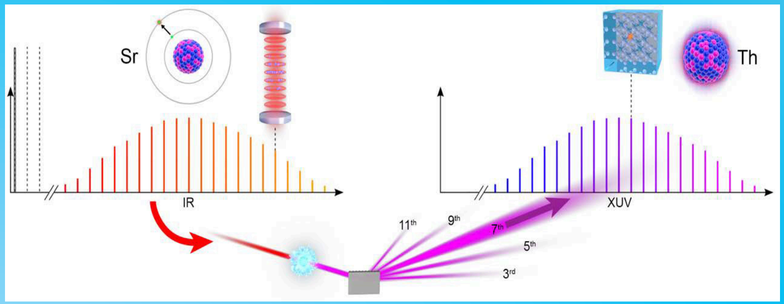
Center for Astrophysics| Harvard & Smithsonian
ITAMP
60 Garden Street
Cambridge, MA 02138 USA

Table-top AMO for Fundamental Physics: Third Workshop

October 3-4, 2024

Organizers

Shimon Kolkowitz *(UC Berkeley)*, **Andrew Jayich** *(UC Santa Barbara),* **Tanya Zelevinsky** *(Columbia)*



Credit: JILA/Ye Labs and Steven Burrows

Ory Forum: 301 A/B
60 Oxford St. Cambridge, MA 02138

ITAMP is funded by the National Science Foundation

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Notes

ITAMP began life in 1989 at the Harvard-Smithsonian Center for Astrophysics. It is the only theoretical AMO "user facility" in the United States. It hosts workshops, and visiting fellows (short- and long-term), sponsors a flagship speaker series, the Joint Quantum Science seminars, with HQI in the Physics Department, and a rigorous postdoctoral program. ITAMP workshops are recorded and avaliable on the ITAMP YouTube channel. There are on average 4-5 workshops each year. A Call for Proposal to organize workshops and a list of workshops are available at http://itamp.harvard.edu. The postdoctoral program has been a recognized success, placing energetic fellows into junior positions at universities and national labs.

ITAMP thrives in the larger Cambridge-area AMO physics ecosystem, drawing upon the considerable depth and breadth of experimental expertise. The mission of ITAMP continues to be in furthering the cause of theoretical AMO physics by providing resources, centrality of location, and scientific and administrative expertise, to enhance collaborative efforts between theory and experiment, and to be broad in advocating for theoretical AMO.

H. Sadeghpour

Synopsis

The focus of this workshop is on the emerging methods in atomic and molecular systems for tests of fundamental physics in the laboratory. Topics will include tabletop searches for dark matter and variations in fundamental constants, searches for permanent electric and nuclear dipole moments, tests of quantum electrodynamics through precision spectroscopy and atom interferometry, tests of short-range gravity and relativity, and precision comparisons between optical atomic and nuclear clocks.

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Tanya Zelevinsky (Columbia University)

Notes

Instructions for Reimbursement Forms

If you have been promised support to help cover your expenses, the following forms will be required paperwork for your reimbursement. Please, only use the attached forms if you have already received an offer of support. If you feel there has been a mistake or are unsure about your support, please ask and we can assist you.We will only need receipts that will total up to your promised support in your invitation letter. If your receipts total over that amount, you will simply just be reimbursed up to that promised amount. Please submit all travel reimbursements within the **45 days after the workshop has ended.**

Here are the directions for filling out the following forms.

1) Reimbursement Setup

In order for reimbursement, you will receive an email shortly to be invited by Harvard University using the Buy-to- Pay (B2P) system for reimbursement. Upon invitation, an email is sent to you from ap_supplieronboarding@harvard.edu. Please get yourself set up in the system therefore we can then process your reimbursement. Please note if you do not receive the invitation to register please let me know. Please complete your profile in B2P so we can process your reimbursement. Please note that if you are in the U.S on a visa there may be additional steps in the B2P set up. Per Harvard University's policy your reimbursement will not be processed until the workshop has ended.

2. The Non-Employee Reimbursement Form

This form is submitted to the University and must be completely filled out. This form can be found at https://travel.harvard.edu/files/procurement-travel/files/nonemployee_reimbursement_form_digital_signature_v1.pdf?m=1617208983. Once you have filled and signed the form please then email it back to Jaclyn Donahue with all receipts. Receipts must include date of transaction, transaction details (what was purchased), the amount of purchase, the form of payment used (cash, credit card, check) and indication that the amount was paid.

3) Missing Receipt Affidavit

You will only need this document if anything you send does not fit the receipt policy or if you are missing an actual receipt. Harvard's receipt policy can be found at https://policies.fad.harvard.edu/files/fad_policies/files/receipt_definitions_website.pdf.

4) Wire Transfer

For domestic USD wire transfers are only allowable provided the amount is $1,000 or more. For foreign invitees if a wire transfer is needed please let me know however the required information is needed for the wire transfer form - Bank name, Bank Address, Swift Code/BIC Code, Beneficiary Account Name, Beneficiary Bank Account Number or IBAN number, and Beneficiary Address.

Please be patient as the reimbursement setup and payment process may take some time. Thank you

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Sarah's Market, 200 Concord Ave.
The Village Kitchen, 359 Huron Ave.
House of Chang, 282 Concord Ave.
Trattoria Pulcinella, 147 Huron Ave.
Armanado's Pizza, 163 Huron Ave.
Hi-Rise Bread CO, 208 Concord Ave.
Formaggio Kitchen, 244 Huron Ave

Massachusetts Ave.
Chang-Sho, 1712 Mass. Ave.
Simons Coffee House, 1736 Mass. Ave.
Nirvana The Taste of India 1680 Mass Ave
Stone Hearth Pizza Co., 1782 Mass.Ave.
Super Fusion, 1759 Mass. Ave.
Cambridge Common, 1667 Mass Ave.
Lizard Lounge, 1667 Mass. Ave.

Welcome to ITAMP

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The wifi connection is eduroam. If you do not have eduroam privileges set up, connect to Harvard University wifi and then go to your favorite web address. This will bring you to a page from which you choose Guest access. Please see the link below.

Link here: https://getonline.harvard.edu/guest/harvard_portal.php?_browser=1

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Table-top AMO for Fundamental Physics: Third Workshop

October 3-4, 2024
Ory Forum - Room 301 A/B

Thursday, October 3, 2024

Chair: Shimon Kolkowitz

8:30 - 9:00 am	Refreshments/Introduction
9:00 - 9:40 am	Piet Schmidt
9:40 - 10:20 am	Jun Ye
10:20 - 10:50 am	Coffee Break
10:50 -11:30 am	Thorsten Schumm
11:30 - 12:10 pm	Dylan Yost
12:10 - 1:30 pm	Lunch

Chair: Andrew Jayich

1:30 - 2:10 pm	Saïda Guellati-Khélifa
2:10 - 2:50 pm	Eric Cornell
2:50- 3:20 pm	Coffee Break
3:20 - 4:00 pm	Nick Hutzler
4:00 - 4:40 pm	Xing Fan

Friday, October 4, 2024

Chair: Xing Fan

8:30 - 9:00 am	Refreshments
9:00 - 9:40 am	John Doyle
9:40 - 10:20 am	Dave DeMille
10:20 - 10:50 am	Coffee Break
10:50 - 11:30 am	Masha Baryakhtar
11:30 - 12:10 pm	Dan Carney
12:00 - 1:30 pm	Lunch

Dylan Yost

Colorado State University

"Rydberg Hydrogen Laser Spectroscopy"

Because of atomic hydrogen's simplicity, its energy levels can be precisely described by theory. This has made hydrogen an important atom in the development of quantum mechanics and quantum electrodynamics (QED). While one can use hydrogen spectroscopy to determine the Rydberg constant and the proton charge radius, a discrepancy of these constants determined through different transitions, or in different species, can indicate new physics. While it is interesting to measure multiple hydrogen electronic transitions to search for new physics, only the 1S-2S two-photon transition is intrinsically narrow. The 1S-2S has a natural linewidth of only 1.4 Hz, which has enabled measurements with a relative uncertainty of 4.2 x 10^{-15} [1]. Other hydrogen transitions which have been the subject of precision measurement typically have natural linewidths 5-7 orders of magnitude larger.

In this talk, I will discuss our efforts in hydrogen spectroscopy to Rydberg levels ($8<n<16$). These transitions are attractive for precision spectroscopy since Rydberg levels have lifetimes which scales as n^3, and therefore demonstrate relatively narrow natural linewidths. In addition, the extent of the wavefunction grows as n^2 and some new physics models predict spectroscopic variations based on the size of the electronic wavefunction (see, for example, [2,3]). Interestingly, despite their potential, transitions to Rydberg states have not typically demonstrated larger transition Q factors (the transition frequency divided by the recovered linewidth) compared to transitions to lower lying states. However, the challenges are technical, and I will highlight our methods to overcome them.

References:

[1] C. G. Parthey et al., Phys. Rev. Lett. 107, 203001 (2011).
[2] S. G. Karshenboim, Phys. Rev. Lett. 104, 220406 (2010).
[3] M. P. A. Jones, R. M. Potvliege, and M. Spannowsky, Phys. Rev. Research 2, 013244 (2020).

Jun Ye

JILA

"Clocks and quantum system scaling"

Quantum state control has fueled revolutionary developments in atomic, molecular, and fundamental physics. Size scaling of quantum systems now represents important steps toward performance for fundamental discoveries. We will discuss some inspirational motivations and sometimes competing requirements for system size, coherence time, and entanglement advantage. Fortunately, quantum technology is now also knocking on the door of nuclear physics, heralded by the recent breakthrough of quantum-state-resolved laser spectroscopy of thorium-229 nuclear transition. This provides a new platform for the number game. Also, the unification of precision metrology and nuclear physics sparks new ideas for testing fundamental physics and promises nuclear-based clock applications.

Chair: Masha Baryakhtar

1:30 - 2:10 pm	Andrei Derevianko
2:10 - 2:50 pm	Igor Pikovski
2:50 - 3:20 pm	Coffee Break
3:20 - 4:00 pm	Giorgio Gratta
4:00 - 4:40 pm	Lindley Winslow
4:40 pm	Adjourn

Masha Baryakhtar

University of Washington

"Order and disorder: dielectrics for wave dark matter detection"

Dark photons and axions with meV-eV masses (THz-optical frequencies) remain less constrained in current and upcoming laboratory experiments. The best current bounds in this mass range come from non-dark matter searches: observations of our Sun and neutron stars. It is crucial to fully explore this parameter space and close the gap between ongoing and planned terrestrial experiments and astrophysical constraints. I will present the LAMPOST and DPHaSE experimental proposals based on dielectric metamaterials, in which axion and dark photon dark matter can efficiently convert to detectable single photons. While an ordered stack provides the deepest dark matter reach, embracing the randomness of a disordered powder allows for a robust, broadband search.

Lindley Winslow

Massachusetts Institute of Technology

"The Search for GUT-Scale Axions: Really Big Magnets and Quantum Sensing"

The particle nature of dark matter remains one of the great open questions in physics. There is a broad category of candidates whose mass is so light that they behave more as waves than as particles. The most well-known is the axion, which has had a renaissance as a dark matter candidate as theoretical studies have improved our understanding of axion cosmology and advances in quantum sensing and cryogenics have opened new opportunities for detection. In this talk, I will focus on the search for GUT-Scale axions, the DMRadio Program and the results from the ABRACADABRA demonstrators. If time permits, I will also discuss our other R&D efforts that span from searching for primordial black holes to coupling quantum dots to SNSPDs.

Thorsten Schumm

TU Vienna

"Optical Mössbauer spectroscopy of Th-229 in CaF crystals"

The recent precision VUV laser spectroscopy of Thorium-229 doped into calcium fluoride single crystals allows to probe nuclear properties and host material parameters with unprecedented accuracy. In this talk I will resume our current understanding of the microscopic doping structure, combining theoretical modelling, solid-state techniques like XAFS and RBS, and precision laser spectroscopy. We also report quenching of the thorium-229 isomer population under X-ray and laser illumination in the VUV, UV and optical range, hinting towards strong and controllable coupling of nuclear and solid-state degrees of freedom.

Dan Carney

Lawrence Berkeley National Laboratory

"Comments on testing quantum gravity"

I will make some comments on tests of single graviton detection, searches for gravitational vacuum fluctuations, and tests of entanglement generated by the newton interaction.

Eric Cornell

JILA

“Precision measurements are having a moment: recent results in g-2 and electric dipoles of leptons”

The past three years have seen three dipole-moment measurements of record-breaking accuracy – the magnetic dipole moments (aka “g-2”) of the muon and of the electron, and the electric dipole moment (EDM) of the electron. I will focus in on the latter measurement, performed at the University of Colorado. I will try to compare and contrast the relative implications of all these three measurements for the search for Beyond Standard Model physics. Finally, I will look into the future for eEDM work.

Piet Schmidt

Leibniz Universität Hannover

“Highly Charged Ion Clocks to Test Fundamental Physics”

The extreme electronic properties of highly charged ions (HCI) render them highly sensitive probes for testing fundamental physical theories. The same properties reduce systematic frequency shifts, making HCI excellent optical clock candidates [1–3]. The technical challenges that hindered the development of such clocks have now all been overcome, starting with their extraction from a hot plasma and sympathetic cooling in a linear Paul trap [4], readout of their internal state via quantum logic spectroscopy [5], and finally the preparation of the HCI in the ground state of motion of the trap [6]. Here, we present the first operation of an atomic clock based on an HCI (Ar^{13+} in our case) and a full evaluation of systematic frequency shifts of the employed $2P_{1/2}$-$2P_{3/2}$ fine-structure transition at 442 nm [7]. The achieved uncertainty is almost eight orders of magnitude lower than any previous frequency measurements using HCI and comparable to other optical clocks. By comparing the isotope shift between $^{36}Ar^{13+}$ and $^{40}Ar^{13+}$ the theoretically predicted QED nuclear recoil effect could be confirmed. One of the main features of quantum logic spectroscopy is the flexibility of the investigated species. This allowed us to perform isotope shift spectroscopy of the $2P_0$-$2P_1$ fine-structure transition at 569 nm in Ca^{14+} ions. In a large theory-experiment collaborations, we combined this data with improved measurements of the Ca^+ $2S_{1/2}$-$2D_{5/2}$ clock transition at 729 nm, new isotope mass measurements, and highly accurate calculations of the 2nd order mass shift. The resulting King plot allows us to put the currently most stringent bound on a hypothetical 5th force coupling neutrons and electrons [8], despite a large ($>100\sigma$) residual nonlinearity, suspected to be dominated by nuclear polarizability. This demonstrates the suitability of HCI as references for high-accuracy optical clocks and to probe for physics beyond the standard model. Through the development of efficient search strategies using quantum logic techniques [9], we were able to identify the logic and clock transitions in Ni^{12+}, a superior HCI clock candidate due to its long excited state lifetime of >10 s.

[1] M. G. Kozlov, M. S. Safronova, J. R. Crespo López-Urrutia, and P. O. Schmidt, “Highly charged ions: Optical clocks and applications in fundamental physics,” Rev. Mod. Phys. 90, 045005 (2018); [2] S. Schiller, “Hydrogenlike Highly Charged Ions for Tests of the Time Independence of Fundamental Constants,” Phys. Rev. Lett. 98, 180801 (2007); [3] M. S. Safronova, D. Budker, D. DeMille, D. F. J. Kimball, A. Derevianko, and C. W. Clark, “Search for new physics with atoms and molecules,” Rev. Mod. Phys. 90, 025008 (2018); [4] L. Schmöger, O. O. Versolato, M. Schwarz, M. Kohnen, A. Windberger, B. Piest, S. Feuchtenbeiner, J. Pedregosa Gutierrez, T. Leopold, P. Micke, A. K. Hansen, T. M. Baumann, M. Drewsen, J. Ullrich, P. O. Schmidt, and J. R. C. López Urrutia, “Coulomb crystallization of highly charged ions,” Science 347, 1233–1236 (2015); [5] P. Micke, T. Leopold, S. A. King, E. Benkler, L. J. Spieß, L. Schmöger, M. Schwarz, J. R. C. López-Urrutia, and P. O. Schmidt, “Coherent laser spectroscopy of highly charged ions using quantum logic,” Nature 578, 60–65 (2020);[6] S. A. King, L. J. Spieß, P. Micke, A. Wilzewski, T. Leopold, J. R. Crespo López-Urrutia, and P. O. Schmidt, “Algorithmic Ground-State Cooling of Weakly Coupled Oscillators Using Quantum Logic,” Phys. Rev. X 11, 041049 (2021); [7] S. A. King, L. J. Spieß, P. Micke, A. Wilzewski, T. Leopold, E. Benkler, R. Lange, N. Huntemann, A. Surzhykov, V. A. Yerokhin, J. R. Crespo López-Urrutia, and P. O. Schmidt, “An optical atomic clock based on a highly charged ion,” Nature 611, 43–47 (2022); [8] J. C. Berengut, D. Budker, C. Delaunay, V. V. Flambaum, C. Frugiuele, E. Fuchs, C. Grojean, R. Harnik, R. Ozeri, G. Perez, and Y. Soreq, “Probing New Long-Range Interactions by Isotope Shift Spectroscopy,” Phys. Rev. Lett. 120, 091801 (2018); [9] S. Chen, L. J. Spieß, A. Wilzewski, M. Wehrheim, K. Dietze, I. Vybornyi, K. Hammerer, J. R. C. Lopez-Urrutia, and P. O. Schmidt, “Identification of highly-forbidden optical transitions in highly charged ions,” (2024)

Igor Pikovski

Stevens Institute of Technology

"Detecting Gravitons"

We show how single gravitons can be detected [1]. The quantization of gravity is widely believed to result in gravitons, but their detection has so far been considered impossible. Here we analyze single emission and absorption processes in macroscopic quantum resonators and show that individual stimulated processes of the exchange of quanta between matter and gravitational waves can be resolved. We analyze optimal parameters and compare the results to previously achieved capabilities. Our results show that single graviton signatures are within reach of near-future experiments with macroscopic quantum resonators and quantum sensing. We will also discuss the implications and limitations of such detections regarding their ability to probe quantum gravity [2]. Our results show that single graviton detection is attainable and that it opens the first window into the experimental exploration of the exchange of quanta as predicted by linearized quantum gravity.

References:

[1] G. Tobar, S. Manikandan, T. Beitel and I. Pikovski. "Detecting single gravitons with quantum sensing". Nature Communications 15, 7229 (2024)
[2] V. Shenderov, M. Suppiah, T. Beitel, G. Tobar, S. Manikandan and I. Pikovski. "Stimulated absorption of single gravitons: First light on quantum gravity". Preprint: arXiv:2407.11929

Dave DeMille

University of Chicago

"Towards new measurements of T- and P-violating nuclear Schiff moments in polar molecules"

The nuclear Schiff moment (NSM) is a time reversal- and parity-violating asymmetric charge distribution, aligned with the spin of a nucleus, that can reveal the existence of many different types of CP-violating interactions between the strongly-interacting particles in the nucleus. Unlike a true electric dipole moment, the Schiff moment can interact with the electrons in an electrically-polarized neutral atom or molecule, resulting in a non-zero energy shift when the nuclear spin is aligned along or against the polarizing E-field. The state of the art in NSM searches is set by experiments using atoms with spherical nuclei, such as Hg-199. Using polar molecules instead of atoms enhances sensitivity to the NSM by factors of up to 10^4. I will describe our CeNTREX experiment, which uses a cryogenic beam of thallium monofluoride (TlF) molecules to search for the NSM of the 205Tl nucleus. Unlike the nuclei used in all other current NSM experiments, Tl-205 has an unpaired valence proton, making it highly complementary to other efforts; we project a sensitivity comparable to that achieved in Hg-199. In nuclei with strong octupole deformations, the size of the NSM can be amplified by a factor approximately 10^3, for the same strength of underlying CP-violating interactions. I will describe our efforts to exploit this additional amplification, using ultracold francium-silver (FrAg) molecules to measure the NSM of the octupole-deformed Fr-223 nucleus. Here, we plan to assemble FrAg molecles from quantum gases of Fr-223 and Ag atoms, using the same methods now commonly applied to create ultracold bi-alkali molecules. The silver atom has an alkali-like structure, which makes it possible to laser-cool and trap using standard techniques; it also has large electron affinity, such that it makes strong ionic bonds with true alkali atoms like Fr. Both Ag and Fr atoms have been magneto-optically trapped. I will describe our progress towards measuring ultracold Ag-Ag scattering properties, and towards production of a continuous, offline source of Fr-223 suitable for loading a magneto-optical trap. Assuming the atoms can be trapped as efficiently as in prior experiments, that these atoms can be assembled into molecules as efficiently as in other bi-alkali molecules experiments, and that nuclear spin coherence times comparable to those demonstrated in bi-alkali experiments can be achieved, we project that an experiment using ^{223}FrAg could be roughly 1,000 times more sensitive to CP-violating interactions between nucleons than the current state of the art.

Andrei Derevianko

University of Nevada, Reno

“Fragility of life: anthropic constraints on transient variation of fundamental constants”

I will review our recent work on various novel regimes of variations of fundamental constants. These include transient, oscillating, and stochastic regimes characteristic of certain dark matter models. I will extend these regimes to oscillating transients that would characterize exotic physics modality in multi-messenger astronomy. Finally, I will place anthropic constrains on large transients sweeping through Earth over the past 4 billion years.

Nick Hutzler

Caltech

“Precision measurement and spectroscopy with molecules containing deformed nuclei”

Molecules with heavy, deformed nuclei can amplify the sensitivity of CP-violating physics in the hadronic sector. We are performing experiments with YbOH, which has a quadrupole-deformed nucleus which enhances the nuclear magnetic quadrupole moment (MQM), and RaOH, which has an octupole-deformed nucleus which enhances the nuclear Schiff moment (NSM). In this talk, I will give an update on the status of these efforts, including production and spectroscopy of RaOH, and coherent control in YbOH.

Saïda Guellati-Khélifa

Laboratoire Kastler Brossel

“Recent progress in measuring the recoil velocity of rubidium using atom interferometry”

Light-pulse atom interferometry allows for high precision measurements of a variety of physical quan tities. This method offers exciting prospects for testing the fundamental laws of physics using low-energy experiments. Notably, the measurement by atom interferometry of the recoil velocity of an atom that absorbs or emits a photon leads to the most accurate determination of the fine structure constant α. This constant is crucial for quantum electrodynamics calculations and for testing certain predictions of the Standard Model of particle physics.
Our experiment measures the recoil velocity of rubidium atoms. In 2020, it provided a new determination of the fine structure constant, achieving a relative uncertainty of 8.1×10^{-11} [1]: $\alpha^{-1} = 137.035999206\ (11)$. This result improves the accuracy of α by nearly a factor of three compared to the previous determination deduced from the caesium recoil measurement [2]. Notably, it also reveals a 5.4 σ discrepancy with that earlier result.

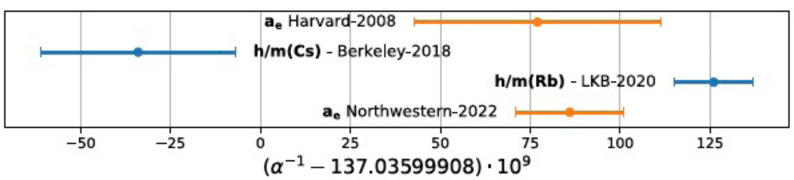

Figure 1: A comparison of most precise determinations of the fine-structure constant. The orange points are from a_e measurements [3, 4] and QED calculations [5] , the blue points are respectively obtained from the measurement of Cs and Rb atomic recoil. Errors bars correspond to ±1σ uncertainty.

To understand the source of this discrepancy, we are currently conducting a detailed investigation of systematic effects, with a particular focus on the effect related to laser wavefront distortions. In this presentation, I will discuss recent developments in this experiment.

References:

[1] L. Morel, Z. Yao, P. Clad´e and S. Guellati-Khelifa, Nature, 588 (2020), 61–65.
[2] R. .H. Parker, C. Yu, W. Zhong, B. Estey and H. M¨uller, Science, 360 (2018), 191–195.
[3] D. Hanneke, S. Fogwell, and G. Gabrielse Phys. Rev. Lett. 100 (2008), 120801.
[4] X. Fan, T. G. Myers, B. A. D. Sukra, and G. Gabrielse Phys. Rev. Lett. 130 (2023), 071801.
[5] T. Aoyama, T. Kinoshita and M. Nio, Phys. Rev. D 97 (2018), 036001.

John Doyle

Harvard University

“The arc of precision searches for BSM physics using cold and ultracold molecules”

Polar molecules, due to their intrinsic electric dipole moment and their controllable complexity, are a powerful platform for precision measurement searches for physics beyond the standard model (BSM) and, potentially, for quantum simulation/computation. This will be a brief talk about the arc of research efforts using cold and ultracold molecules for BSM searches. Starting with an update on the ACME experiment and ending with proposed experiments using ultracold polyatomic molecules with octupole deformed nuclei, the goal is to place in the status of our work in technical context.

Xing Fan

Northwestern University

"Single Electron in a Penning Trap Universe for a Precision Test of the Standard Model"

I will present the recent measurement of the electron Magnetic Dipole Moment, known as the g-factor. The new measurement tests the most precise prediction of the Standard Model (SM). Key techniques include an isolated electron in a Penning ion trap, cooling to its quantum ground state, quantum non-demolition detection, and controlling cavity-QED systematic shifts.

I will describe how the ideal environment is realized, along with the effort for improved measurement, matter-antimatter symmetry tests, and other applications for fundamental physics.

Giorgio Gratta

Stanford University

"Testing Gravity at ever shorter scale: a trip into exotic experimental physics"

Since the times of Henry Cavendish and John Mitchell, the strength of gravity has been measured by comparing it to the reaction of a calibrated mechanical spring. While in the last 60 years planetary measurements (with natural and artificial bodies) have provided remarkable accuracy at large distance, measurements in the lab have continued to rely various incarnations of the good old mechanical springs, in many cases resulting in superb experiments and results.

In this talk, I will explore a number of drastically different techniques recently developed specifically to tackle the short distance regime, where many theories suggest something exotic may be happening. This will be a trip into AMO and high resolution nuclear spectroscopy. While science results are gradually appearing, I hope to convince the audience that, as is often the case with new techniques, a new and exciting array of questions and applications are also emerging!