\end{document}

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Primary authors: Mr GRININ, Alexey (MPQ); Dr MATVEEV, Arthur (MPQ)

Presenter: Mr GRININ, Alexey (MPQ)

Session Classification: Hydrogen

Contribution ID: **82** Type: **oral without proceeding**

The best determination of the Boltzmann constant k by acoustic thermometry of helium-4 gas

Monday, 14 May 2018 10:15 (20 minutes)

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print service

Primary authors: RISEGARI, Lara (LNE-Cnam); PITRE, Laurent; SPARASCI, Fernando; GUIANVARC'H, Cécile; ET AL.

Presenter: RISEGARI, Lara (LNE-Cnam)

Session Classification: New SI System

Contribution ID: **83** Type: **any type**

Exploiting highly accurate frequency ratio measurements over coherent fiber links for exploring fundamental physics problems

Monday, 14 May 2018 11:50 (20 minutes)

text provided in uploaded pdf

print service

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Primary author: Dr CALVERT, James (SYRTE)

Presenter: Dr CALVERT, James (SYRTE)

Session Classification: Special Transitions

Contribution ID: **84** Type: **poster contribution**

The ALPHATRAP g-Factor Experiment

Tuesday, 15 May 2018 18:10 (5 minutes)

ALPHATRAP is a high-precision Penning-trap based experiment dedicated to the exploration of ground-state properties of heavy, highly charged ions (HCI). The major goal of ALPHATRAP is the measurement of the bound-electron gyromagnetic factor, or *g*-factor, which can be predicted to very high precision in the framework of bound-state quantum electrodynamics (BS-QED). The comparison of the experimental results with recent theoretical calculations will not only serve as a sensitive test of BS-QED, but also yields a new approach for the determination of fundamental constants such as the electron mass or the fine structure constant .
The measurement of the bound-electron *g*-factor of a single HCI is performed in an improved cryogenic double Penning-trap setup, utilizing the continuous Stern-Gerlach effect. For injection of externally produced HCI up to $^{208}Pb^{81+}$ the ALPHATRAP experiment is coupled to various ion-sources, including the Heidelberg Electron-Beam Ion Trap. The ALPHATRAP apparatus including beamline, trap tower and electronics was successfully commissioned with single $^{12}C^{5+}$ and $^{40}Ar^{13+}$ ions, and is in preparation for its first *g*-factor measurement. This poster will give an overview of the experimental setup.

print service

no, I'll bring my poster to the conference

Primary author: Mr WEIGEL, Andreas

Presenter: Mr WEIGEL, Andreas

Session Classification: Poster Session, Tuesday

Contribution ID: **85** Type: **oral without proceeding**

The ALPHATRAP g-Factor Experiment

Tuesday, 15 May 2018 14:25 (20 minutes)

text provided in the uploaded pdf

print service

Primary author: Dr HÖCKER, Martin (Max-Planck-Institute for Nuclear Physics)

Presenter: Dr HÖCKER, Martin (Max-Planck-Institute for Nuclear Physics)

Session Classification: QED, g-factors #2

Contribution ID: **86** Type: **oral without proceeding**

Atomic photoexcitation by twisted light

Monday, 14 May 2018 12:10 (20 minutes)

abstract provided as attached pdf-file

print service

Primary author: Prof. CARLSON, Carl (College of William and Mary/JGU-Mainz)

Presenter: Prof. CARLSON, Carl (College of William and Mary/JGU-Mainz)

Session Classification: Special Transitions

Contribution ID: **87** Type: **poster contribution**

Precision Tests of Fundamental Interactions with Ion Trap Experiments

Monday, 14 May 2018 18:05 (5 minutes)

Single particles in traps allow for clean investigations of basic interactions and also for the determination of fundamental constants. This has been demonstrated by investigations of Quantum Electrodynamics (QED) with respect to the g-factor of the free electron [1] and of hydrogen-like or lithium-like ions [2 - 4], which form the most precise determinations of the fine-structure constant and of the mass of the electron, respectively. Ion traps are also suitable for the study of the interaction of atomic ions with high-intensity laser radiation [5]. The trapping of hydrogen-like heavy ions up to uranium is possible at the heavy-ion accelerator at GSI with stripping and post-deceleration. At the HITRAP facility at GSI, the final stage for deceleration and trapping of bare and hydrogen-like heavy ions up to uranium has been commissioned. After stripping at energies of a few 100 MeV/u, the ions are decelerated down to 4 MeV/u in the Experimental Storage Ring (ESR) and further down to 6 keV/u by a combination of an IH and a RFQ structure operating as decelerators. Finally, the ions will be captured and cooled down to cryogenic temperatures in a Penning trap by means of electron cooling and resistive cooling. From this trap, they can be extracted and used for experiments. With this novel technique of deceleration, trapping and cooling of highly charged ions, atomic physics studies on slow highly charged ions up to uranium U92+ interacting with photons, atoms, molecules, clusters, and surfaces will be performed. In addition to collision studies, high-accuracy atomic physics experiments on trapped highly charged ions will be a significant part of the atomic physics program of the HITRAP facility. At the upcoming Facility FAIR, the HITRAP facility will form an integral component of both the SPARC as well as the FLAIR Collaborations.
This work was supported by BMBF, DAAD, DFG, EMMI, Helmholtz Association, and the Max-Planck Society.

[1] D. Hanneke et al., Phys. Rev. Lett. 100, 120801 (2008)
[2] S. Sturm et al., Phys. Rev. Lett. 107, 023002 (2011)
[3] S. Sturm et al., Nature 506, 13026 (2014)
[4] F. Köhler et al., Nature Comm. 7, 10246 (2016)
[5] S. Kumar et al., J. of Phys. 635, 092070 (2015)

print service

yes, I'd appreciate a poster print service

Primary authors: Dr QUINT, Wolfgang (Helmholtzzentrum GSI); Dr VOGEL, Manuel (Hlmholtzzentrum GSI)

Presenter: Dr QUINT, Wolfgang (Helmholtzzentrum GSI)

Session Classification: Poster Session, Monday

Contribution ID: **88** Type: **poster contribution**

Low dimensional modeling of atomic and molecular systems

Tuesday, 15 May 2018 17:45 (5 minutes)

For abstract see the attached pdf file.

print service

yes, I'd appreciate a poster print service

Primary author: MAJOROSI, Szilárd (University of Szeged)

Co-authors: Dr CZIRJÁK, Attila (University of Szeged, ELI-ALPS); Prof. BENEDICT, Mihály G. (University of Szeged)

Presenter: MAJOROSI, Szilárd (University of Szeged)

Session Classification: Poster Session, Tuesday

Contribution ID: **89** Type: **poster contribution**

A new approach for measuring antiproton annihilation at rest with Timepix3

Tuesday, 15 May 2018 18:45 (5 minutes)

For abstract please see the attached pdf.

print service

no, I'll bring my poster to the conference

Primary author: GLIGOROVA, Angela (Austrian Academy of Sciences (AT))

Presenter: GLIGOROVA, Angela (Austrian Academy of Sciences (AT))

Session Classification: Poster Session, Tuesday

Contribution ID: **90** Type: **oral with proceeding**

Quantum electrodynamic theory of the g factor of highly charged ions

Tuesday, 15 May 2018 14:00 (25 minutes)

for abstract see attached pdf file

print service

Primary author: HARMAN, Zoltan (Max Planck Institute for Nuclear Physics)

Presenter: HARMAN, Zoltan (Max Planck Institute for Nuclear Physics)

Session Classification: QED, g-factors #2

Contribution ID: **91** Type: **oral with proceeding**

First search for invisible decays of ortho-positronium confined in a vacuum cavity

Thursday, 17 May 2018 16:50 (25 minutes)

For abstract see attached pdf file.

print service

Primary author: VIGO HERNANDEZ, Carlos (ETHZ - ETH Zurich)

Presenter: VIGO HERNANDEZ, Carlos (ETHZ - ETH Zurich)

Session Classification: Casimir & Cosmology

Contribution ID: **93** Type: **oral without proceeding**

Spectroscopy of hydrogen 1S-3S transition in cryogenic atomic beam

Tuesday, 15 May 2018 16:55 (20 minutes)

Laser spectroscopy of atomic hydrogen is a source of valuable data for a least-square adjustment of fundamental constants and precise tests of QED. Further improvement of precision of those measurements is of key interests for a problem, known as a Proton Size Puzzle \cite{Antognini2013}. This work requires suppression of different systematic effects, including a Doppler shift. Cooling the atomic beams to cryogenic temperatures opens a possibility to decrease the velocities of atoms, reducing the uncertainty, caused by velocity distribution of the atoms.

We report about our experiment on two-photon spectroscopy of the transition 1s-3s in atomic hydrogen by frequency combs \cite{Yost2016}. For the excitation of atomic transition we use a mode-locked Ti:Sa laser with two frequency doubling stages. The excitation takes place in a beam of atomic hydrogen expanding in a vacuum chamber. To reduce a first-order Doppler effect we use a technique of two-photon spectroscopy in counter-propagating laser beams \cite{Baklanov1977}. Using a cryogenic nozzle, cooled down by liquid helium, helps us to decrease the velocity of atoms, improving systematic uncertainties in our experiment.

In the presentation we discuss main systematic effect which is presented in our experiment, namely the first-order Doppler shift caused by chirp of the laser pulses. We discuss modelling of this shift and model-independent approaches, allowing to eliminate this effect.

print service

Primary authors: Dr MATVEEV, Artur (Max-Planck-Institute fuer Quantenoptik); GRININ, Alexey (MPQ); MAISENBACHER, Lothar (Max Planck Institute of Quantum Optics); ANDREEV, Vitaly (MPQ); Prof. YOST, Dylan (Colorado State University); Prof. POHL, Randolf (Max-Planck-Institute fuer Quantenoptik); Prof. HAENSCH, Theodor (Max-Planck-Institute fuer Quantenoptik); Prof. UDEM, Thomas (Max--Planck-Institute fuer Quantenoptik)

Presenter: Dr MATVEEV, Artur (Max-Planck-Institute fuer Quantenoptik)

Session Classification: Hydrogen

Contribution ID: **94** Type: **poster contribution**

Nonlinear Zeeman effect in boronlike highly charged ions

Tuesday, 15 May 2018 18:05 (5 minutes)

abstract provided as attached pdf-file

print service

Primary author: Mr AGABABAEV, Valentin (Saint-Petersburg State University)

Co-author: GLAZOV, Dmitry (St. Petersburg State University)

Presenter: GLAZOV, Dmitry (St. Petersburg State University)

Session Classification: Poster Session, Tuesday

Contribution ID: **95** Type: **oral with proceeding**

Positronium precision spectroscopy: Measuring the 1s-2s and excited state hyperfine transitions

Wednesday, 16 May 2018 09:00 (25 minutes)

Positronium is an excellent system to test bound state QED theory to very high precision, since it is almost exlusively governed by the electromagnetic force and does not exhibit the finite size effects which plague measurements of protonic atoms.

Numerous precise experiments have therefore been conducted in the past to measure the hyperfine splitting of Positronium. However, these experiments show almost 4σ disagreement with the most recent bound state QED calculations. PHySES' approach is to eliminate several possible sources of systematics present in earlier experiments by a novel experimental design to conclusively check this discrepancy.

Furthermore, measuring the 1s2s transition in Positronium would allow for a very stringent test of bound state QED in the ppb range. Current efforts to reach this sensitivity include upgrades to a pulsed positron beam and a novel time-of-flight detection scheme involving rydberg excitation of excited positronium.

Additionally, by comparing theory to experimental values gained by these experiments, one can test CPT and Lorentz violating effects and their corresponding coefficients in the Standard-Model extension (SME) complementary to those gathered by hydrogen spectroscopy.

This talk will report on the design, implementation, current status and future prospects of ongoing efforts at ETH Zurich to measure the 1s-2s and excited state hyperfine splitting in Positronium.

print service

Primary author: HEISS, Michael W. (ETH Zurich - Institute for Particle Physics and Astrophysics)

Co-authors: WICHMANN, Gunther (ETH Zurich - Institute for Particle Physics and Astrophysics); COOKE, David A. (ETH Zurich - Institute for Particle Physics and Astrophysics); ANTOGNINI, Aldo (ETH Zurich - Institute for Particle Physics and Astrophysics); KIRCH, Klaus (ETH Zurich - Institute for Particle Physics and Astrophysics); RUBBIA, Andre (ETH Zurich - Institute for Particle Physics and Astrophysics); CRIVELLI, Paolo (ETH Zurich - Institute for Particle Physics and Astrophysics)

Presenter: HEISS, Michael W. (ETH Zurich - Institute for Particle Physics and Astrophysics)

Session Classification: Positronium & Muonium

Contribution ID: **96** Type: **oral without proceeding**

Atomic parity violation in ytterbium

Friday, 18 May 2018 11:20 (20 minutes)

text provided in the uploaded pdf

print service

Primary author: Dr ANTYPAS, Dionysios (Helmholtz Institut-Mainz)

Presenter: Dr ANTYPAS, Dionysios (Helmholtz Institut-Mainz)

Session Classification: Symmetry Violations & EDMs

Contribution ID: **97** Type: **oral with proceeding**

g-factor of middle-Z lithiumlike and boronlike ions

Thursday, 17 May 2018 09:25 (25 minutes)

text provided in the uploaded pdf

print service

Primary authors: GLAZOV, Dmitry (St. Petersburg State University); Dr VOLOTKA, Andrey (St. Petersburg State University); AGABABAEV, Valentin (Saint-Petersburg State University); Mr ZINENKO, Dmitry (St. Petersburg State University); Prof. SHABAEV, Vladimir (St. Petersburg State University); Prof. TUPITSYN, Ilya (St. Petersburg State University); Prof. PLUNIEN, Guenter (Technische Universitaet Dresden)

Presenter: GLAZOV, Dmitry (St. Petersburg State University)

Session Classification: QED, g-factors #3

Contribution ID: **98** Type: **oral without proceeding**

Cold muonium atoms for future atomic physics and gravity experiments

Wednesday, 16 May 2018 10:15 (20 minutes)

In PDF

print service

Primary author: Dr SOTER, Anna (Paul Scherrer Institute)

Presenter: Dr SOTER, Anna (Paul Scherrer Institute)

Session Classification: Positronium & Muonium

Contribution ID: **99** Type: **oral without proceeding**

Measuring the Ground State Hyperfine Splitting of Antihydrogen

Monday, 14 May 2018 14:25 (20 minutes)

for abstract see attached pdf-file

print service

Primary authors: Ms KOLBINGER, Bernadette (Stefan Meyer Institute, OEAW); ON BEHALF OF THE ASACUSA-CUSP COLLABORATION

Presenters: Ms KOLBINGER, Bernadette (Stefan Meyer Institute, OEAW); KOLBINGER, Bernadette (Austrian Academy of Sciences (AT))

Session Classification: Antihydrogen

Track Classification: Antimatter and exotic atoms

Contribution ID: **100** Type: **oral without proceeding**

Higher-order finite-nuclear-size contributions in light muonic atoms

Thursday, 17 May 2018 12:20 (20 minutes)

abstract provided as attached pdf-file

print service

Primary author: KORZININ, Evgeny

Presenter: KARSHENBOYM, Savely (LMU, MPQ, Pulkovo)

Session Classification: Exotic Atoms

Contribution ID: **101** Type: **poster contribution**

Status Update of NoMoS

Monday, 14 May 2018 19:00 (5 minutes)

We present a new method of spectroscopy, utilizing a drift effect to disperse charged particles in a uniformly curved magnetic field. The curved field results in a drift of the charged particles perpendicular to the radius of the curvature and to the magnetic field, which is proportional to the particle's momentum. A spatial-resolving detector will determine the momentum spectra.
The first realization, called NoMoS (Neutron decay prOducts MOmentum Spectrometer), will measure correlation coefficients in free neutron beta decay to test the Standard Model of particle physics and to search for physics beyond. Currently, the focus is on the design and the construction of the magnet system.

print service

no, I'll bring my poster to the conference

Primary authors: MOSER, Daniel (Technische Universität Wien); BROUSSE, Clement; Dr KONRAD, Gertrud (SMI & TU Wien); FILLUNGER, Harald; ABELE, Hartmut (TU Wien); BOSINA, Joachim; ZMESKAL, Johann (Austrian Academy of Sciences (AT)); PITSCHMANN, Mario (Vienna University of Technology); KLOPF, Michael (TU-Wien); SOLDNER, Torsten; WANG, Xiangzun

Presenter: MOSER, Daniel (Technische Universität Wien)

Session Classification: Poster Session, Monday

Contribution ID: **103** Type: **oral without proceeding**

A fundamental constant as basis for the SI unit kilogram

Monday, 14 May 2018 09:55 (20 minutes)

for abstract see attached pdf-file

print service

Primary authors: NICOLAUS, Dr. Arnold (PTB Physikalisch-Technische Bundesanstalt); Dr BETTIN, Dr. Horst (Physikalisch-Technische Bundesanstalt)

Presenter: NICOLAUS, Dr. Arnold (PTB Physikalisch-Technische Bundesanstalt)

Session Classification: New SI System

Contribution ID: **104** Type: **poster contribution**

Near threshold ionization of argon by positron impact

Monday, 14 May 2018 19:15 (5 minutes)

PDF Attached

print service

yes, I'd appreciate a poster print service

Primary author: MURTAGH, Daniel James (Austrian Academy of Sciences (AT))

Presenter: BABIJ, Tamara (Australian National University)

Session Classification: Poster Session, Monday

Contribution ID: **105** Type: **oral with proceeding**

Quantum metrology –in search of dark matter

Thursday, 17 May 2018 17:35 (15 minutes)

This is a Precision measurement plays an important role in unveiling new physics by probing beyond the known boundaries of knowledge. In a similar footing, it has a wide range of application in trade and commerce. From fundamental physics viewpoint, the Standard Model (SM) of particle physics though considered to be the most celebrated model in physics is known to have shortcomings as is evident from numerous experimental findings. Precision measurements with simple atomic systems provide the opportunity to explore the possible deviations from the SM. The limit to the uncertainty of any frequency measurement is given by the Heisenberg limit. However as will be shown here, using a time dependent Hamiltonian it is possible to surpass this limit. Using, this technique, a trapped single atomic probe provides a weak limit of the coupling of a electron spin to a certain type of dark matter candidate. Possible new experiments can further improve the limit for more assertive searches.

print service

Primary author: Prof. MUKHERJEE, Manas (Centre for Quantum Technologies, National University of Singapore)

Co-author: Dr DUTTA, Tarun (Centre for Quantum Technologies, NUS)

Presenters: Prof. MUKHERJEE, Manas (Centre for Quantum Technologies, National University of Singapore); Dr DUTTA, Tarun (Centre for Quantum Technologies, NUS)

Session Classification: Casimir & Cosmology

Contribution ID: **106** Type: **oral without proceeding**

Charmonium(-like) spectroscopy with BESIII

Friday, 18 May 2018 13:55 (15 minutes)

After a short review of the overall physics program of BESIII and the key features of the BEPCII collider and BESIII detector, I will present some of the recent highlights of the charmonium(-like) spectroscopy program of BESIII. The results include measurements of radiative and hadronic decays of several charmonium(-like) states below and above the open-charm production threshold. The ultimate aim is to provide data to study the dynamics of the strong interaction in the confinement region and to understand the nature of the recently discovered XYZ states. In this talk, I will discuss on what has been learned so far and what the future perspectives could be in this field of hadron physics.

print service

no, I'll bring my poster to the conference

Primary author: MESSCHENDORP, Johan

Presenter: MESSCHENDORP, Johan

Session Classification: Hadrons

Contribution ID: **107** Type: **oral without proceeding**

Precision spectroscopy of hydrogen molecular ions: present status of theory and perspectives.

Tuesday, 15 May 2018 12:10 (20 minutes)

At present a theoretical prediction for the spin-averaged frequency of vibrational transitions in the hydrogen molecular ions (HMI) has reached a relative precision of $\sim 7.5\times10^{-12}$ [1]. On the other hand, recent experiment [2] on pure rotational transition in HD^+ has demonstrated the power of the Lamb-Dicke regime for precision spectroscopy of the HMI and potentiality in the nearest future to achieve a ppt level of spectroscopic accuracy. At the same time, it discloses new problems, which have to be solved in theory in order to comply with requirements of precision comparison with experiment. Namely, for pure rotational transitions it is essential to include into consideration the spin-dependent part of transition energy, which takes into account all corrections up to order $m\alpha^6$.

In our presentation we also discuss other problems, which are to be considered in order to improve theoretical predictions (by a factor of three at least). That will bring theoretical precision to the level better than the uncertainty in the Rydberg constant as determined by the CODATA14 adjustment of the fundamental constants [3].

References:
[1] V.I. Korobov, L. Hilico, and J.-Ph. Karr, Fundamental transitions and ionization energies of the hydrogen molecular ions with few ppt uncertainty. Phys. Rev. Lett. \textbf{118}, 233001 (2017).
[2] S. Alighanbari, M.G. Hansen, S. Schiller, and V.I. Korobov, Rotational spectroscopy of cold, trapped molecular ions in the Lamb-Dicke regime. Nature Physics 14, (2018).
[3] P.J. Mohr, B.N. Taylor, and D.B. Newell, Rev. Mod. Phys. 88, 035009 (2016).

print service

Primary author: Dr KOROBOV, Vladimir (Joint Institute for Nuclear Research)

Presenter: Dr KOROBOV, Vladimir (Joint Institute for Nuclear Research)

Session Classification: Electron and Proton Masses

Contribution ID: **108** Type: **oral without proceeding**

Precision Fundamental Physics with Trapped Antihydrogen

Tuesday, 15 May 2018 09:00 (25 minutes)

text provided in the uploaded pdf

print service

Primary author: FUJIWARA, Makoto (TRIUMF (CA))

Presenter: FUJIWARA, Makoto (TRIUMF (CA))

Session Classification: Antihydrogen & Antiprotonic Helium

Contribution ID: **109** Type: **poster contribution**

3D-imaging of antimatter annihilation using the ASACUSA Micromegas tracker

Monday, 14 May 2018 19:05 (5 minutes)

For abstract, please see attached PDF file.

print service

no, I'll bring my poster to the conference

Primary author: Dr MAECKEL, Volkhard (RIKEN (JP))

Presenter: Dr MAECKEL, Volkhard (RIKEN (JP))

Session Classification: Poster Session, Monday

Contribution ID: **110** Type: **poster contribution**

Positron Production and Storage for Antihydrogen Production

Monday, 14 May 2018 19:10 (5 minutes)

For abstract, please see the attached PDF file.

print service

Primary authors: MAECKEL, Volkhard (RIKEN (JP)); MURTAGH, Daniel James (Austrian Academy of Sciences (AT))

Presenter: MAECKEL, Volkhard (RIKEN (JP))

Session Classification: Poster Session, Monday

Contribution ID: **111** Type: **poster contribution**

Ramsey set-up for (anti-)hydrogen hyperfine spectroscopy

Tuesday, 15 May 2018 18:50 (5 minutes)

Please see the attached pdf file for the abstract.

print service

no, I'll bring my poster to the conference

Primary author: Mr NANDA, Amit (SMI, Vienna)

Presenters: Mr NANDA, Amit (SMI, Vienna); NANDA, Amit (Austrian Academy of Sciences (AT))

Session Classification: Poster Session, Tuesday

Contribution ID: **112** Type: **oral without proceeding**

Measurement of the hydrogen hyperfine splitting in a beam: results and prospects

Monday, 14 May 2018 14:45 (25 minutes)

abstract provided as attached pdf-file

print service

Primary author: MALBRUNOT, Chloe (CERN)

Presenter: MALBRUNOT, Chloe (CERN)

Session Classification: Antihydrogen

Contribution ID: **115** Type: **poster contribution**

Precision x-ray spectroscopy of the 1s Lamb shift in high-Z hydrogen-like systems

Monday, 14 May 2018 18:15 (5 minutes)

abstract as attachment

print service

Presenter: WEBER, Günter (GSI)

Session Classification: Poster Session, Monday

Contribution ID: **116** Type: **oral without proceeding**

Antihydrogen 1S-2S laser spectroscopy

Monday, 14 May 2018 14:00 (25 minutes)

abstract as attachement

print service

Presenter: LENZ CESAR, Claudio (Federal University of of Rio de Janeiro (BR))

Session Classification: Antihydrogen

Contribution ID: **117** Type: **oral without proceeding**

Laser spectroscopy of cooled antiprotonic helium atoms

Tuesday, 15 May 2018 09:25 (25 minutes)

abstract as attachement

print service

Presenter: HORI, Masaki (Max-Planck Institute of Quantum Optics (DE))

Session Classification: Antihydrogen & Antiprotonic Helium

Contribution ID: **118** Type: **oral without proceeding**

High-precision comparisons of the fundamental properties of protons and antiprotons

Tuesday, 15 May 2018 10:10 (25 minutes)

abstract as attachement

print service

Presenter: Dr ULMER, Stefan (RIKEN (JP))

Session Classification: Antihydrogen & Antiprotonic Helium

Contribution ID: **119** Type: **not specified**

Welcome - Opening

Monday, 14 May 2018 09:00 (2 minutes)

print service

Presenter: WIDMANN, Eberhard (Austrian Academy of Sciences (AT))

Session Classification: Welcome

Contribution ID: **120** Type: **not specified**

Welcome - Chair

Monday, 14 May 2018 09:02 (8 minutes)

print service

Presenter: KARSHENBOYM, Savely (LMU, MPQ, Pulkovo)

Session Classification: Welcome

Contribution ID: **121** Type: **not specified**

Welcome - IUPAP

Monday, 14 May 2018 09:10 (5 minutes)

print service

Presenters: Prof. BURGDÖRFER, Joachim (TU Wien); Dr MOHR, Peter (National Institute of Standards and Technology, USA); Dr MOHR, Peter (NIST)

Session Classification: Welcome

Contribution ID: **122** Type: **poster contribution**

Guiding and manipulating Rydberg positronium using inhomogeneous electric fields

Tuesday, 15 May 2018 19:05 (5 minutes)

print service

Presenter: ALONSO, Alberto (University College London)

Session Classification: Poster Session, Tuesday

Contribution ID: **123** Type: **poster contribution**

Testing fundamental interactions on light atoms

Tuesday, 15 May 2018 19:10 (5 minutes)

We critically examine the current status of theoretical calculations of the energies and the isotope shift of the lowest-lying states of helium, searching for unresolved discrepancies with experiments. Calculations are performed within the nonrelativistic quantum electrodynamics ex- pansion in powers of the fine structure constant α and the electron-to-nucleus mass ratio m/M. For energies, theoretical results are complete through orders α6m and α6m2/M, with the result- ing accuracy ranging from 0.5 to 2 MHz for the n = 2 states. The isotope shift between 3He and 4He is treated theoretically with a sub-kHz accuracy, which allows for a high-precision determi- nation of the differences of the nuclear charge radii δr2. Several such determinations, however, yield results that are in a 4σ disagreement with each other. Apart from this, we find no significant discrepancies between theory and experiment for the helium atom.
Further, we present the complete relativistic O(α2) nuclear structure correction to the energy levels of ordinary (electronic) and muonic hydrogen-like atoms. The elastic part of the nuclear structure correction is derived analytically. The analytical result is verified by high-precision nu- merical calculations. The inelastic O(α2) nuclear structure correction is derived for the electronic and muonic deuterium atoms. The correction comes from a three-photon exchange between the nucleus and the bound lepton and has not been considered in the literature so far. In the case of deuterium, the inelastic three-photon exchange contribution is of a similar size and of the opposite sign as the corresponding elastic part and, moreover, cancels exactly the model dependence of the elastic part. The obtained results affect the determination of nuclear charge radii from the Lamb shift in ordinary and muonic atoms.

[1] K.Pachucki,V.Patkó s̆,V.A.Yerokhin,Testingfundamentalinteractionsontheheliumatom, Phys. Rev. A 95, 062510 (2017).
[2] V. Patkó s̆, K. Pachucki, V. A. Yerokhin, Higher-order recoil corrections for singlet states of the helium atom, Phys. Rev. A 95, 012508 (2017).
[3] K. Pachucki, V. Patkó s̆, V. A. Yerokhin, Three-photon exchange nuclear structure correction in hydrogenic systems, submitted to Phys. Rev. A.

print service

Presenter: PATKOS, Vojtech (Charles University in Prague)

Session Classification: Poster Session, Tuesday

Contribution ID: **124** Type: **any type**

Welcome - LOC

Monday, 14 May 2018 09:15 (10 minutes)

print service

Presenter: WIDMANN, Eberhard (Austrian Academy of Sciences (AT))

Session Classification: Welcome