IUPAP International Union of Pure and Applied Physics

Newsletter

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THE PRESIDENTS' MESSAGE

You will read elsewhere in this newsletter of the co-operation of IUPAP with the International Mathematical Union (IMU), the International Union of Pure and Applied Chemistry (IUPAC), and the International Union of Biological Sciences (IUBS) in the Global Gender Gap Project and you have read earlier of our cooperation with the The International Union of Crystallography (IUCr) in the Lightsources for Africa, the Americas, Asia and Middle East Project (LAAAMP) project. These are just two examples of the increasing involvement of our Union with the other Unions of the International Science Council (ISC). There are many reasons why this co-operation is increasing after a period in which we concentrated on doing our own work, and why much more co-operation will happen in the future.

One of the main reasons is that the evidence-based process that is the scientific method is being questioned and denigrated worldwide, placing it at a level of diminished importance in the eyes of the public. This threatens the intake of new scientists for our discipline and the financial support that we will receive. At the same time; it makes our education of the public and our governments in the methods and the results of science harder to achieve, and yet vital to achieve. All sciences are under threat, and if we do not work together, we will be diminished separately.

Some time ago, the Unions of the then ICSU (now ISC) appointed Inter-Union representatives in order to ensure that they worked together. The various Unions were placed in clusters to provide the mechanism for cooperation. Some clusters were more efficient than others. In the new ISC, the clusters no longer exist, and we are finding our own way to co-operate with each other. As well as the projects mentioned above, we have been working with the IUPAC and other Unions of the International Year of the Periodic Table, and in proclaiming 2022-2023 as the International Year of Basic Sciences for Development, in which IUPAP will coordinate the efforts of many of our fellow Unions.

Much of this issue of the newsletter is devoted to the recipients of the IUPAP Young Scientists Prizes. We encourage you to read about them and the physics they have been doing. Their personal stories are inspiring, and the cutting edge of physics represented by their work shows a discipline making great advances on many fronts. This inspiring work also challenges our Union to find ways in which it can work more closely with younger physicists. We are negotiating a closer relationship with physics students, but there is a gap between the students and the senior physicists who are members of our Commissions. These mid-career physicists could provide the Union with valuable advice on the way in which it should develop. Our challenge is to find a way to reap those insights without placing a burden on the mid-career physicists at a time when they are building their careers. Perhaps, we could create an Advisory Group whose members are the recent recipients of the Young Scientist Prizes.

Kennedy Reed, President
Michel Spiro, President Designate
Bruce McKellar, Past President

Membership matters

Nithaya Chetty, Vice-President at Large (Membership)

IUPAP is working hard to retain member nations which could be faltering in their commitment to the organization, and reaching out to potential new member countries and attracting them to the IUPAP-fold. In doing so, driving membership is intimately connected with promoting the organization internationally, and keeping the world of physics informed of the roles that IUPAP is playing in strengthening the discipline of physics on a worldwide scale.

IUPAP has been advancing physics across international boundaries for almost 100 years. Thirteen countries established the organization in Brussels in 1922. Today, there are 57 member nations from around the world.

During the cold war, IUPAP was especially active in ensuring the free circulation of scientists despite the political divisions that existed at that time. Physics as a discipline benefitted because eastern bloc scientists could, with the support of IUPAP, participate in scientific meetings in the West and vice versa. And of course, humanity benefitted because physics was able to bring people together from across the Iron Curtain that helped build important human bridges that eventually led to the end of the cold war.

The changing environment for science

Today, the environment for science is very different. Our challenges for physics, and for science in general, in the 21st century are different from barely a generation ago.

The UN Millennium Developmental Goals provide an important framework for the social, political and economic imperatives that we face today, and this is setting the basis for a burgeoning new international research agenda. IUPAP, being the voice of physics on a global scale, is at the very centre of helping drive this movement from a physics perspective.

We find increasingly today that truth is being undervalued and is often being blurred. This problem is growing even in the developed world where scientific research is becoming increasingly politicized. The effort required to advance knowledge for societal benefit is not always understood and appreciated by society the world over.

Today, thanks to the internet, we have free and easy access to information. One must ask whether our university and research systems are thus becoming less relevant today. They will be, if we do not adjust our educational systems accordingly. It is becoming difficult but vital to discriminate between real and bogus information. How do we counter plagiarism, protect intellectual property, etc.?

All of this requires a global voice for science and IUPAP deals with many of these matters in the advancement of physics.

The current big science questions need big – meaning expensive – research infrastructures that no single country can readily afford. This calls for large multidisciplinary teams and large multinational collaborations. This is a challenge, especially in the developing world, but also an opportunity for us scientists. We must ask: how can we participate more effectively?

Being globally connected through our communications also means that we are susceptible to problems of cybersecurity. How do we protect ourselves more effectively? This problem cannot be solved individually, one nation at a time, but by joining forces and setting international standards and benchmarks for the way in which we conduct ourselves.

What is of great concern are the widespread disparities in science, with the ensuing widespread disparities in development across the world. These two issues are inextricably connected. The challenge for us this century is to develop science more extensively and universally for the benefit of all of humanity. This is very central to the mission of the IUPAP.

Increasing IUPAP membership

Recruiting new members is central to IUPAP's long term sustainability. Over the past year, Jordan and Uruguay have become members. Egypt has re-joined after losing their membership at the most recent general assembly. IUPAP is working closely with the Ethiopian Physical Society of North America to secure a deal that will keep Ethiopia in the IUPAP-fold. We are also having discussions with many other countries about the benefits of joining. Scrutinizing the most productive physics nations who are currently not members is a useful way to guide this discussion and to target potentially new members.

Increasing IUPAP membership strengthens the international voice for the agenda for physics worldwide. IUPAP creates an international platform where scientists can raise their concerns and express their views on any matter that relates to physics and the practice of physics in this world, and in so doing, help to propose solutions and action plans to address such matters. This enables physicists to participate in decision-making that impacts physics on an international level in significant ways.

IUPAP has at times been active in supporting physics in countries when their science system or their scientists have come under some kind of political threat. This calls for astute leadership and careful scientific diplomacy to make constructive impact, as the potential for making the opposite effect will always be there.
Invariably, increasing membership means more resources that enables IUPAP to do more with and for physics as well as the benefit of humanity. This means more support for IUPAP-related activities, such as the annual commission conferences, workshops, working group meetings and so on, that are open to the international world of physics.

Physics for society

Communicating the importance of physics to mainstream society still requires a big effort from professional physicists all around the world. There are ample reasons to highlight the importance of physics. The entire technological world in which we live is due to discoveries and understanding developed in physics.

The transistor, invented in 1947, is the basis for the digital electronic industry that many simply take for granted today. The world wide web was developed at CERN in Geneva. Many of the medical diagnostic tools used today, such as MRI, CT scans, etc., all have their origins in physics. But, the most attractive aspects of physics concern themselves with developing deeper understanding of the physical world in which we live, which invariably touches on the origins of the universe and the very nature of life itself.

We can all do a better job in communicating the wonders of physics to mainstream society. We should be connecting physics education much more to everyday life experiences.

Travel Grants for Women in Developing Countries

Gillian Butcher (Chair, WG5) and **Silvina Ponce Dawson** (Vice-President at Large (Gender Champion))

Attending international conferences is a crucial part of any physicist's career development, sharing results, learning about new developments and making valuable connections. However, as was highlighted by Ivie [ref] women are not so likely to access travel funds, particularly in developing countries: 31% of women from developing countries said they had access to travel funding compared with 64% of men from highly-developed countries.
Since its creation in 2002, WG5 Women in Physics has been tasked with administering IUPAP travel grants to women from developing countries who wish to attend conferences. It is interesting to note that in the 18 years of funding, over 400 grants have been distributed to applicants in 53 countries.

Impressive as those statistics are, it is the effect that these grants have on individuals that is most telling. We have here the statement by a female researcher from Argentina who received a travel grant at a time when Argentina was facing very bad economic conditions and the support for science was practically non-existent:

"Even if the award is relatively modest, it is very good for a starting point. It helped me a lot. I've got it in 2002, when the economic situation in my country (Argentina) was horrible, there were no openings for scientific jobs, I had just finished my post-doctoral fellowship. With the grant, I went to an international congress in Brazil and started collaborating with experimentalists from Porto Alegre and Rio de Janeiro that lasted many years with me working in Argentina and traveling every now and then to visit them (that was very hard for me with 4 little kids). That kept my scientific career "alive" for a while until the situation in Argentina improved."

Ref: R. Ivie, C. Langer Tesfaye *Women in Physics: A tale of limits* Physics Today (Feb 2012)

The Global Gender Gap Project

Gillian Butcher, Silvina Ponce Dawson, Igle Gledhill (Working Group 5 - Women in Physics)

Global Gender Gap project Co-ordination meeting in Berlin, February 2019

The co-ordination meeting of the ISC funded project was held in Berlin on 18th-19th February 2019. In its 3rd and final year, it was exciting to begin to see results from all the work and planning, and the data and information-gathering all coming together.

The Global Survey, Task 1, which builds on previous surveys of physicists, was closed for input at the end of December 2018 and 30,500 responses were received. Of these, some 7,865 (25.8%) were from physicists. Preliminary data has been released for initial analysis by team members, it will be interesting to compare physics' responses with those of other disciplines and also with previous physics surveys.

Task 2 has advanced in developing the necessary software to analyse large data sets of scientific publications, particularly, to disambiguate the gender of the co-authors. A paper on the strategy implemented was published.

Task 3 has reviewed a large number of initiatives available online. A database has been created with currently some 50 initiatives from 39 countries (although all are in English at present). It is possible to search on initiative by focus (whether for policy makers or for girls or for educators). Only 7 of the initiatives have measured the impact.

One of the pleasing outcomes of the project so far has been the connections made between the various Unions' women's networks, all of which are keen to continue collaborating beyond the current project.

So watch this space as we analyse the data and bring you the results.

Portuguese Speaking Countries Form New Physics Union

Sekazi K. Mtingwa, Principal Partner at TriSEED Consultants, USA and Chair, C13

The beautiful island nation of São Tomé e Príncipe, located off the west coast of Africa, played host to the 3rd Physics Conference of Portuguese Speaking Countries which focussed on the topic, Physics for Sustainable Development. The chosen venue for the conference was the picturesque Hotel Praia located next to the ocean. After many excellent scientific oral and poster presentations, the conference culminated in a business meeting that launched the new União de Físicos dos Paises de Língua Portuguesa (UFPLP), or Union of Physicists from Portuguese Speaking Countries. The participants at the 1st Physics Conference of Portuguese Speaking Countries in Maputo, Mozambique proposed the concept for the UFPLP approximately 10 years ago, and some participants of the third conference have pursued that dream ever since.

In addition to the Portuguese Physical Society and Brazilian Physical Society, countries represented at the conference included Angola, Brazil, Cape Verde, Mozambique, Portugal, and São Tomé e Príncipe. Also, the author (SKM) traveled from the United States to attend. Approximately 60 researchers and ten students, some sponsored by the Portuguese company Galp, were in attendance, and the speakers discussed major advances in the following areas: (i) Physics Education, (ii) Energy, (iii) Nanotechnology, (iv) Environment and Climate, and (v) Health Physics. During the opening ceremony, the country's Prime Minister, the Honorable Jorge Bom Jesus, and the rector of the University of São Tomé e Príncipe, Aires Bruzaca Menezes, addressed the participants and encouraged them to continue making significant contributions to physics research and training. The Education Minister, the Honorable Julieta Rodrigues, was also present. A group photo of the conference participants and government officials is shown in Figure. 1.

Figure 1. Group Photo
In the middle of the first row is the Education Minister Julieta Rodrigues. To her immediate right is University Rector Aires Bruzaca Menezes. To her immediate left are Prime Minister Jorge Bom Jesus, SKM, María da Conceição Abreu and Marcos Gomes Eleutério da Luz, who are Presidents of the Portuguese and Brazilian Physical Societies respectively as well as main conference organizers.

In addition to the scientific presentations, several of the participants visited local institutions, including the National Institute of Meteorology and a hospital. The visits were organized as two parallel sessions. One consisted of visits to three local secondary schools: National Lyceum, Mª Margarido and Gadalupe, where Professors José Paixão (Universidade de Coimbra) and Paulo Freitas (Laboratória Ibérico Internacional de Nanotechnologia) performed demonstrations of science experiments with commonly found inexpensive materials, based on the book Física no dia-a-dia, or Physics in everyday life. The second effort was a visit to the University of São Tomé e Príncipe consisting of an intensive course by Professor Horácio Fernandes (Instituto Superior Técnico-ULisboa) and two postgraduate students about micro controllers. They encouraged the students to pursue science and engineering careers, especially in engineering to help solve their country's socioeconomic challenges (Figure. 2). A visit to the World Pendulum at the Portuguese secondary school resulted in a conference participant's donation of an air conditioner to one of the school's science laboratories. The Camões Institute sponsored the visits.

Figure 2. Conference Educational Outreach

Professor Horacio Fernandes, standing in the rear between two accompanying postdocs, during the intensive course at the University of São Tomé e Príncipe.

Local medical doctors and radiography technicians attended the Conference's Health Physics discussion. See Figure.3.

Figure 3. Local Medical Professionals at the Conference

Medical doctors and radiography technicians with conference organizer, Maria da Conceição Abreu (standing, third from left)

On the final day of the conference, Marcos Gomes Eleutério da Luz from the Brazilian Physical Society and Maria da Conceição Abreu from the Portuguese Physical Society convened a business meeting, during which the participants resolved the final details for launching the UFPLP. The first resolution adopted was to locate the headquarters of the organization in Lisbon. Next, the participants adopted a resolution that defined the following objectives:

i. To develop conditions that promote a unifying environment and solidarity among physicists of the associated countries and territories in the UFPLP, with the goal of creating opportunities and conditions conducive to successive careers in the physics profession.

ii. To cooperate in the various fields of physics in which the professional activities of physicists are devoted to the cultural, scientific, technological and economic development of the different countries and territories, under the principle of prioritizing and defending the best interests of their peoples, in particular the most disadvantaged in terms of teaching and research infrastructures.

iii. To provide channels for forming mutual partnerships with individuals and international organizations of a professional or cultural nature, fostering networks of collaboration and influence.

iv. To contribute to the promotion and defense of the historical heritage and professional activity of every physicist and, in general, to promote all the activities that bolster the strengthening of the elements of cultural identities that unite them.

Next, the participants adopted a resolution that defined both group and individual memberships. Group membership would be open to physical societies from Portuguese speaking countries, while individual membership would be open to any physicist who requests to join, subject to approval. Other categories of membership will be defined in the future.

The governing bodies of UFPLP will be the Board, Executive Council and Fiscal Council, with the Board, consisting of a Board President and two Secretaries, meeting annually and being the maximum authority. The Executive Council, composed of an Executive President, two Vice-Presidents and a Treasurer, will be responsible for carrying out UFPLP's activities. The Fiscal Council will consist of a Fiscal President and two members and will be responsible for conducting internal audits of UFPLP's financial records. All officers will serve for three years and can stand for re-election to the same office only once.

At the conclusion of the business meeting, there was a signing ceremony for the various countries' representatives for the launch of the UFPLP. The plan is to complete the launch by November 2019 and convene the next conference in Cape Verde during the International Year of Basic Sciences for Development in 2022.

IUPAP Laser Physics and Photonics Young Scientist Prizes 2019

Tsuneyuki Ozaki, Chair, C17

The IUPAP Commission on Laser Physics and Photonics runs its Young Scientist Prizes every two years, recognizing early-career researchers of the very highest level of achievements in fundamental and applied research. The 2019 prizes attracted multiple nominations from Australia, Canada, China, Germany, Ireland, United Kingdom and the USA.

The 2019 IUPAP Young Scientist Prize in Laser Physics and Photonics (Fundamental Aspects) was awarded to Dr. Sergey Kruk, Nonlinear Physics Centre, Australian National University, Australia. Dr. Kruk was awarded the prize "for his ground breaking contributions to the study of topological states of light at the nanoscale, particularly for his pioneering work on nonlinear and nonreciprocal effects in photonic nanostructures". Dr. Kruk received his Diploma in Physics with High Distinction from the Belarusian State University in 2011, and his PhD in Physics from the Australian National University in 2015. Subsequently,

Dr. Sergey Kruk receiving his award

he held a postdoctoral fellow position at the Australian National University until 2015, and is currently Research Fellow at the Australian National University, as well as Visiting Researcher at Oak Ridge National Laboratory.

The 2019 IUPAP Young Scientist Prize in Laser Physics and Photonics (Applied Aspects) is shared by Dr. Alireza Marandi, Department of Electrical Engineering and Applied Physics, California Institute of Technology, USA, and Dr. Jinyang Liang, Institut national de la recherche scientifique – Centre Énergie, Matériaux, Télécommunication (INRS-EMT), Canada.

Dr. Marandi was awarded "for contributions to nonlinear photonics, particularly his pioneering work on computing with networks of OPOs and demonstration of optical Ising machines, as well as half-harmonic generation of mid-infrared frequency combs." Dr. Marandi received his PhD from Stanford University in 2013, and went on to hold various positions at the National Institute of Informatics (Japan), Stanford University and Dolby Laboratories Inc. (USA). He is currently Assistant Professor of Electrical Engineering and Applied Physics at the California Institute of Technology, Visiting Scholar at the E. L. Ginzton Laboratory, Stanford University and Visiting Professor at the National Institute of Informatics.

Dr. Jinyang Liang was awarded, "for his outstanding contributions that apply coded-aperture optical imaging to ultrafast visualization and ultra-precise modulation of laser beam/pulse profiles". Dr. Liang received his PhD from the University of Texas at Austin in 2012 under the supervision of Prof. Michael F. Becker. He then took on post-doctoral positions with Prof. Lihong V. Wang, first at Washington University in St. Louis and later at the California Institute of Technology. He is currently Assistant Professor at the INRS-EMT near Montreal, Canada.

An awards ceremony was held during CLEO-Europe on 25 June 2019 in Munich, Germany. Our heartfelt congratulations to the winners of the C17 Young Scientist Prizes 2019!

Dr Alireza Marandi receiving his award

Dr Jinyang Liang receiving his award

Probing Fundamental Physics with Gravitational-wave Observations

Kento Yagi (2019 – AC2 YSP Winner)

The historic detections of gravitational waves from binary black holes and neutron stars by LIGO and Virgo marked the dawn of gravitational-wave and multi-messenger astronomy. These new sources allow us to probe many different aspects of fundamental physics that were difficult to access previously.

One important direction is to test General Relativity (GR). Unlike other tests of gravity, such as solar system experiments and binary pulsar observations that have led to precision tests in the weak and/or non-dynamical regime of gravity, compact binary mergers can be used to probe GR in the strong and dynamical regime. So far, no evidence showing violations of GR has been found.

We performed the following tests of gravity with gravitational waves. First, we derived bounds on various parameters that can capture non-GR effects in a generic way (similar bounds were also obtained by the LIGO and Virgo Collaborations). We then extracted implications for physics from such bounds by comparing the above generic non-GR parameters to coupling constants in example theories beyond GR that violate at least one fundamental pillars in GR, such as the equivalence principle, Lorentz invariance and parity invariance. Comparing these new bounds from gravitational waves with other existing bounds, we found that in most cases, the former are weaker than the latter. Though the former have important meaning as these are the bounds obtained for the first time in the strong/dynamical regime of gravity. Furthermore, there are theories in which some regions in parameter spaces of the theories were constrained for the first time through gravitational wave observations.

Another important direction is to probe nuclear physics with gravitational waves. One of the largest uncertainties in dense-matter physics is to understand the nature of nuclear matter via the equation of state (the relation between density and pressure). Nuclear physics at density much larger than the nuclear saturation density is difficult to probe with ground-based experiments. On the other hand, neutron stars offer us a natural testbed to probe such physics as the central density can easily exceed the saturation density. For example, the relation between two neutron star global quantities, such as the stellar mass and radius, depends strongly on the underlying equation of state.

Unlike the relations between the mass and radius above, there are relations that do not depend sensitively on the unknown equations of state. For example, we found such universal relations among the stellar moment of inertia, tidal deformability (or tidal Love number) and quadrupole moment (I-Love-Q relations, see Fig. 1). We also found universal relations among various tidal parameters in binary neutron stars (binary Love relations).

These universal relations have many interesting applications. For example, one can apply them to probe nuclear physics via gravitational wave observations. As two neutron stars come closer together due to the gravitational wave emission, a tidal field of one star acts onto its companion, generating tidal deformation on the latter. The amount of such deformation is controlled by the tidal Love number, which depends strongly on the equation of state and affects the gravitational waveform. As we showed, the universal relations help us to break degeneracies among tidal Love numbers and other system parameters, enhancing the measurability of the former. This was also demonstrated by the LIGO and Virgo Collaborations by applying the universal relations to the data for the binary neutron star merger event GW170817. Other applications of universal relations include tests of GR. Such relations help us to break degeneracies between uncertainties in nuclear physics and gravitational physics. For example, by combining future gravitational wave and binary pulsar observations and applying the universal I-Love relation, we found that the effect of parity violation in gravity can be probed with precision that is higher than the current options by several orders of magnitude.

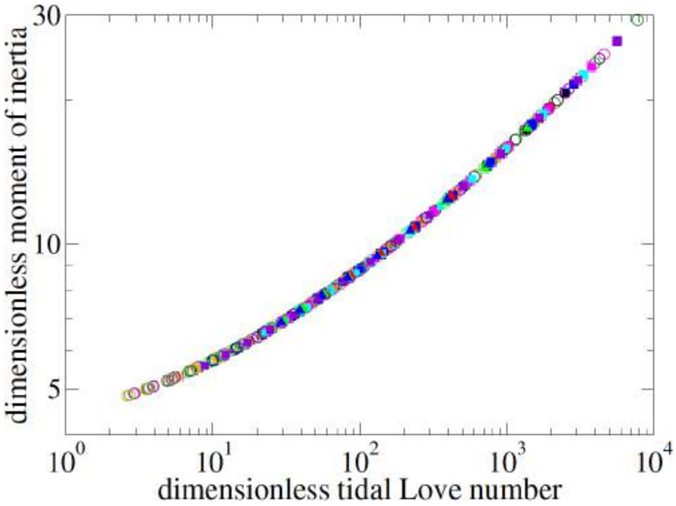

Figure 1: Universal I-Love relation between moment of inertia and tidal Love number. Different markers correspond to different equations of state. Observe how the relation is insensitive to the choice of such equations of state.

Quality assurance for automatic segmentation

Kuo Men (2019 – AC4 YSP Winner) **and Jianrong Dai**

Innovation: Use of convolutional neural networks (CNN [1–2]) has been shown to be a state-of-the-art method for segmentation (contouring) of tumor targets and organs at risk (OARs) [3-4] in radiotherapy. A CNN can accomplish contouring much faster than physicians, and has higher accuracy than that of other computer-aided methods[5]. However, the considerable variability in medical images can lead to major errors even when using the best model. Physicians must spend a considerable amount of time examining contours slice by slice, which reduces the benefit of the automatic tool greatly. Therefore, evaluation of the quality of segmentation using an automatic method is crucial so that flawed contours can be identified for expert review. Here, we proposed a fully automatic quality-assurance method for deep learning-based segmentation by predicting quality with a CNN. We adopted the well-known ResNet-101 framework with high performance for quality prediction. The input of the CNN included the maps of computed tomography (CT) as well as the probability and uncertainty of segmentation. The output was the segmentation quality. The uncertainty map is calculated as: $u(i,j)=1-\max[p(i,j),1-p(i,j)]$, where $u(i,j)$ denotes the uncertainty of the pixel (i,j) and $p(i,j)$ denotes the probability that the pixel (i,j) belongs to the region to be segmented. We used the Dice Similarity Coefficient (DSC) as the index of segmentation quality, and divided the range into three levels: [0.95, 1] for "good", [0.8, 0.95) for "medium", and [0, 0.8) for "bad" segmentation quality.

Figure 1 illustrates the overall architecture. It had two main parts: an automatic-segmentation network and a quality-assurance network. The two networks were based on a CNN. The proposed pipeline had four main steps: (i) run the automatic-segmentation method to obtain segmentation probability maps; (ii) calculate the uncertainty maps using the segmentation probability; (iii) predict the segmentation quality using a classification model based on the CT image, probability map, and uncertainty map; (iv) physicians revise the automatic segmentation according to their knowledge and the predicted quality.

The proposed method is novel with four main contributions. First, the proposed method can predict, in real time, the performance of a segmentation model on each individual slice without the ground truth (GT). Second, maps of segmentation probability and uncertainty were introduced to predict contours' quality. These two kinds of maps can reflect directly the confidence of the segmentation model that is closely related to its performance. Third, the proposed method can predict the segmentation quality based on the DSC, which can provide a quantitative index for physicians to use their judgment. Finally, the proposed method can be used to integrate into current segmentation pipelines in clinical routine to improve efficiency.

Key Results: Table 1 lists the quality-prediction results on the test set. The balanced accuracy of all quality levels was above 0.89, which indicated that >89% of automatic segmentation could be classified accurately into a quality level. The speed was fast and prediction time was about 2 s per patient.

Organ	GT	Number of samples	BA	SEN	SPE	F-score	AUC
CTV	Good	3154	0.97	0.96	0.99	0.98	0.96
	Medium	1815	0.94	0.94	0.95	0.91	0.93
	Bad	605	0.89	0.80	0.98	0.81	0.88

Table 1. Results of quality prediction

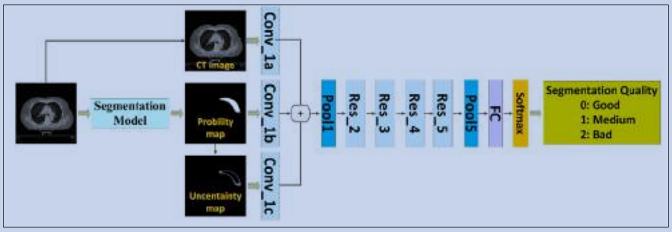

Figure 1. The architecture of the proposed method

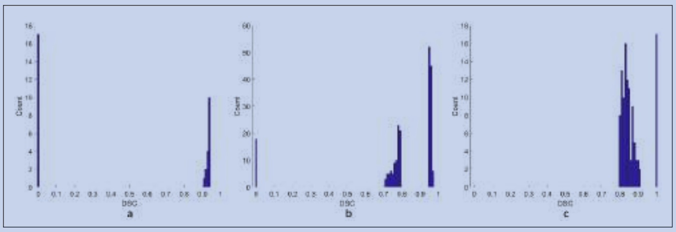

Figure 2. Histogram of the DSC for incorrect prediction. a: misclassified as "good"; b: misclassified as "medium"; c: misclassified as "bad".

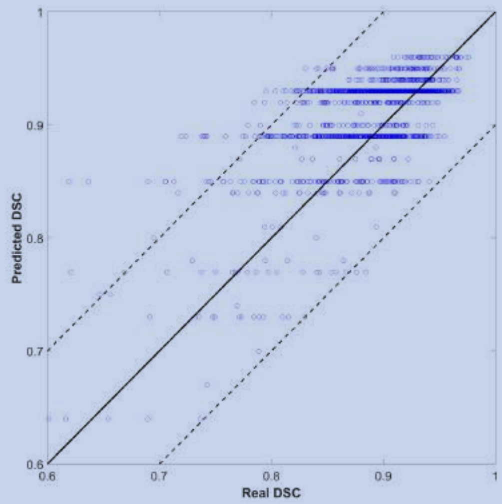

Figure 3. Analyses of the ROC curve for quality prediction.

We analyzed the DSC for incorrect prediction. The distribution is shown in Figure 2. For the contours misclassified as "good" quality (Figure 2a), half of them had a DSC of ~0.95, which was the boundary between "good" and "medium". Most of the contours misclassified as "medium" quality (Figure 2b) were also at the boundary of quality classification. The contours misclassified as "bad" quality (Figure 2c) had a wider DSC range. In addition, a few contours with a DSC of 0 or 1 were not recognized correctly. A classification of "0" meant that the segmentation model missed or generated redundant contours, whereas "1" meant that no contour was generated by the segmentation model or by physicians. Usually, these slices were located at the top or bottom boundaries of the CTV, where the classification model was prone to make mistakes.

We also tried to predict the DSC instead of the quality level for segmentation. The output (DSC) was set to 101 classes (i.e., 0 to 100 with an interval of 1). Figure 3 shows the scatter plots of predicted versus real DSC for all the test contours. With the increase of classification types, the accuracy of prediction was reduced. This low accuracy may have been due to the small difference in characteristics between samples with a similar DSC, which made it difficult for the classifier to make an accurate prediction. However, the predicted DSC was very close to its real value with mean error of 0.06±0.19. Specifically, 80%, 85%, and 93% of the prediction had an absolute error within 0.03, 0.05, and 0.10 respectively, compared with reality.

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Single antiprotons and protons under the precision microscope

Andreas Mooser[1,2,3,4] and Christian Smorra[1,5] (2019 – C15 YSP Winners)

1 RIKEN, Fundamental Symmetries Laboratory, Wako, Japan
2 Max-Planck-Institut für Kernphysik, Heidelberg, Germany
3 Johannes Gutenberg-Universität Mainz, Institut für Physik, Mainz, Germany
4 Helmholtz-Insititute Mainz, Mainz, Germany
5 CERN, European Organization for Nuclear Research, Geneva, Switzerland

The Standard Model of particle physics is the theory which best describes our current understanding of the fundamental particles of nature and their interactions, apart from gravity. However, so far this theory does not give an answer to all of our observations and a number of open questions have yet to be answered. "What happened to the primordial antimatter?" is certainly one of them. Our astronomical observations show that we live in a matter-dominated Universe, and no indication for primordial antimatter has been found [1]. It is still unclear which mechanism generated the matter- antimatter asymmetry, and the Standard Model with its current parameters cannot reproduce the observed matter excess [2].

One possible explanation of this asymmetry is that a fundamental assumption of the Standard Model does not hold exactly – namely the invariance of the interactions under the combined charge- (C), parity- (P) and time-reversal (T) transformation [3]. This invariance requires that conjugate particle- antiparticle pairs have identical fundamental properties, such as charge-to-mass ratios and magnetic moments, except for the sign. In our research, we compare these fundamental properties of protons and antiprotons with high precision, and test whether the CPT invariance holds in the baryon sector. We perform these comparisons by using single-trapped protons and antiprotons, which are stored for measurements in cryogenic Penning traps at 4 K for several months. The static electro-magnetic fields and the ion form a well-defined and controllable quantum system, which allows searching for tiny modifications mediated by new interactions. Examples for those are CPT-violating interactions described in the Standard Model Extension [4], effects of CPT-odd dimension-five operators [5], or an anomalous gravitation of antimatter systems [6].

To set the most stringent limits on these effects, we have constructed and operated two advanced multi-Penning trap systems – one for protons located at the University of Mainz, Germany, and one for antiprotons at the antiproton decelerator facility of CERN, recognized as BASE-Mainz and BASE-CERN experiments. Using these two experiments, we conducted the most precise measurements of the proton magnetic moment [7,8] todate, the anti-proton magnetic moment [9], and the most stringent charge-to-mass ratio comparison between the proton and the antiproton [10].

One of the key techniques to measure the magnetic moment is the non-destructive detection of quantum spin-transitions of single (anti-) protons. To this end, we employ the elegant continuous Stern-Gerlach effect, which in analogy to the classical Stern-Gerlach effect makes the motion of the ion dependent on the spin-state [11,12,13]. Thus, we confine single (anti-)protons in a Penning trap superimposed to a strong inhomogeneous magnetic field, and observe changes in the oscillation frequency of about 180 mHz caused by quantum spin-transitions. Since however nuclear magnetic moments are smaller by orders of magnitude compared to the magnetic moment of electrons or positrons, the application of this technique is particularly challenging for (anti-)protons, and requires the use of the strongest magnetic bottle ever introduced in such systems (3.105 T/m2), and the preparation of particles at sub-thermal temperatures of 0.1 K.

The magnetic bottle, however, broadens the linewidth of the spin transition. To perform high- precision measurements of the (anti-)proton magnetic moments, we have developed multi-trap techniques [9,14,15], where the (anti-)proton spin-transition frequency is measured in a homogeneous trap, and moved into the magnetic bottle to determine the spin state. The cyclotron frequency of the trapped particle provides an excellent in-situ magnetic field measurement, and we extract the antiproton magnetic moment and the proton magnetic moment in units of the nuclear magneton from the spin-transition-to-cyclotron frequency ratio:

$$\mu_p = 2.792\,847\,344\,62\,(82)\,\mu_N$$

$$\mu_{\bar{p}} = -2.792\,847\,344\,2\,(41)\,\mu_N$$

Our Penning trap based proton magnetic moment measurement is by a factor of 30 more precise then the so far best indirect hydrogen maser measurement [16], and the antiproton magnetic moment is a factor 106 more precise compared to the value extracted from exotic atom spectroscopy [17], and a factor of 350 more precise than single-Penning trap measurements [18], respectively.

Comparing the cyclotron frequencies of antiprotons and negative hydrogen ions allowed us to compare the charge-to-mass ratios of protons and antiprotons with unprecedented precision:

$$\frac{(\frac{q}{m})_{\bar{p}}}{(\frac{q}{m})_{p}} + 1 = 1\,(69)\,10^{-12}.$$

Our results are consistent with CPT invariance, and no indication for new physics has been found at the present measurement precision. Therefore, we develop new techniques to test CPT invariance with even higher sensitivity. One of those is the sympathetic cooling of (anti-)protons with laser- cooled ions [19]. This will remove temperature limitations from our CPT invariance tests and improves their sensitivity. Furthermore, this technique improves the sensitivity on nuclear spin- transitions, so that we can measure the magnetic moment of the even more challenging 3He ion to provide a standard for absolute magnetic field measurements.

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YOUNG SCIENTIST PRIZES 2018

Commission on Biological Physics (C6)

Nikta Fakhri

“For her significant contributions to applying fundamental principles of thermodynamics to experimental nonequilibrium biological systems, and advancing our understanding of how molecular-scale non-equilibrium processes are manifest in the system dynamics at larger scales.”

Nikta Fakhri is the Thomas D. and Virginia W. Cabot Career Development Assistant Professor of Physics at MIT (Cambridge, MA, USA). She completed her undergraduate degree at the Sharif University of Technology, Tehran, Iran and her PhD at Rice University (Houston, TX, USA) in 2011. She was a Human Frontier Science Program postdoctoral fellow at Georg-August-Universistät in Göttingen, Germany where she pioneered the use and development of fluorescent single-walled carbon nanotubes as probes in soft matter and biophysics. At MIT, her lab focuses on identifying underlying principles of collective dynamics and complex spatiotemporal patterns in far from equilibrium biological systems.

International Commission on Optics (ICO) (AC1)

Can Bayram

"For revolutionizing the way graphene has been employed and making major contributions to III-V photonic devices."

Can Bayram is an Assistant Professor in the Department of Electrical and Computer Engineering of University of Illinois at Urbana-Champaign, IL, USA. He is an expert in III-V materials and photonic and electronic devices. He has performed more than 3,000+ epitaxial growths with metalorganic chemical vapor deposition (MOCVD) systems and fabricated detectors, light emitting diodes, solar cells, resonant tunneling diodes, and transistors in class 100 and 1000 cleanrooms totaling 20,000+ hours of equipment usage. His current research interests lie in the intersection of novel III-V materials, hetero-structures, and photonic and electronic quantum devices. Particularly, his research group explores novel materials, devices, and their 3D hetero-integration on unconventional platforms such as graphene and silicon and investigates heat transport across/through semiconductors; efficiency droop mechanisms and remedies in AlInGaN emitters; and ultra-fast THz photonics/electronics.

Prof. Bayram worked as a postdoctoral Research Scientist in the Silicon Technologies Division at the IBM Thomas J. Watson Research Center, Yorktown Heights, NY, USA from 2011 till 2014. His postdoctoral work at IBM on a novel means of thin film technology achieved record-breaking specific power solar cells and was featured on the cover of Advanced Energy Materials. He has – for the first time–integrated GaN-based devices on CMOS-compatible silicon substrates. This work was highlighted as the frontispiece in an Advanced Functional Materials issue. He demonstrated direct epitaxy of GaN on Graphene for the first time, as published in Nature Communications.

Prof. Bayram received his PhD degree from Prof. Manijeh Razeghi, Center for Quantum Devices, EECS of Northwestern University, IL, USA with a focus on Solid State and Photonics in 2011. His thesis work has demonstrated the first ultraviolet regime single photon detection, the first hybrid LED, and the first GaN intersubband devices.

International Commission on Medical Physics (IOMP) (AC4)

Kuo Men

"For automatic segmentation of the clinical target volume and organs at risk in the planning CT for rectal cancer using deep dilated convolutional neural networks."

Kuo Men is an associate professor at Cancer Hospital, Chinese Academy of Medical Sciences, Beijing, China. He did his PhD work 2014-2017 in Medical Physics at Peking Union Medical College under the supervision of Professor Jianrong Dai, and then worked as postdoctoral fellow with Professor Ying Xiao at the University of Pennsylvania. He developed a dual energy imaging technology for online cone beam CT and pioneered deep learning methods to many areas of radiotherapy. The application of these novel methods is ground breaking and the impact in clinical environtments is enormous.

YOUNG SCIENTIST PRIZES 2019

Commission on Statistical Physics (C3)

Lucile Savary

"For her pioneering contributions to our understanding of complex quantum states of matter, with particular reference to quantum spin liquids."

Lucile Savary is a permanent CNRS researcher in condensed matter theory at the Laboratoire de physique at ENS de Lyon. Before moving there, she was a PhD student at the University of California, Santa Barbara, and a Gordon and Betty Moore postdoctoral fellow at MIT.
Her research focuses on exotic phenomena in real systems, with an emphasis on frustrated magnetism. It includes quantum spin liquids, and in particular quantum spin ice, order-by-disorder, quantum criticality, the theory of RIXS, spin-orbital systems, thermal transport, and unconventional superconductivity in multi-band spin-orbit coupled materials.

Alexandre Solon

“For his outstanding theoretical contributions to the development of non-equilibrium statistical physics and the field of active matter.”

Alexandre Solon received in 2015 a PhD in Theoretical Physics from Université Paris-Diderot where he studied several aspects of the statistical mechanics of active matter under the supervision of Dr. Julien Tailleur. In particular, a large part of his PhD work focused on understanding the transition to collective motion, as exhibited in the Vicsek model, and elucidating the particular properties of the mechanical pressure exerted by active fluids. He was then appointed “Physics of Living Systems” postdoctoral fellow at MIT where he continued his research on active matter and other nonequilibrium systems. His main contributions during this time concern the understanding of motility-induced phase separation and of the optimal thermodynamic protocols minimizing fluctuations. Since October 2018, Alexandre has been a CNRS research scientist working in Sorbonne Université in Paris.

Manlio De Domenico

“For his important contributions to the modeling of complex systems based on statistical physics and nonlinear dynamics, in particular, the development of the physics of multilayer networks and a quantum-inspired statistical mechanics of networks.”

De Domenico obtained his PhD in Physics in February 2012 at the School for Advanced Studies of the University of Catania. He is currently Senior Researcher at Fondazione Bruno Kessler – a leading Italian research institution – and Director of the Research Unit "Complex Multilayer Networks" (CoMuNe) Lab, an interdisciplinary group working at the edge of Statistical Physics, Applied Math and Computer Science. He holds the National Scientific Habilitation (ASN) as Full Professor in Theoretical Physics of Condensed Matter.

His primary research field gravitates around theoretical and computational aspects of Statistical Physics, with the main focus on modeling of complex systems based on statistical physics and nonlinear dynamics. For his recent contributions to the field – including the development of a physics of multilayer networks and a quantum-inspired statistical mechanics of networks – he paved the way for interdisciplinary applications of Statistical Physics to the modeling and analysis of the human proteome, the human brain and collective behavior in social and socio-technological systems far from equilibrium.

De Domenico has been received recognition in national and international prizes, including the “Junior Scientific Award” from the Complex Systems Society (2016) – for “a number of pioneering contributions to the field of multilayer networks” – and the “Prize in Formal Sciences” from the Universal Scientific Education and Research Network (2017) – for “modeling the complexity of systems of systems”.

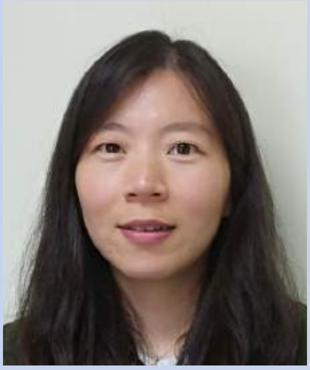
Commission on Astroparticle Physics (C4)

Anna Nelles

“For outstanding contributions to the radio detection of cosmic rays and neutrinos.”

Anna Nelles, received the 2019 IUPAP Young Scientist Prize during the 36th International Cosmic Ray Conference in Madison, USA.

Anna Nelles competed her PhD in 2014 at Radboud University Nijmegen, the Netherlands under the supervision of Prof. J.R. Hörandel. She had a key role in connecting the activities of the LOFAR radio telescope in Europe, with the Auger Engineering Radio Array located in Argentina that contributed toward the development of radio detection of air showers. Her subsequent postdoctoral work at the University of California, Irvine on the ARIANNA project led to significant breakthroughs in detection of ultra-high energy neutrinos. She now holds a joint appointment at DESY Zeuthen and Friedrich Alexander University in Erlangen Nuremberg both in Germany. Her current focus continues to be on the radio detection of neutrinos in challenging but pristine environments of Antarctica and Greenland.



Siyao Xu

"For fundamental theoretical contributions to astroparticle physics that reveal profound connections among diverse phenomena."

Siyao Xu, received the 2019 IUPAP Young Scientist Award during the 36th International Cosmic Ray Conference held in Madison, USA on 25th of July 2019.

She is currently a Hubble Fellow at the University of Wisconsin-Madison. She completed her PhD at Peking University (Beijing, China) under the supervision of Professor Bing Zhang in 2017. Her thesis on magnetohydrodynamics (MHD) turbulence and its astrophysical applications was recognized, with the 2017 International Astronomical Union (IAU) PhD Prize and the 2019 Cecilia Payne-Gaposchkin Doctoral Dissertation Award in Astrophysics. Her research focuses on understanding of the fundamental physics of cosmic ray propagation and particle acceleration in high-energy astrophysical environments. Her work demonstrates that the key to studying cosmic ray propagation is to obtain a proper description of MHD turbulence. Her pioneering theoretical studies have been applied for addressing diverse and long-standing astrophysical problems related to gamma-ray bursts, pulsar wind nebulae, and supernova remnants, to name a few.

Commission on Biological Physics (C6)

Knut Drescher

"For his significant contributions to imaging and understanding the spatiotemporal development and function of bacterial multicellular behaviors, ranging from collective motion to bacterial biofilm communities."

Knut Drescher is currently both a professor of biophysics at the Philipps-Universitaet Marburg and a Max Planck Research Group Leader at the Max Planck Institute for Terrestrial Microbiology in Marburg, Germany. Knut received his undergraduate education in physics at the University of Oxford from 2003-2007, before completing a PhD in biophysics at the University of Cambridge in 2011, where he pioneered measurements of flow fields around microorganisms and their hydrodynamic interactions. He became interested in bacterial multicellular behavior and molecular biology during his postdoctoral fellowship at Princeton University, in the Department of Molecular Biology from 2011-2014. In 2014, Knut Drescher moved to Marburg, Germany, to take up his current positions.

Knut's work focuses on understanding the morphogenesis of bacterial communities, and the evolutionary fitness consequences of life within bacterial communities. His work combines genetics, biochemistry, and biophysical techniques to explore molecular, physical, and evolutionary mechanisms underlying bacterial behaviors within communities. Most recently, he has developed live-cell imaging techniques for biofilms and swarms that simultaneously capture the single-cell dynamics and community dynamics, thereby facilitating major new insights into bacterial collective behavior.

Commission on Magnetism (C9)

Julia Mundy

"For pathbreaking research on electric field control of magnetism using epitaxially designed multiferroics."

Julia Mundy joined the Physics department at Harvard University as an assistant professor in 2018. She received her PhD in Applied Physics from Cornell University where she workded in the groups of Professor Darrell Schlom and Professor David Muller. From 2015-2017, she was the University of California President's Postdoctoral Fellow at UC Berkeley in the group of Professor R. Ramesh. Dr. Mundy's research combines thin film synthesis with picoscale imaging to design, construct and probe novel materials. Dr. Mundy is also the recipient of the 2019 George E. Valley, Jr. Award from the American Physical Society and is a Moore Fellow in Materials Synthesis.

Commission on Structure and Dynamics of Condensed Matter (C10)

Ming Yi

"For her fundamental contributions in understanding electronic and magnetic order and dynamics in quantum materials, including iron-based superconductors."

Ming Yi started as an assistant professor in the Physics and Astronomy Department of Rice University in January 2019. She obtained her BS degree from the Massachusetts Institute of Technology and her PhD degree from Stanford University, both in physics. She worked as a postdoctoral researcher at the University of California, Berkeley from 2014-2018. Ming's main research interest is to discover, understand, and manipulate emergent phenomena in quantum materials using experimental probes such as angle-resolved photoemission spectroscopy and x-ray scattering. She has worked extensively in the field of high temperature superconductors, where her main contributions include key experimental evidences for the important role of orbital physics in iron-based high temperature superconductors, in particular, that of electronic nematicity and orbital-selective correlation effects.

Commission on Nuclear Physics (C12)

Or Hen

"For extending our knowledge and understanding of short range correlations in nuclei, and for the discovery of a remarkable linear relationship between high-momentum correlations and the deviation of the quark momentum in a heavy nucleus."

Or Hen received a combined B.Sc. degree in physics and computer engineering. He then joined the Nuclear Research Center in the Negev and in parallel, started his graduate studies at Tel Aviv University, where he completed his PhD. thesis in 2015. That same year he was awarded the IPS Prize for a Graduate Student in Experimental Physics by the Israel Physical Society. In 2015, he also received the prestigious Pappalardo Fellowship at Massachusetts Institute of Technology, MIT, and within one year after his PhD. he was offered a tenure-track faculty position at MIT. His results are based on experiments at Jefferson Lab, and already, in this early phase of his carreer, he plays a leadership role in precision electron-scattering experiments. He has made several important research contributions to frontier subjects related to the interface between nuclear and particle physics, and he has shown that the new knowledge gained has important implications for a remarkable array of topics, including the quark structure of the proton and neutron, connections between nuclei and ultra-cold atomic systems, neutrino physics, and the kinetic symmetry energy of nuclear matter. In 2018 he received the distinguished Altarelli Award based on the implications of his work for nucleon-nucleon correlations.

Chun Shen

"For his groundbreaking contributions to the field of high energy nuclear physics, and in particular, his development of a comprehensive code package dynamically simulating all stages of relativistic heavy-ion collisions of importance for the investigation of strongly-coupled quark-gluon plasmas."

Chun Shen obtained his PhD. in Physics from Ohio State University in August 2014. He won the Chinese National Award for Outstanding PhD. Students Abroad, and his PhD. thesis won the 2016 Dissertation Award in Nuclear Physics of the American Physical Society, as well as an honorable mention in the 2015 RHIC Thesis Award competition. After having completed a 2-year postdoctoral fellowship at McGill University in Montreal he turned down an offer of an Oppenheimer Fellowship from the Los Alamos National Laboratory, to accept a Goldhaber Distinguished Fellowship at Brookhaven National Laboratory, where he became a member of their Nuclear Theory Group. In 2018, Shen started a new position as Assistant Professor at Wayne State University in Detroit. Shen's area of expertise is in theoretical relativistic heavy-ion physics, with a specific emphasis on the hydrodynamic evolution of transport properties of quark-gluon plasma and its electromagnetic radiation spectrum. Heavy-ion collisions allow one to explore the properties of QCD matter under the most extreme conditions of temperature and energy density with wide-ranging implications. Chun's research provides an important theoretical support for the relativistic heavy-ion programs at the Large Hadron Collider in Switzerland and at the Relativistic Heavy Ion Collider at Brookhaven National Laboratory.

Xiaofei Yang

"For her realization of a unique laser spectroscopy technique to be applied at the projectile-fragmentation (PF)--type radioactive isotope beam facility and for the substantial contribution to the development and operation of the laser spectroscopy devices at ISOLDE which measure the basic properties of exotic atomic nuclei with high resolution and efficiency."

Xiaofei Yang received her Ph.D. degree in nuclear physics from Peking University, China in 2014. Her Ph.D. research work was conducted at RIKEN Nishina Center, Japan, and focused on the development of a novel laser spectroscopy technique OROCHI until the completion of the associated first physics experiment. She worked at RIKEN for 3 years as an International Program Association joint student. She then joined the nuclear moment group at IKS, KU Leuven, Belgium, as a postdoctoral researcher. Her work there was mainly devoted to the laser spectroscopy experiments COLLAPS and CRIS to study the structure of exotic isotopes. She had been a local member of CERN-ISOLDE from 2016 till 2017, supported by the Junior Mobility Program of KU Leuven and FWO Grant for a Long-Stay in Europe, Belgium. Since October 2017, she has been a faculty member at Peking University, China. Her main research interests are the development of high-precision and high sensitivity laser spectroscopy techniques and the associated structure studies of exotic nuclei.

Commission on Atomic, Molecular and Optical Physics (C15)

Christian Smorra

"For his outstanding contribution to determine the most precise comparison of the proton-to-antiproton charge-to-mass ratios and the most precise comparison of the proton and antiproton magnetic moments, constituting two different world-record tests of the fundamental charge, parity, and time reversal symmetry in these systems."

Christian Smorra graduated as a PhD student in 2012 at the Ruprecht-Karls-University Heidelberg. As part of the "Cooled and Stored Ions Division" of the Max-Planck-Institute for Nuclear Physics, he measured the energy release of double-electron capture transitions with high precision using Penning trap mass spectrometry techniques. As RIKEN postdoctoral researcher, he joined the BASE collaboration at CERN to construct a new Penning-trap system for high-precision tests of CPT invariance with antiprotons. Here, he contributed to the development of the antiproton reservoir trap and to the most precise charge-to-mass ratio comparison of protons and antiprotons. He continued this work as a CERN research fellow, which resulted in a 350-times improved measurement of the antiproton magnetic moment. Currently, he is working at RIKEN on new methods to increase the sensitivity of low-energy antiproton measurements.

Andreas Mosser

"For his outstanding contribution to determine the most precise comparison of the proton-to-antiproton charge-to-mass ratios and the most precise comparison of the proton and antiproton magnetic moments, constituting two different world-record tests of the fundamental charge, parity, and time reversal symmetry in these systems."

Andreas Mooser received his PhD. in 2014 from the Johannes Gutenberg-University of Mainz for the first direct observation of single spin-transitions and the first direct high-precision measurement of the nuclear magnetic moment of a single proton. He received for his work the thesis award of the University of Mainz and GSI Darmstadt. Afterwards, he obtained the highly competitive RIKEN FPR fellowship to join the BASE collaboration at CERN. Here, he performed high-precision measurements of the fundamental properties of single protons and antiprotons, which culminated in the most precise tests of the CPT symmetry with protons and antiprotons to date. In parallel, he worked on the implementation of sympathetic laser cooling in Penning traps at the BASE-Mainz experiment and, together with researchers from the Max-Planck Institute for Nuclear Physics, Heidelberg, conducted the most precise measurement of the atomic mass of the proton. Since 2018, he joined the Max-Planck Institute for Nuclear Physics to lead a new research group, focusing on the high-precision measurements of the ground state hyperfine-splitting of single ionized 3He and the nuclear magnetic moment of the helion ion to investigate the nuclear structure of light atoms and establish a new standard for absolute magnetometry.

Commission on Plasma Physics (C16)

Istvan Cziegler

"For his major contributions to the understanding of coupling between plasma flows and turbulence, especially with regard to their role in transitions between tokamak confinement states which are central to the achievement of fusion energy."

Istvan Cziegler is a lecturer in the York Plasma Institute of the Department of Physics at the University of York. He completed his undergraduate studies at the Eötvös Loránd University (Hungary) in atomic and molecular physics, earning an MSc with honors for studies on edge plasma modes and hydrodynamic chaos. He received his PhD in physics from the Massachusetts Institute of Technology (MA, USA) for a thesis in the area of turbulence and transport phenomena in fusion plasmas. During his graduate studies, he built an ultra-fast imaging system and developed analysis techniques for turbulence nonlinearity which allowed him to resolve the fine time structure of turbulence phase transitions. His main research interests include self-organization, transport, and spectral transfer phenomena in plasma turbulence, core and edge coupling in fusion grade plasmas of tokamak and spherical torus devices, alternative regimes of high confinement operation, and the development and exploitation of optical plasma diagnostics.

Commission on Laser Physics and Photonics (C17)

Sergey Kruk
'Fundamental Aspects'

"For his ground breaking contributions to the study of topological states of light at the nanoscale, particularly for his pioneering work on nonlinear and nonreciprocal effects in photonic nanostructures".

Sergey Kruk graduated from Belarusian State University, and received his PhD in physics from the Australian National University. He holds a Research Fellow position at the Nonlinear Physics Centre, Research School of Physics, Australian National University where he has developed and is managing experimental facilities on nonlinear meta-optics and nanophotonics. Dr. Kruk has conducted his research at the Australian National Fabrication Facility; at Oak Ridge National Laboratory, US; and at the Ultrafast Nanophotonics group, Paderborn University, Germany. His work has led to more than 30 publications among which are Nature Nanotechnology, Nature Communications, Science, Nano Letters and Optica.

Sergey's recent focus has been on topologically nontrivial states of light in dielectric nanoresonators. His interest lies in introducing nonlinear optical interactions to topologically nontrivial nanostructures. This work has brought nonlinear topological photonics to the realm of nanoscience, it has led to demonstrations of nonlinear light generation in topological nanostructures and to direct observations of robust light propagation in nanostructured topological waveguides.

Jinyang Liang

'Applied Aspects'

"For his outstanding contributions that apply coded-aperture optical imaging to ultrafast visualization and ultra-precise modulation of laser beam/pulse profiles".

Jinyang Liang is an Assistant Professor at the Institut National de la Recherche Scientifique (INRS) – Université du Québec. He leads the Laboratory of Applied Computational Imaging. His research interests cover a broad range of areas, including ultrafast imaging, high-precision laser beam shaping, and photoacoustic microscopy. His research primarily focuses on implementing optical modulation techniques to develop new optical instruments for applications in physics and biology. He has published over 50 journal papers and conference proceedings, including Nature (cover story), Science Advances, and Light: Science & Applications. He has applied seven U.S. patents on ultrafast optical imaging technology. He received his B.E. degree (with honor) in Optoelectronic Engineering from Beijing Institute of Technology in 2007, and his M.S. and Ph.D. degrees in Electrical Engineering from the University of Texas at Austin in 2009 and 2012. From 2012 to 2017, he was a postdoctoral trainee at Washington University in St. Louis and California Institute of Technology.

Alireza Marandi

'Applied Aspects'

"For contributions to nonlinear photonics, particularly his pioneering work on computing with networks of OPOs and demonstration of optical Ising machines, as well as half-harmonic generation of mid-infrared frequency combs."

Alireza Marandi is an Assistant Professor of Electrical Engineering and Applied Physics at Caltech. Before joining Caltech, he held positions as a postdoctoral scholar and a research engineer at Stanford. He was also a visiting scientist at the National Institute of Informatics in Japan and a senior engineer in the Advanced Technology Group of Dolby Laboratories. He received his PhD from Stanford University in 2013, his MS from the University of Victoria, Canada and his BS from the University of Tehran, Iran, all in electrical engineering. His research is focused on fundamental technological developments in nonlinear photonics. His work explores the frontiers of ultrafast optics, optical frequency combs, quantum optics, optical information processing, mid-infrared photonics, and laser spectroscopy. He is a Senior Member of OSA and IEEE and has received the faculty's early career development (CAREER) award from NSF in 2019.

Commission on Computational Physics (C20)

Jesús Carrete Montaña

"For his original contributions and development of pioneering computational methods in the emerging field of ab-initio thermal transport, enabling the parameter-free prediction of thermal conduction properties of solid materials, and opening these novel methods to the broader scientific community through open source codes."

Jesús Carrete finished his BSc in Physics from the University of Santiago de Compostela in 2007 and received a national award from the Spanish Ministry of Education as the best graduate in that discipline in his year. His thesis work in Materials Science, completed with honors in 2012 at the same university, was also recognized with an outstanding PhD award. He then joined the Laboratory for Innovation in New Energy Technologies and Nanomaterials at the French Alternative Energies and Atomic Energy Commission as a postdoctoral researcher. In 2014, he was promoted to research engineer. Since 2016, he holds a position as a senior scientist at the Institute of Materials Chemistry at TU Wien in Vienna, Austria.

His research is centered on first-principles, predictive thermal conductivity calculations. He has had a leading role in the design, implementation, support and promotion of open-source software that has been pivotal in the development of this relatively young area of study. Moreover, he has pioneered applications of this formalism to new materials and structures of theoretical and applied interest, from novel laminar compounds to doped bulk semiconductors.

International Commission on General Relativity & Gravitation (ISGRG) (AC2)

Kent Yagi

"For his insightful and broad contributions to the physics of gravitational waves, neutron stars, and experimental gravitation"

Kent Yagi was awarded the 2019 Young Scientist Prize in General Relativity and Gravitation for his insightful and broad contributions to the physics of gravitational waves, neutron stars, and experimental gravitation.

Kent Yagi received his PhD from Kyoto University in 2012. As a graduate student, he worked on testing General Relativity with gravitational waves, in particular using space-borne detectors. After receiving his PhD, he became a postdoctoral researcher at Montana State University (2012-2015). While continuing to work on the experimental gravity frontier, he started studying neutron star physics. He and Nicolas Yunes (the 2015 Young Scientist Prize winner) discovered the universal I-Love-Q relations for neutron stars and a few other similar relations, which have recently been applied by the LIGO-Virgo Collaboration for probing nuclear physics from the binary neutron star merger event. Yagi then became a postdoctoral researcher at Princeton University (2015-2017). Yagi, Yunes and Frans Pretorius used the first gravitational wave event to reveal how well one can probe fundamental aspects of General Relativity, including the equivalence principle and Lorentz invariance.

In August 2017, Yagi joined the Physics Department at the University of Virginia as an assistant professor. He is currently leading a group of ~10 members. His latest work with students include measuring nuclear parameters with gravitational waves and probing strong gravity with black hole / pulsar binaries. He has close collaborations with researchers not only within the Physics Department (such as a string theorist, high energy physicists and a nuclear theorist), but also in the Astronomy Department and National Radio Astronomy Observatory. He occasionally hosts joint colloquiums between these Departments and the Observatory to enhance interaction among them.

Yagi has received several distinctions including the MSU Outstanding Staff Award and the JSPS Fellowships. He will serve as a Sloan Fellow from September 2019.

CONFERENCE REPORTS - 2018

5th African School on Electronic Structure Methods and Application (ASESMA), held in Addis Ababa, Ethiopia from 22/10/2018 – 02/11/2018. The School provided an introduction to the theory of electronic structure and other atomistic simulation methods, with an emphasis on the computational methods for practical calculations. It also covered basic and advanced topics and applications of these methods to the structural, mechanical and optical properties of materials. It had hands-on tutorial sessions based on public license codes (including, but not limited to, the Quantum Espresso package). In the second week, students were asked to split up into teams and work on specific projects under the guidance of the lecturers and mentors.

XXX IUPAP Conference on Computational Physics, held at University of California (ICCP), Davis, USA, from 29/7/2018 – 02/08/2018 showcased new work on using artificial intelligence to accelerate the discovery of new materials. It also provided the platform for mew advances in quantum computing alongside highlighting the major projects in cosmology/astrophysics that will provide key information on the evolution of the universe. The banquet speaker, Prof Tony DeRose gave a fascinating talk on the physics of animation. He generally outlined, the dramatic increase in the use of computation in a broad array of physics-related disciplines that will accelerate discovery from traditional physics, materials science, cosmology/astrophysics, quantum and statistical mechanics, biophysics and more.