



Newsletter

President: **Bruce McKellar** • Editor-in-Chief: **Kok Khoo Phua** • Editors: **Maitri Bobba; Sun Han**

JUNE 2016

Message from the President

IUPAP now has its own office for the very first time. One of the first visitors to the new IUPAP office was Dr Sparisoma Viridi of Indonesia discussing the possible mutual advantages of Indonesia joining IUPAP. In early June, I had discussions with the Thai Physical Society about the possibility of their joining IUPAP, and I will continue my discussions with the Vietnamese in July.

I will tell you about these discussions in the next newsletter and devote the rest of my usual space to a snippet about the names of the new elements. This edition was fully taken up when the news broke.



From Left: Dr L.C.Kwek, Dr Sparisoma Viridi and Dr Bruce H McKellar at IUPAP office, Singapore

ELEMENTS 113, 115, 117 AND 118 ARE NAMELESS NO MORE.

In January 2016, the report of the IUPAP-IUPAC joint working party was published which verified the claims for the discovery of the elements 113, 115, 117 and 118. The discoverers were then invited to propose names and symbols for the new elements, and on 8 June, the provisional recommendation of IUPAC for these names was published. The names were announced in simultaneous press releases by IUPAC and IUPAP. The elements were named after a country, a state, a region and a scientist involved in the discoveries.

48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og

Element 113: Nihonium (with the symbol Nh) ; Element 115: Moscovium (with the symbol Mc) ;
Element 117: Tennessine (with the symbol Ts) ; Element 118: Oganesson (with the symbol Og)

Element 113: Nihonium (with the symbol Nh) was discovered at the RIKEN Nishina Center for Accelerator Science in Japan and named using one of the Japanese names for Japan, Nihon (the land of the rising sun).

Element 115: Moscovium (with the symbol Mc) was named after the Moscow region, the location of the Joint Institute for Nuclear Research in Dubna, which was the home of the accelerator used to initiate the reactions leading to this element and the next two

Element 117: Tennessine (with the symbol Ts) was named after the US state of Tennessee. The name recognizes the contribution of the Oak Ridge National Laboratory and Vanderbilt University in that state to the discovery of the element tennessine, by the production of the rare berkelium target used in its discovery.

Element 118: Oganesson (with the symbol Og) was named after the nuclear physicist Professor Yuri Oganessian. Professor Oganessian led Dubna research into super heavy nuclei and the search for new elements, including the element oganesson. This element completes the seventh row of the periodic table.

Nuclear physics has played a central role in all of these discoveries and it is expected to continue playing a role in the future discoveries of elements in the eighth row of the table.

Monaco ITER International Fusion Energy Days MIIFED (8-11 February 2016)

M. Q. Tran (Vice Chair of C16)

The Monaco ITER International Fusion Days is an event, which is organised under the high patronage of H.S.H Prince Albert II of Monaco. The event was also sponsored by the IUPAP C16 (Plasma Physics) Commission. It has gathered about 590 participants, coming both from research institutions and industry (285 companies worldwide having registered). The goal of the forum is to foster collaboration between industry and ITER, the large fusion tokamak reactor under construction in Cadarache (F). It is why it is coupled with the ITER Business Forum. ITER (“The Way” in Latin) is an international endeavour that includes China, the European Union (and Switzerland), India, Japan, Russia, South Korea and the USA.

In his introductory talk, Dr B. Bigot, Director General of ITER reminded everyone that ITER is an absolute prerequisite for



Dr. Bernard Bigot , DG of ITER at MIIFED 2016:
“Working for ITER is working for Peace”.

building an electricity-producing reactor connected to the grid. He stated his conviction that **“As you work for ITER you are working to shape a better world for our children and our children’s children – a world where access to an unlimited energy source will guarantee economic and social development and ease international tensions. Working for ITER is working for peace”**. These statements resonate particularly after the COP21 meeting in 2015 and in view of the tension in the world.

In his answer, H.S.H. Prince Albert II of Monaco recalled that his government is supporting ITER through funding of fellowships that support post-doctoral work at ITER, the so-called “Monaco fellows”. He mentioned the ambitious goals set forth by his Principality in the field of energy. Returning to ITER, he reminded the audience that, **“You (the fusion community) have the way, we have the will”**.

It was then explained to the participants how large international projects (such as CERN, the Square Kilometer Array, the joint EU-Japan superconducting tokamak JT 60 SA, and of course ITER and its international partners) were organised, with a special focus on how to bring together industry and research organisations. Detailed discussions were organised through roundtable debates as well as specialised technical talks describing the status of the ITER project and its large components.

The ITER project is a key element in all international roadmaps that move towards the industrialisation of fusion electricity. It is therefore natural that the Commission C16 Plasma Physics of IUPAP is fully associated with MIIFED.



H.S.H. Prince Albert II of Monaco in his answer stated:
“You have the way, we have the will”. In the background is a picture of the construction site of ITER in Cadarache (F).

IUPAP Visits and Connections in South East Asia

In October 2015, Prof Bruce McKellar, President of IUPAP, and Prof L.C. Kwek visited Hanoi. Dr Nguyen Dai Hung (Institute of Physics, Vietnam Academy of Science and Technology, VAST and President, Vietnam Physical Society, VPS) hosted the visit and explained that VAST had already put up a proposal to the Vietnamese Government (Prime Minister Office, PMO) for funding to join IUPAP earlier on in March 2015, when a directive from the PMO decreed and approved a program of development in the field of Physics in Vietnam by 2020. He reiterated that Vietnam is eager to join IUPAP although the details concerning the funding for the membership shares would be decided later. There was another meeting between IUPAP delegates and Dr Le Hong Khiem, Director, IOP, VAST regarding the research landscape in Vietnam.

Also in the same month in 2015, IUPAP President, Prof Bruce McKellar visited the Universiti Brunei Darussalam where he spoke to officials of the University regarding the possible participation of Brunei in IUPAP and the importance of Brunei's representation in the Union. At the meeting, the IUPAP President was introduced to representatives of the Universiti Brunei Darussalam (UBD):

- Dr Joyce Teo Siew Year - Assistant Vice Chancellor (Global Affairs)
- Dr Sabrina Dato Daud - Deputy Director Global Relations
- Dr Jimmy Lim, . Director, Centre For Advanced Material And Energy Science
- Professor Liyanage - Deputy Director (Faculty Integrated Technology)

During the meeting, Dr Joyce explained that the UBD had been restructured to transform the economic position of Brunei to one that is less reliant on oil and gas reserves. Prof McKellar was also informed that 70% of students doing physics at UBD were women.

Prof L.C. Kwek visited Suranaree University, Thailand in March 2016. In June 2016, Prof McKellar delivered a plenary talk on International Collaboration in Physics at the Annual Meeting of the Siam Physical Society. On both visits, the current President of the Siam Physical Society, Prof. Sukit Limpijumng, has reiterated Thailand's aim to join IUPAP as a member.

Facilitated by Prof Freddy Zen, Dr Sparisoma Viridi visited Singapore IUPAP Office in April 2016 to discuss the possible IUPAP membership of Indonesia. Dr Sparisoma talked about the current research directions in Indonesia and explained that it is important for them to present a good case to the government in order to convince them of the importance of IUPAP membership.

Overall, the IUPAP Office has made good progress connecting the Union to countries in Southeast Asia. It is anticipated that this region will become a research hub in the next decade.



Prof Bruce H McKellar and Dr Joyce Teo Siew Year

Why is it so difficult to measure the gravitational constant?

Stephan Schlamminger (stephan.schlamminger@nist.gov)

Most people learned the law of universal gravitation in high school. Written down by Isaac Newton in the 17th century, although in a different form, this law describes the gravitational force between two masses. The attractive force is given by the product of the mass of each bodies divided by their distance squared times G . The constant G denotes the strength of gravitation and is a fundamental constant of nature.

It is notoriously difficult to measure G . Since Cavendish's first laboratory measurement (1793-1798), more than 300 measurements have been made and yet the most precise measurements don't agree. Figure 1 shows fourteen measurements that have been published in the last 34 years. While the smallest relative uncertainties achieved in these experiments are of order 2×10^{-5} , the relative spread of the data exceeds 50×10^{-5} . Explanations for this inconsistency can be sorted into three categories. (1) The reported value is correct but the reported uncertainty too small. (2) The reported uncertainty is correct, but

the reported value is wrong. (3) There is new unknown physics that can explain the scatter in the experiments. While the third possibility is the least likely, it is also the most exciting one. It should not be discarded lightly.

Attempts to understand these results can make real impact in measurement science. Measuring G means determining a weak force with absolute accuracy. Being able to measure a force absolutely will become especially important after 2018, when, according to the current plan, the international system of units will be redefined. This redefinition will free the definition of the unit of mass from an artifact. After 2018, the unit of mass will be realized by apparatuses that can generate an absolute force and balance it against the weight of a mass. It seems obvious that G experiments and the experiments to realize the mass unit at small scales have a lot in common and the lessons learned in one can be applied to the other.

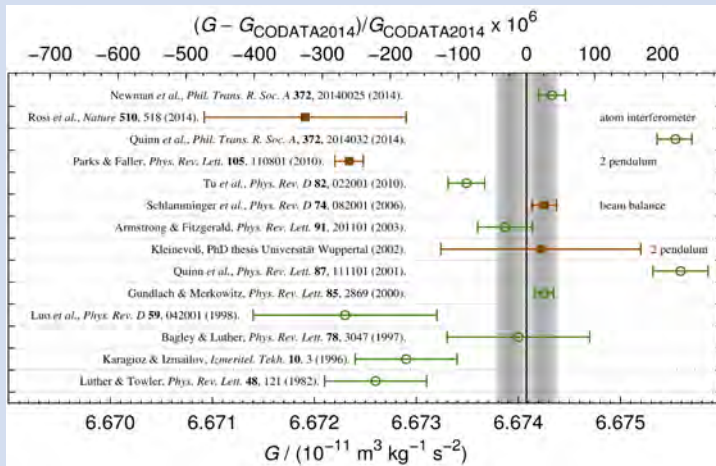


Figure 1 Measurements of the gravitational constant published in the last 34 years. The points denoted with open circles were measured using a torsion balance, the solid points by other means. The error bars denote the 1-sigma standard uncertainty. The black vertical line indicates the recommended value by the task group on fundamental constants of the Committee on Data for Science and Technology (CODATA). The grey area surrounding the black line denotes the 1-sigma uncertainty interval of the recommended value.



Figure 2 The G experiment carried out at the Bureau International des Poids et Mesures (BIPM) by Quinn and others. At the beginning of May 2016, this experiment was shipped to the National Institute of Standards and Technology (NIST). There the experimental apparatus will be used in another measurement campaign. Photo: T. J. Quinn (BIPM)

Four factors make it difficult to measure G : (1) The forces are small. Typically, the gravitational forces are well below $1 \mu\text{N}$. (2) The gravitational background fields generated by the Earth and the surroundings cannot be shielded. (3) The density profile of the masses must be well known which can be challenging at the level of 10^{-5} . (4) The exact mass distribution of the experiment must be known and a numerical mass integration must be conducted to convert the measurement into G .

A coordinated effort is needed to obtain a better understanding of the determinations of G . Individual experimenters have measured this constant for more than 300 years to little avail. The primary purpose of the IUPAP Working Group on G is to coordinate experimental efforts. The working group will provide a group of experts that can advise experimenters on technical issues, convene regular meetings on the subject of G measurements, serve as a forum to discuss future experiments, proposals and new ideas, and attempt to understand the discrepancies between results.

A first step towards understanding the discrepancies was recently taken. The apparatus (see Figure 2) used by the team led by Quinn at the Bureau International des Poids et Mesures (BIPM) was shipped to the National Institute of Standards and Technology (NIST). There, a group of independent researchers will undertake another measurement campaign. This is the first time in history that a specific G experiment is being repeated at a second laboratory. It will be exciting and interesting to see what results the researchers at NIST, who intend to perform the experiment blind, will obtain. This will give us for the first time a measure of how truly reproducible one experiment is. Stay tuned.

Astrophysical space observatory “Lomonosov” has been launched

M. Panasyuk (Skobeltsyn Institute of Nuclear Physics of Lomonosov Moscow State University, panasyuk@sinp.msu.ru)

On 28 April satellite “Lomonosov” was launched by the first start from the new spaceport “Vostochny” located in the Russian Far East in Siberia. The main goal of the project is to investigate the extreme processes in space: ultra high energy cosmic rays (Ultra High Energy Cosmic Rays - UHECR), gamma-ray bursts (Gamma Ray Bursts - GRB), transient glow in the atmosphere (Transient Luminous Events - TLE), the near-Earth space radiation variations, and monitoring of artificial and natural cosmic bodies as potentially dangerous space objects. The scientific satellite payload was made by Moscow State University in collaboration with University of Korea, Spain, Denmark, Taiwan, the United States and Mexico.

It is known that the Earth’s atmosphere is a “target” for various types of cosmic radiation entering in. This radiation contains cosmic rays which are charged particles of the solar, galactic and extragalactic origin. High-energy particles in the atmosphere give rise to cascades of secondary particles - Extensive Air Showers (EAS), by



“Lomonosov” project emblem

recording them we can estimate the parameters of the primary particles. However, in the universe there are not only charged particles. Gamma radiation of the universe, and, above all, the most energetic phenomena GRB are the object of attention of researchers in our day as a manifestation of astrophysical phenomena of the early universe.

Cosmic rays with ultrahigh energies of extragalactic origin and GRBs are the main astrophysical problems facing the project “Lomonosov”. Cosmic rays of ultrahigh-energy will be recorded with help of ultraviolet telescope by the fluorescent glow caused by the EAS of these particles. GRB will be investigated in gamma rays, X-rays, ultraviolet and optical wavelengths. For this purpose, different instruments are installed on the “Lomonosov”.

GRB also produce their “response” in the atmosphere in the form of Cherenkov radiation. But “bombarding” of the atmosphere by particles is not limited to these two processes. We must take into account that charged particles trapped by the magnetic field in the Earth’s radiation belts, can disappear, precipitate from the magnetic trap into the Earth’s atmosphere, producing in it extensive regions of ionization. The energy of the radiation belt particles is sufficiently high, for instance, there are relativistic electrons with energy of several MeV among them, which can penetrate deep into the atmosphere and by rate of ionization can easily compete with EAS. Besides space factors, physical processes near the Earth’s surface also have an effect on the atmosphere. A demonstrative example of it is recently discovered TLE. They are interpreted as “the Earth gamma-bursts”. Their nature is probably associated with atmospheric electricity phenomena. Studies of the described above phenomena are a main goal of the “Lomonosov” satellite.

In addition, relevant applied research will be carried out on the satellite board: testing of the space segment of monitoring system for the dangerous objects in the near-Earth space. These dangerous objects are of artificial (space debris) or natural origin and can be detected by small telescope with a wide field of view. Also, one of the goals of the project application is investigation of dangerous radiation environment for satellite electronics, by recording radiation doses created by a charged component of the cosmic radiation and by neutral as well.

Details about the project “Lomonosov” can be found on the site lomonosov.sinp.msu.ru



Satellite “Lomonosov” during testing. In the foreground - ultraviolet telescope mirror for the registration of cosmic rays of ultra-high energies.



MSU team at the spaceport.

Report of Recent ICUIL Activities

T. Tajima (Chair, ICUIL ; Department of Physics and Astronomy, UC Irvine)

ICUIL represents the community of ultraintense ($>10^{19}$ W/cm²) lasers around the world. The community is exponentially increasing the world total cumulative laser power from 11PW in 2010 to the expected 132PW in 2017. The community projects total more than \$4 billion in research investment and 1500FTEs technical staff now around the world. Here I concentrate on some typical activities of ICUIL accentuating the works that relate to collaborative works with other IUPAP Working Group ICFA and topics that encompass other fields and cross-Group activities.

Brief History of the ICUIL-ICFA collaboration

In 2008 Chair of ICUIL (T. Tajima) spoke with incoming Chair of

ICFA (A. Suzuki) to initiate joint collaborative work on laser acceleration to examine its promise and challenge for its future collider application. In 2009 ICUIL and ICFA launched the Joint Task Force for laser accelerators (W. Leemans was named chair of the task force). JTF produced its report in 2011 (published in ICFA Newsletter in 2011, W. Chou et al. as editors). It found that: (1) The science of laser acceleration has matured and validated; (2) The high rate rated, high fluence laser technology needs to be developed in order to meet the collider luminosity. Since then a fiber laser technology called CAN (coherent amplification network) was invented (2013) in order to meet the above challenge. Currently, the community is trying to develop this technology.

Meanwhile, the worldwide laser wakefield acceleration (LWFA) experiments have advanced to produce several GeV over a few cm in typically 10^{17-18} /cc plasma (Kim et al. 2013; Leemans et al. 2014).

The Higgs energy by laser wakefield acceleration

In order to reach and go beyond the Higgs energy (>100GeV), three paths have been considered. One path is to have multi-stages to boost the acceleration in the above-mentioned technology.

The second path and third path have been recently considered through examining the scalings of the LWFA (Tajima-Dawson, 1979; Nakajima et al. 2011). The energy gain in the wakefield is proportional to the inverse of the plasma density and proportional to the normalized vector potential of the laser

$$E_b = \frac{2}{3} m_e c^2 a_0 \frac{n_c}{n_e} = 38[\text{GeV}] a_0 \left(\frac{1 \mu\text{m}}{\lambda_L} \right)^2 \left(\frac{10^{16} \text{cm}^{-3}}{n_e} \right)$$

The accelerating length is typically decided by the dephasing length L_{dp} , which scales as the 3/2 power of the density of plasma, square of the frequency of the laser, and square-root of the laser vector potential (see, e.g., Nakajima, et al. 2011). They suggested that the density should be scaled from the typical of 10^{18-17} /cc in the present day experiments to typical of 10^{17-16} /cc in the near future. This would increase the electron energy by 1-2 orders of magnitude of what the contemporary experimental energy gain from several GeV to on the order of 100GeV.

However, in order to achieve this goal, we have to increase the laser power inversely proportional to the plasma density. This is the main reason why we need to increase the laser energy. We

suggested to employ the world largest energy lasers that are available in a compressed fashion such as the laser at GSI, PETAL at LMJ and ARC at NIF.

Increase of the laser frequency: the third path

From the LWFA energy gain scaling, there is an alternative and third path by increasing the laser frequency (i.e. n_{cr}). One way is to use the 3ω frequency laser in place of 1ω , which would increase the n_{cr} nearly by an order of magnitude and reducing the accelerating length by 30.

The recent additional breakthrough in the laser compression (Mourou et al. 2014) indicates the possibility of single-cycle laser, which opened up a path toward the single-cycled X-ray laser (even at EW power). Because of this development, the third path of energy gain by the frequency of the laser has been revolutionized. This approach has been suggested by Tajima (2014) to adopt nanomaterials driven by intense X-ray laser suggested above. This "TeV on a chip" acceleration allows the accelerating gradient on the order of TeV/cm starting from an originally PW optical laser driver.

References

1. G. Mourou, *et al.*, Nature, Photon. **7**, 258 (2013).
2. H.T. Kim *et al.*, Phys. Rev. Lett. **111**, 165002 (2013).
3. W.P. Leemans *et al.*, Phys. Rev. Lett. **113**, 245002 (2014).
4. T. Tajima and J. M. Dawson, Phys. Rev. Lett. **43**, 267 (1979).
5. K. Nakajima, *et al.*, Phys. Rev. ST Accel. Beams, **14**, 091301 (2011).
6. G. Mourou *et al.* Eur. Phys. J. **223**, 1181 (2014).
7. T. Tajima, Eur. Phys. J. **223**, 1037 (2014).

YOUNG SCIENTIST AWARDS

Commission on Statistical Physics (C3)



2016 – Lisa Manning

In recognition of her outstanding statistical physics contributions to the fields of granular materials, jamming, and biological cell dynamics.

Manning has become a clear leader in the community studying glassy dynamics and jamming, and has also established the importance of these phenomena to biological tissues. In glasses, she has used random matrix theory to uncover universal vibrational properties, and has identified soft vibrational modes as harbingers of local failure. In biology, she has explored the competition between cell-cell adhesion and cortical tension to understand surface tension at the tissue level. Further, she discovered that this competition controls a new rigidity transition in tissues, a startling new member of the jamming transition family that is relevant to asthma and likely also to embryogenesis, tumorigenesis, and wound healing.



2016 – Martin Lenz

For his remarkable creativity in using active processes in living cells as a rich source of new ideas in statistical physics. At the same time, he shows how these ideas can inspire new thinking in biology proper.

Lenz' main contributions concern two quite different but ultimately related areas: the structure and dynamics of the cytoskeleton on the one hand, and the mechanics of protein-induced remodelling of the cell membrane on the other hand. Both of these problems involve understanding how non-equilibrium driving forces establish the structure of the cell. In these problems, the existing knowledge of the biological actors at the molecular scale is still only partial, and Lenz has displayed great subtlety in producing robust theoretical results in sensitive to unknown molecular details.

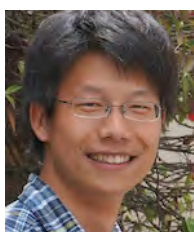
Commission on Particles and Fields (C11)



2016 – Stefan Hoeche

For developing high precision Monte Carlo simulations of events at hadronic colliders

Stefan Hoeche received his Diploma in 2004 from the Dresden University of Technology, and his Ph.D. in 2008 from Durham University. After a postdoctoral appointment at the University of Zurich, he moved to SLAC National Accelerator Laboratory where he is now a Staff Scientist. His professional career has been devoted to providing more accurate simulations of the complex scattering events that take place when two high energy hadrons collide, such as at the Large Hadron Collider. Such simulations are essential to experimentalists for precision measurements of Higgs boson couplings as well as in the search for new physics. He has produced simulations that are accurate to next-to-next-to-leading order in the strong coupling constant for benchmark processes such as Higgs production and W and Z boson production. He has also shown how to construct simulations that are accurate to next-to-leading order, even for events with additional jets within the same sample. He recently developed a novel parton shower formalism which has significantly improved behavior compared with previous ones. His work sets the standards for the precision calculations and simulation tools used at the LHC today.



2016 – Liangjian Wen

For his original contributions to the physics of neutrinos, and in particular, to the discovery of the non-zero neutrino mixing angle θ_{13}

Liangjian Wen is an Associate Research Fellow at the Institute of High Energy Physics (IHEP), Chinese Academy of Sciences, Beijing. He graduated from the University of Science and Technology of China (USTC) in 2005, and received his Ph.D. from IHEP in 2010. He has worked on the measurement of θ_{13} at Daya Bay experiment, on the search of neutrino-less double beta decays (0nbb) with EXO-200/nEXO, and on the determination of the neutrino mass hierarchy (MH) with JUNO.

Liangjian Wen made major contributions to the discovery of non-zero θ_{13} at the Daya Bay reactor neutrino experiment, spanning from the design, construction and commissioning of the detector to the software and data analysis. In particular, he developed a new energy calibration scheme, an energy response model, and novel methods to reject backgrounds and determine systematics, which led to the rapid and precise measurement of θ_{13} .

Commission on Plasma Physics (C16)



2016 – Sam M Vinko

In recognition of his seminal contributions in using the world's first hard x-ray free electron laser to create and diagnose solid density plasmas, and for new insights into the electronic structure and collisional dynamics of such systems.

Sam Vinko received his Master's degree from the University of Rome Tor Vergata (Italy) in 2007, and his doctorate from the University of Oxford (UK) in 2011, after working with Prof. Justin Wark, investigating the interaction of intense XUV light with solid-density matter on the FLASH free-electron laser (FEL) in Hamburg (Germany). He was awarded the Culham thesis prize from the UK Institute of Physics for this work in 2012. As a postdoctoral researcher at the University of Oxford, he worked extensively on the Linac Coherent Light Source FEL in Stanford (USA), showing how intense X-rays could be used to create and study plasmas at temperatures and densities similar to those found half-way towards the centre of the Sun, with exquisite precision and control. Vinko was awarded a Royal Society University Research Fellowship in 2014 and now leads a research group at the University of Oxford focused on investigating matter in extreme conditions using X-ray FEL sources. He shared the 2015 Dawson Award for Excellence in Plasma Physics Research, awarded by the American Physical Society for outstanding achievement in plasma physics.

International Commission for Optics (AC1)



2015 – Frank Koppens

For his remarkable, outstanding, groundbreaking, pioneering and numerous contributions to Nano-Optoelectronics

Frank Koppens obtained his PhD in experimental physics at the Kavli Institute of Nanoscience, the Netherlands. After a postdoctoral fellowship at Harvard University, since August 2010, Koppens is a group leader at the Institute of Photonic Sciences (ICFO). He has received the Christiaan Huygensprijs 2012, the ERC award as well as two ERC proof-of-concept awards. Koppens is the leader of the optoelectronics workpackage of the graphene flagship (€1 billion project for 10 years). Since 2015, Koppens is also holder of an ICREA professorship.

