

europhysicsnews

THE MAGAZINE OF THE EUROPEAN PHYSICAL SOCIETY

Focus: light, optics, fibres
Young Minds in lock down
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51/3
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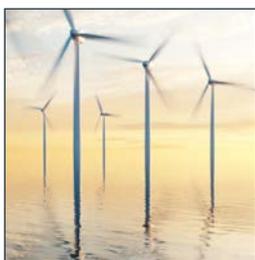
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Cover picture: In May of 1960, Theodore Maiman fired the first laser and changed science and society. Today, lasers are everywhere, from bar code scanners to medical surgery, from industrial precision sensors to conveying the information on the internet.



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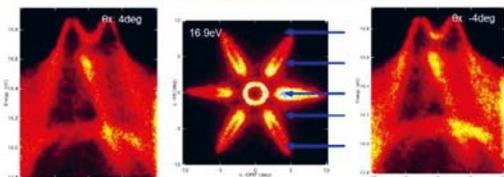
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[EDITORIAL]

EPS acts for a fair gender balance and no harassment

Although the percentage of female heads in public or private institutions has approached the level of 20%, there is still a long way to go before we reach gender equality in the European research landscape. Excellence in physics would, however, highly benefit from scientific resources and opportunities being equally distributed between women and men.

The European Union (EU), through a large body of legislation, is actively promoting gender balance in areas such as equal pay, work-life equality, health and safety at work, social security, and access to goods and services. In Horizon 2020, gender equality is a cross-cutting issue and its programme integrates the gender dimension in research and innovation. To fight against gender inequalities, the “She Figures” report, published every three years by the European commission, gives an overview of the gender equality situation and provides a broad range of indicators reporting on the presence of women across different sectors of the economy and on segregation by sex in industry as well as in academia. It emphasises the (under-)representation of women in the highest grades and as heads of academic institutions. Instructive statistics compare the percentage of women doctoral graduates and female scientists holding a grade A position. Such statistics, as extracted from the “She Figures 2018” publication, speak for themselves: only about 38% of people with a PhD are women while 18% of them reached high-level positions in the 28 countries of the EU.

For several years, the EPS has launched an ambitious programme to promote gender balance throughout the European physics community and to contribute to reducing the gender gap through well-targeted actions led by its Equal Opportunity Committee. The programme started in 2013 when the Emmy Noether Distinction was established. In parallel, the important role of women in sciences was advertised by regular interviews of outstanding female researchers in physics.

In 2018, another action consisted in monitoring statistics of female participants in the EPS conferences. The first data

collected from the project named “Monitoring for Gender Fairness in Physics” show that between 18% and 30% of the speakers or organisers are usually female scientists. Compared to the number of women holding a PhD in physics, these numbers are encouraging, but they are still too low.

Another important decision of the EPS was to recently elaborate on a Code of Conduct for the EPS-managed meetings. The Code follows the outlines already drawn up by several learned societies overseas and it will be published through the EPS media channels.

Last but not least, for the challenge to attract the young generation of women to an enjoyable career in physics, the EPS relies on its numerous Divisions and Chairs to support the actions of the Equal Opportunity Committee by delegating one of their members to this Committee and to increase the number of women scientists recruited on their Board. Details of all the EPS activities for gender balance can be found in a feature article in the present issue of EPN.

In conclusion, the EPS pursues a solid policy reinforcing the means to reduce gender inequalities and leading to the full respect of women physicists. More efforts will be developed, e.g., in the directions of mentoring and assisting young female scientists, proposing dedicated childcare zones in conferences or taking care of pregnant researchers. Inclusion of more gender diversity should also target LGBT+ communities. These topics will constitute the next roadmap to improve the equal opportunity policy of the EPS for the coming years. ■

■ Luc Bergé,

*Chair, Equal Opportunity Committee and
President-elect, European Physical Society*

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Grant for multi-messenger astronomy studies

Astrophysical neutrino hunter Gwenha l de Wasseige was awarded a LabEx UnivEarthS grant supporting her research program in multi-messenger astronomy. On request of EPN, she wrote a personal report.

Currently, I am a Marie Sklodowska-Curie individual fellow at the *AstroParticule et Cosmologie* laboratory (APC), Universit  de Paris. I received my PhD degree in 2018 at the *Vrije Universiteit Brussel*, working with the IceCube Neutrino Observatory buried in the ice of the South Pole [1]. I then joined the KM3NeT Collaboration that is deploying three neutrino telescopes in the Mediterranean Sea [2]. Since early 2020, I am leading the interdisciplinary LEAK project (Low Energy Astrophysics with KM3NeT), that is supported by a LabEx UnivEarthS grant [3]. With the LEAK project we aim at exploring the potential of the observation of low energy neutrinos for multi-messenger astronomy.

What are neutrinos?

They are tiny neutral elementary particles that only interact weakly with the matter around us. The ones I am interested in have low energies and might be emitted in cataclysmic explosions happening in our Universe. My role is to understand if and how these neutrinos are produced by the astrophysical sources and interpret the multi-messenger signature of the source, *i.e.* using neutrinos but also using electromagnetic and gravitational waves.

Curious about my daily work?

The KM3NeT Research Infrastructure, currently being constructed in the Mediterranean Sea, has originally been designed to search for *high-energy* astrophysical neutrinos with its ARCA detector at the Italian site, and to study neutrino properties, such as mass ordering, with the ORCA detector in deployment offshore Toulon in France. Together with colleagues, I am working on turning these two detectors into low-energy astrophysical neutrino telescopes. The goal is to improve their sensitivities in the sub-TeV range, expanding the fraction of the astrophysical neutrino flux that can be probed with KM3NeT. This requires improving our understanding of the background noise produced by the environment that surrounds the KM3NeT sensors, especially the signal created by living organisms in the sea water, developing new trigger algorithms to lower the energy range in which we are sensitive, and optimising various statistical approaches to increase the sensitivity to this low-energy signal. I also work on understanding the processes in the different astrophysical sources that may give rise to a sub-TeV neutrino flux and evaluate the signal that these sources would produce in neutrino telescopes.



“**Collaboration is the key**”

◀ The Author

What is a LabEx UnivEarthS grant?

Ten years ago, the French government launched the “Investments for the Future” program aiming to bring the country at the forefront of innovation. The Laboratory of Excellence (LabEx) is part of the program. The aim of the LabEx is, among others, to develop significant research units with international visibility and to build an integrated policy for research, training and development of high level. The LabEx *UnivEarthS* [3] is one of the 100 winners of the first wave of the LabEx call and it funds promising projects that gather researchers from several laboratories in Paris, including the APC, where I work.

I received a LabEx *UnivEarthS* exploratory grant to work on low-energy astrophysical neutrinos. The goal is to study GeV neutrino emission from solar flares or gamma-ray bursts, as well as the MeV neutrinos emitted by a galactic core-collapse supernova. As a thankful winner of the grant, I now lead a group of astrophysicists that are expert in these different sources and researchers working on the DUNE experiment for neutrino science [4] and the DarkSide experiment for Dark Matter detection [5] to study the potential synergies in combining our observations. We want to

determine how multi-detector analyses will help us to better understand the astrophysical sources, and the grant allows us to hire interns, organise workshops, invite guests, and travel to conferences.

In addition to research, what do I appreciate in my work?

With no doubt: working on increasing diversity, defending early-career scientists and communicating about science. I feel lucky to be part of the KM3NeT Collaboration for several reasons – one of the most important ones being the active and concrete efforts that aim to increase the diversity within the Collaboration and the scientific community in general. I try to make a contribution through my role as Early-Career Scientist Representative in KM3NeT. It allows me to defend the interest



◀ Logo of the ‘Draw me a neutrino’ contest.

of the younger members within the board of the KM3NeT Collaboration, help the integration of new comers through a mentoring program, and collaborate with the Equality, Diversity and Inclusion committee of KM3NeT to welcome everyone within our collaboration.

I am also heavily involved in communicating science to diverse audiences. In addition to giving presentations and developing hands-on activities, I love building up large-scale contests. The latest one? Draw-me a neutrino! The participants have to draw their personal representation of a neutrino based on the information we provide on our website [6].

Tempted to learn more about neutrinos and how KM3NeT detect them, while freeing your inner artist? The deadline for submission is June 30th!

Which advices would I give to young researchers?

Collaboration is the key. I am convinced that we can achieve more by working in a group with different skills than one can do alone. Don’t be afraid to let your research project evolving off the beaten track. Interesting results may be waiting for you where no one else looked up yet!

■ **Gwenhaël de Wasseige**
with a very thankful
note to Rasa Muller for
precious editing advices.

References

- [1] IceCube Observatory, <https://icecube.wisc.edu>
- [2] KM3NeT Research Infrastructure, <https://www.km3net.org>
- [3] LabEx *UnivEarthS*, <http://www.univearths.fr/en/home>
- [4] DUNE International Experiment for Neutrino Science, <https://www.dunescience.org>
- [5] DarkSide Experiment, <http://darkside.lngs.infn.it>
- [6] The ‘Draw me a neutrino’ contest, <http://wos.ba.infn.it>

The 100th anniversary of the Polish Physical Society

Shortly after Poland regained independence in November 1918 and the three parts of Poland that for 123 years had been ruled by Russia, Prussia and the Austro-Hungarian Empire reunited, physicists enthusiastically started to organise their laboratories and make research plans.

On April 11, 1920 a group of 18 physicists from centres all over the country chaired by Professor Władysław Natanson decided to establish the Polish Physical Society. Soon after the charter of the Society was adopted Władysław Natanson was elected its first president. The main aims of the Society were to promote physics and related sciences, raising the general level of knowledge among the public and supporting the development of physics in Poland. Emphasis was placed on raising the level of high school education in physics and sciences in general.

The history of the Society is strongly linked with the dramatic history of Poland. After less than 20 years of existence the Society had to interrupt its legal activity during the Second World War between September 1939 and May 1945. During the war many physicists were killed by the Nazis and many laboratories were robbed of their most valuable equipment and books. Immediately after the war the Society restarted its activity and helped to revive research and teaching and resettle scientists from the prewar eastern parts of Poland such as Lwów (now Lviv in Ukraine)

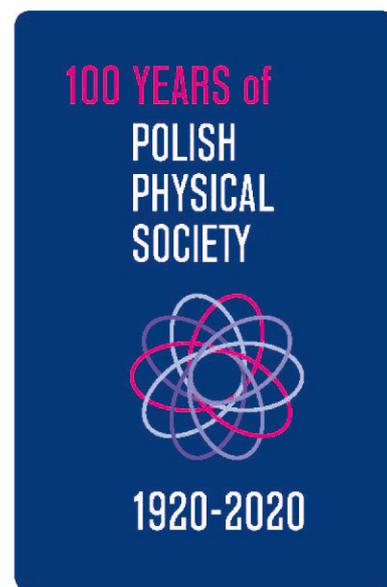
Year of Physics in Poland

and Wilno (now Vilnius in Lithuania) mostly to Wrocław and Toruń.

Nowadays the PPS is a non-governmental, public benefit organisation with 19 regional branches. It organises conferences, meetings and lectures for academic and general audiences. Every year the Society awards several prestigious prizes to physicists, teachers and people involved in the promotion of physics. The PPS joined the European Physical Society in 1972.

To celebrate the centennial of the Polish Physical Society the Polish Senate declared 2020 the Year of Physics in Poland. During this year many events are planned to promote successes of Polish physicists. The main event will be the extraordinary meeting of the PPS that initially was planned to begin on April 24 but due to the coronavirus pandemic has been rescheduled for October 16. It will be a three-day event. The first day will be held at the Warsaw Technical University and will be devoted to the

▼ Ceremony for the Popularisation of Physics and Krzysztof Ernst Medal Award 2018. Middle: Witold Zawadzki, Laureate of the Award. Left: Katarzyna Chałasińska-Macukow, Past President of PPS. Right: Leszek Sirko, President of PPS.



history of the Society. The first lecture “Century of the Polish Physical Society” will be given by Professor Andrzej K. Wróblewski. Later representatives of the five centers which participated in the meeting that established the Society will briefly describe activities at these centers. The second day will be held at the Faculty of Physics of University of Warsaw and will be devoted to “Physics in Poland – where are we?” with 13 half-hour lectures describing the most important achievements from gravitational waves to positronium in physics, biology and medicine. The last day will be devoted to “Century of teaching physics in Poland”. In five lectures advancements of teaching methods and demonstrations will be presented. Throughout the day participants will be able to visit laboratories at three main physics centers in Warsaw and the Copernicus Science Centre. ■

More details at https://100lat.ptf.net.pl/?page=start_en

■ Polish Physical Society



The Union of Physicists from Portuguese Speaking Countries

On 15 November 2019, in the beautiful Penafiel Palace in Lisbon, headquarters of the Comunidade de Países de Língua Portuguesa (CPLP), physicists from Angola, Brazil, Cape Verde, Mozambique, Portugal and São Tomé Príncipe established the “União de Físicos de Países de Língua Portuguesa” – the UFPLP was born!

The day started with a conference on “Physics for Sustainable Development in the CPLP” which was followed by the Constitutive Assembly of the UFPLP. Its statute was approved and the administrative committees (General Assembly, Director Board and Fiscal Council) were appointed. It was the culmination of a process that started in 2010 with the 1st Physics Conference of Portuguese Speaking Countries in Maputo, where the idea of UFPLP was first proposed. The following editions of this Conference in 2012 in Rio de Janeiro and in 2019 in São Tomé laid the foundations of the Union.

A webpage for the Union was created (www.ufplp.org) and is still under development. The logo for the Union (<UF | P | LP>) was chosen as a free association of its acronym with the most used framework in physics – quantum mechanics.

▼ Photograph taken in the Meeting Hall of the CPLP with some participants of the UFPLP's Constitutive Assembly.

The main goals of the Union are:

- 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 successful careers in the physics profession;
- 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 prioritising and defending the best interests of their peoples, in particular the most disadvantaged in terms of teaching and research infrastructures;
- To provide channels for forming mutual partnerships with individuals and international organisations of a professional or cultural nature, fostering networks of collaborations and influence;
- 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 the cultural identity that unite them.

At the website, already several journals in Portuguese are available, such as the *Gazeta de Física*, the *Revista Brasileira de Ensino de Física* and *Física na Escola*, a link to a series of “lives” in Physics, as well as a COVID-19 report from the African Academy of Sciences. We are also planning to have the 4th edition of the Physics Conference of Portuguese Speaking Countries in Cape Verde in 2022, during the International Year of Basic Sciences for Development. We do hope to increase our activities after the COVID-19 pandemic becomes more manageable. We welcome ideas for initiatives and cooperation. Please do not hesitate to contact us via secretariado@ufplp.org if you can think of joint opportunities! ■

■ **Rogério Rosenfeld,**

*Instituto de Física Teórica - UNESP,
São Paulo, Brazil – President of UFPLP*



Portuguese Speaking Physicists unite 🇵🇹🇵🇵

Closing in on CERN's future – the most significant proposals discussed in Nature Physics focus issue

The discovery of the Higgs particle is not yet 10 years old, but Europe's particle physicists are already reviewing options for a dedicated Higgs factory at CERN, the European Organization for Nuclear Research. The factory, a large particle collider dedicated to high-precision studies of the Higgs particle, could see first collisions in the late 2030s to succeed the High-Luminosity Large Hadron Collider.

A recent focus issue of Nature Physics [Nat. Phys. 16, 369 (2020)] covers the ongoing decision-making process, a collegial exercise known as the European Strategy of Particle Physics Update (ESPPU) that aims to identify the projects with the highest scientific impact for recommendation to CERN's decision-making body, the CERN Council.

The focus issue highlights the most prominent proposals in detail: the Compact Linear Collider (CLIC), an

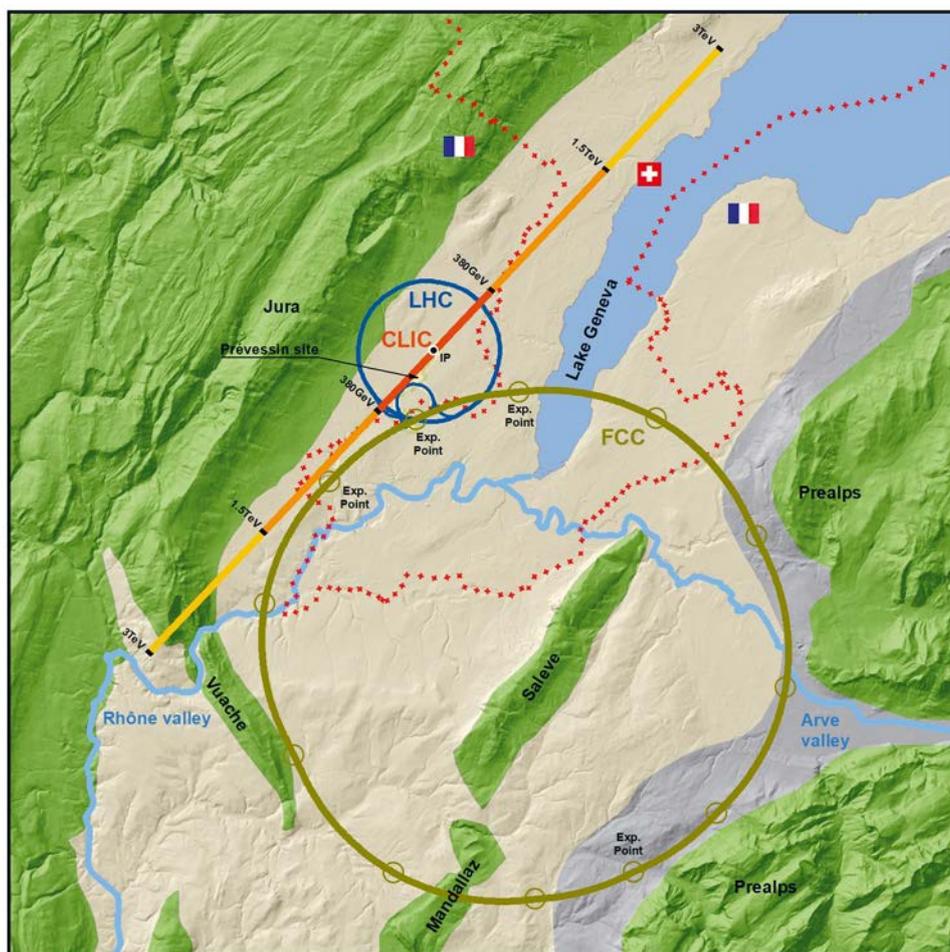
expandable linear accelerator, up to 50 km long, that relies on a novel two-beam acceleration concept, colliding electrons with positrons at energies between 380 GeV and 3 TeV, and the Future Circular Collider (FCC), a circular accelerator of 100 km circumference initially foreseen for electron-positron collisions at 91-365 GeV and later upgradable to a proton-proton collider to explore physics far beyond the Higgs sector, at about 100 TeV. The focus issue also discusses proposals using methods

other than high-energy-frontier colliders to advance on main open issues in particle physics and reviews the world-wide engagement, highlighting the synergy between CERN's future commitments and planned projects in Japan, China, and the United States.

Articles in the focus issue discuss the technical readiness of the various proposals and their sensitivity to exploring new physics, whether through direct production of new particles, or indirectly through high-precision measurements. Scrutiny of the Higgs particle with unprecedented precision is a central theme, since the Higgs boson is deeply connected to some of the most puzzling aspects of the Standard Model of particle physics. In addition, the Higgs particle's unique properties may play an important role in the continued hunt for dark matter and other unresolved issues. Complementary experiments with lower energy but high intensity or precision are considered within the Physics Beyond Colliders programme.

A Higgs factory could collide particles well into the second half of the century and has the capacity to take our understanding of the Higgs particle much deeper than any previous research facility. At the same time it gives the community time to reflect on the next steps, potentially adapting its course as new technologies emerge.

The ESPPU process is currently put on hold acknowledging the devastating impact of the COVID-19 outbreak. ■



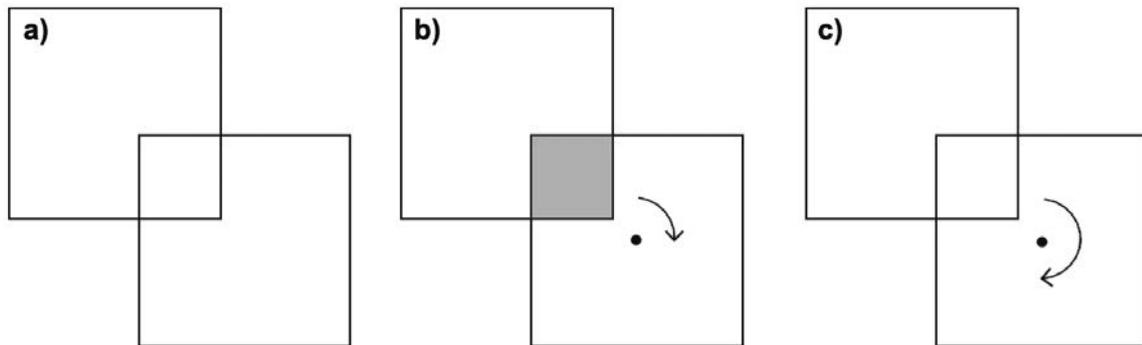
Legend for the map:
 - LHC: Blue circle
 - FCC: Green circle
 - CLIC: Orange line
 - Limestone: Green area
 - Molasse: Yellow area
 - Molasse subalpine: Grey area

◀ Map showing the footprint of possible future accelerators at CERN: the three phases of CLIC in shades of orange, and FCC in green. The existing infrastructure, including the LHC, is indicated in blue. © 2019-2020 CERN (License: CC-BY-4.0).

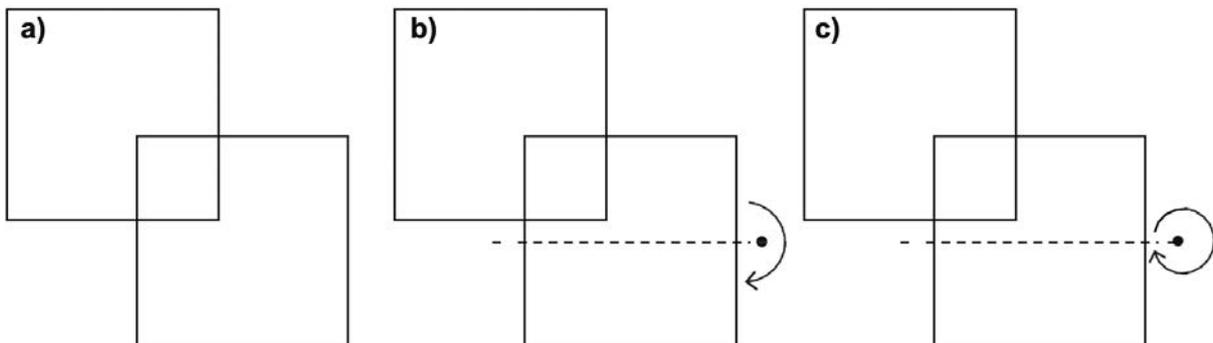
by Tony Klein,
Emeritus Professor with the School of Physics, University of Melbourne

This quiz concerns a special kind of polarising sheet that I have dubbed "Super Polaroid". Can you figure out how it works? The correct answer can be found on <https://epn.eps.org/epn-51-3-quiz-answer/>.

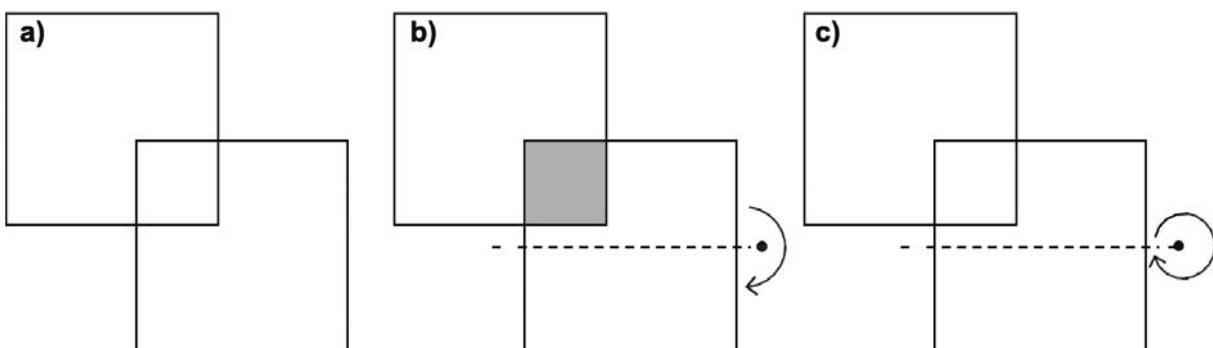
When two pieces of ordinary polarising plastic sheet (*i.e.* "Polaroid") are superimposed the overlapping region is transparent (fig. 1a), but when one of the sheets is rotated by 90° about a perpendicular axis, the overlapping region becomes opaque (fig 1b) – and clear again if rotated by a further 90° (fig 1c). This is how polarising sunglasses work.



Furthermore, when the top piece is rotated by 180° about a horizontal axis as in figure 2 (a, b, c), the behaviour remains unchanged – the same if the overlapping region starts out opaque: it will remain opaque.



Now consider the behaviour of "Super Polaroid": When the top piece is rotated about the perpendicular axis, *i.e.* in plane, by 90° , it behaves just like ordinary polaroid in fig. 1. However, when rotated by 180° about a horizontal axis, the overlapping region becomes opaque (fig. 3b) and becomes clear again when rotated by a further 180° (fig. 3c).



How do you explain this behaviour? What is special about "Super Polaroid"?



Lockdown, millennials and European networks: how is quarantine in the eyes of a Young Mind?

■ Roberta Caruso¹, Tanausú Hernández Yanes²

■ ¹ University of Naples Federico II, Naples, IT – ² University of La Laguna, San Cristóbal de La Laguna, ES – Contact: ac@epsyoungminds.org

The sudden outbreak of Covid-19 has affected the life of everyone all over the world. While governments are putting all their efforts into preventing the spread of the disease and containing the medical, social and economic consequences of the pandemic, schools and universities are challenged to carry on their activities under these unprecedented circumstances. Young Minds (YM) is a European network, which gathers and supports local sections, so it is affected in its roots by the new situation.

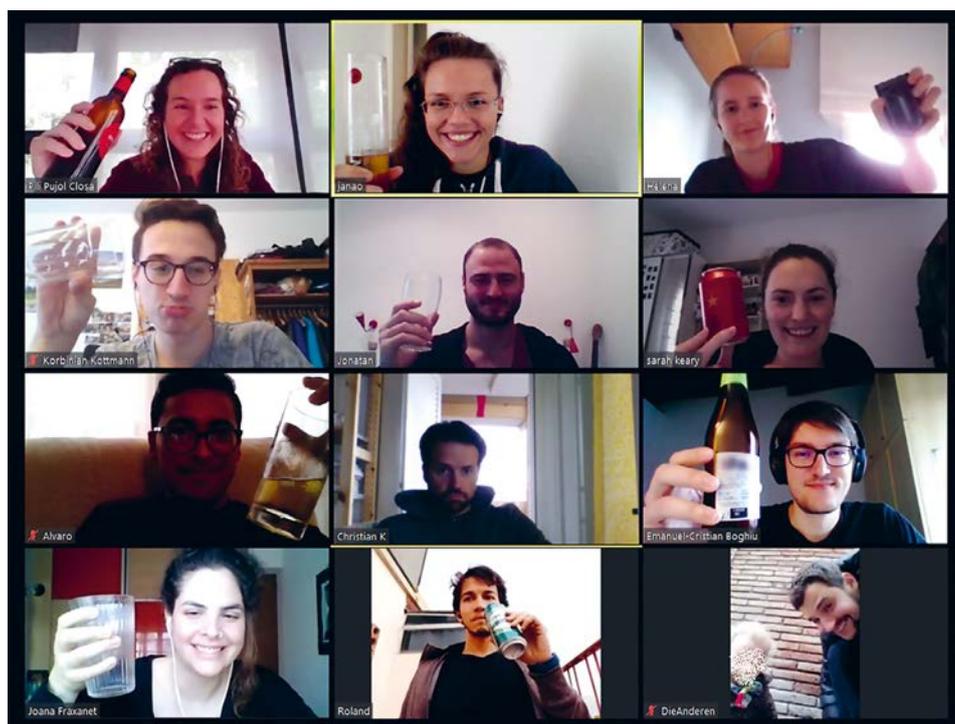
On one hand YM members deal with their personal challenges as students or young researchers. On the other they have the additional burden of running a section and its activities. How is it being part of a European network in times of lockdown? As members of the Action Committee, we are trying our best to keep the project running, and the best answer probably comes from the YM sections themselves.

This year marks the 10th anniversary of YM, and for the first time the annual leadership meeting had been postponed. Special celebrations were supposed to take place in Barcelona at the beginning of May, co-hosted and supported by ICFO. Pilar Pujol, member of the local ICONS-YM section and local organizer of the meeting, has reported that the local YM section was forced to postpone a large part of their activities, besides the meeting

▼ Virtual Social Friday organised by ICONS - Barcelona YM section

organization. However, they managed to carry on some of the planned activities by turning them into quarantine-appropriate versions. As pointed out by ICONS, it is of extreme importance to keep up the spirit of the group, so one of their activities has been the organisation of a Virtual Social Friday, an informal online meeting between students sharing the same projects, to chat and have fun together.

Common activities among YM sections entail large gatherings – as for last year, around 15 sections participated in the organisation of large, city-wide science festivals, and within the Young Minds Conference Award (YMCA) program nine conferences have been co-organized by YM sections – so obviously their yearly planning required major changes. Some sections, such as the Physics League from Valladolid, are strongly devoted to outreach. This section has its main focus on public activities like physics shows and demonstrations, so they could do nothing but suspend all their projects for the time being. It must be hard to be forced to refrain from such rewarding activities, and even harder for a section like Physics League which mostly comprises undergraduate students that are already uncertain about their usual academic activity, such as graduations and exams.





While many sections were forced to cancel their planned activities, many more decided to go forward and try new approaches to keep in touch with their audiences. For instance, PONYS in Naples and Yerevan YM planned the release of outreach videos showing simple experiments to be conducted at home, as well as the explanation for some everyday phenomena. Other sections, like SCOPE in Glasgow, decided to stay active on social media and on their website, publishing contents of professional development for students and young researchers: it is not easy to be efficient while at home, so tips for facing the crisis are surely a relief! Some students were able to bring their experimental setup at home, while others are devoted to a more theoretical research project and so they don't experience major changes in their everyday life.

▲ Angular momentum conservation demonstrated by PONYS - Naples YM section member Paolo Di Meo. Picture taken during the European Researchers Night in September 2018.

This is the case for the Kharkiv section, which is already used to discuss and organise activities remotely. They changed the original plans for their activities in such a way that they can be done without physical contact – as an example, they realized an article contest for young researchers as planned. When we asked how they were dealing with the current crisis, the answer was simply “people adjust to new conditions, and if you cannot change the situation, change your attitude towards it”. We believe that in these peculiar days students and young researchers shouldn't be pushed to outperform their standard



Creativity is one of the main tools of a scientist and we would love to see our members coming up with even more ideas to keep their activities running”

productivity, so we can do nothing but agree with their philosophy.

Our goal as program committee is rather to encourage and support individuals and sections that are willing to remain active during the forced stop, and to reassure them that they are not alone in facing the challenges of this difficult time. Nevertheless, creativity is one of the main tools of a scientist and we would love to see our members coming up with even more ideas to keep their activities running; no matter if they are meant for outreach, networking or going forward in their careers. ■

Acknowledgement

The authors would like to thank Giovanni Gaudino and Giorgia Tortora from PONYS Naples section, Pilar Pujol from ICONS Barcelona section, Tetiana Rokhmanova from Kharkiv section, Inés Vega González from Physics League Valladolid and Emma La Francois from SCOPE Glasgow.

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Tanausú Hernández Yanes joined YM in 2016, currently as a member of the YM Action Committee. He just finished a

Master in Astrophysics with specialty on structure of matter and has focused on the thermodynamics of open quantum systems.

Highlights from European journals

NON-LINEAR PHYSICS

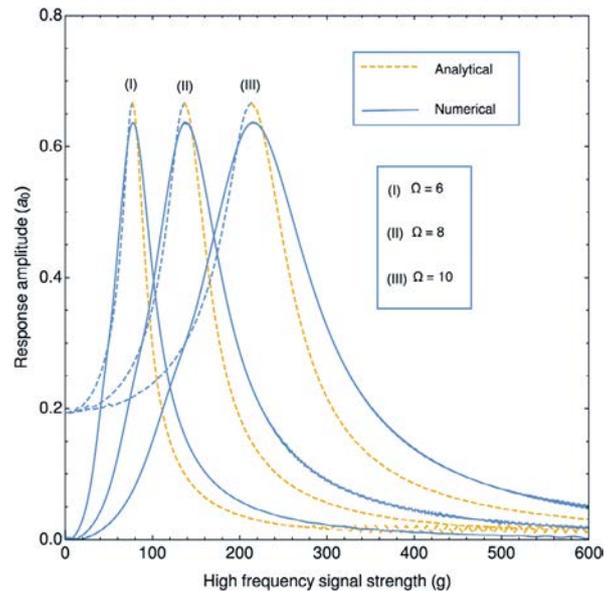
Stimulating resonance with two very different forces

In some specialised oscillators, two driving forces with significantly different frequencies can work together to make the whole system resonate.

“Nonlinear” systems can display dramatic responses when the forces which cause them to vibrate are changed. Some of these systems are sensitive to changes in the parameters which define their driving forces, and can be well described using mathematical equations. In this work, it is shown in detail for the first time that some ‘parametric’ oscillators can be made to resonate when tuned by a high driving frequency to match a separate, far lower frequency. ■

■ **S. Roy, D. Das and D. Banerjee,**

‘Nonlinear Response of a Parametric Bistable Oscillator with Multiple Excitations’, *Eur. Phys. J. B* (2020), DOI: 10.1140/epjb/e2019-100414-5



▲ Fine-tuning frequencies to achieve resonance

ATOMIC PHYSICS

Frozen-planet states in exotic helium atoms



▲ Low energy anti-proton accelerator. © Wikipedia, Tom Purves from Toronto, Canada

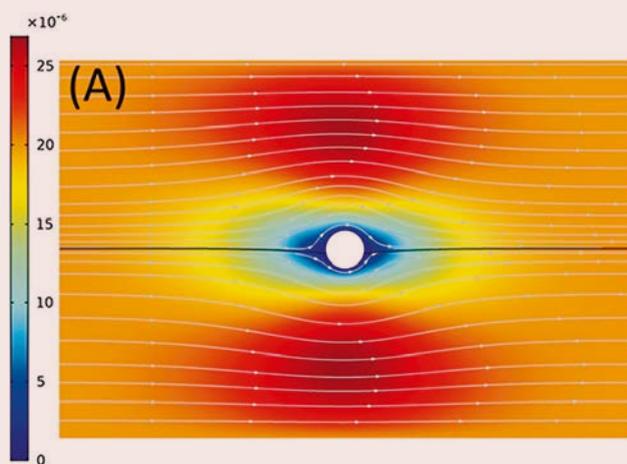
■ **T.P. Grozdanov and E.A. Solov'ev**

‘Hidden-crossing explanation of frozen-planet resonances in antiprotonic helium; their positions and widths’, *Eur. Phys. J. D* (2020) 74:50, DOI: 10.1140/epjd/e2020-100565-0

Mapping the energy levels and estimated the stability of a ‘frozen planet’ configuration of anti-protonic helium.

Exotic subatomic particles that are like ‘normal’ particles apart from one, opposite, property - such as the positron, which is like an electron but positively rather than negatively charged - are collectively known as antimatter. Direct studies of collisions between particles of matter and those of antimatter using giant facilities such as those at CERN can advance our understanding of the nature of matter. In this work, the energy levels of an exotic form of helium produced in this way are mapped. The work has been described by one commentator as ‘... a new jewel in the treasure of scientific achievements in atomic physics theory’. ■

PHYSICS OF LIQUIDS

Distortion isn't a drag on **fluid-straddling particles**

▲ Straddling particles deform fluid interfaces

■ J.-C. Loudet, M. Qiu, J. Hemaueur and J.J. Feng,

'Drag force on a particle straddling a fluid interface: influence of interfacial deformations', *Eur. Phys. J. E* (2020) 43:13. DOI 10.1140/epje/i2020-11936-1

The drag forces experienced by particles which straddle and distort the interfaces between un-mixable fluids are less influenced by the shape of the distortion than previously thought.

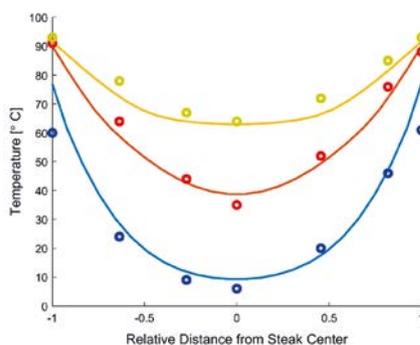
Some intriguing physics can be found at the interfaces between fluids, particularly if they are straddled by particles like proteins or dust grains. When placed between un-mixable fluids such as oil and water, a variety of processes, including inter-molecular interactions, will cause the particles to move around. These motions are characterised by the drag force experienced by the particles, which is itself thought to depend on the extent to which they distort fluid interfaces. In this work it is shown that the drag force experienced by fluid-straddling particles is less affected by interface distortion than previously believed. ■

PHYSICS OF COOKING

Models explain changes in cooking meat

By treating meat as a network of flexible polymers surrounded by flowing moisture, computer models can accurately predict how much it will shrink when cooked.

Made up of complex networks of moisture-saturated proteins, meat displays some intriguing physical properties when it is cooked. In this work, mathematicians show that by modelling meat as a fluid-saturated matrix of elastic proteins, which are deformed as the fluid moves, cooking behaviours can be simulated precisely. ■



▲ Moisture flows in cooking meat. Temperature at 10 min. (blue), 30 min. (red) and 50 min. (yellow).

■ S. Deyo, S. Granzier-Nakajima, H. Nelson, P. Puente, K. Tully and J. Webb

A mathematical model for meat cooking, *Eur. Phys. J. Plus* (2020) 134:322, DOI 10.1140/epjp/s13360-020-00311-0

CONFERENCE PROCEEDINGS

HIAS 2019

In September 2019, the Department of Nuclear Physics of the Australian National University welcomed delegates from around the world to Canberra for the 7th Heavy Ion Accelerator Symposium (HIAS 2019).

The Symposium series takes place at Australia's Heavy Ion Accelerator Facility and provides a forum to build cross-institutional and interdisciplinary links in research areas exploiting the capabilities of heavy-ion accelerators and their associated state-of-the-art instrumentation. HIAS 2019 had a particular focus on Nuclear structure and nuclear data, Accelerator Mass Spectrometry Applications, Nuclear Astrophysics, Nuclear Reactions, and New Instrumentation for Nuclear Science and Applications. ■

■ A.J. Mitchell, S. Pavetich and D. Koll (Eds.),

'Heavy Ion Accelerator Symposium (HIAS 2019)', Canberra, Australia, September 9-13, 2019, EPJ Web of Conferences 232 (2020)



ARABIC SCIENCE OF LIGHT: THE BIRTH OF MODERN OPTICS AND OF THE EXPERIMENTAL METHOD

■ A. Boudrioua¹, M. Chergui² and R. Rashed³ – <https://doi.org/10.1051/epn/2020301>

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A millennium ago, the world witnessed a major revolution via the field of Optics. The study of Light, freed from postulates and axiomatic approaches, by the Arab Scholar Ibn-Al-Haytham marked the birth of the experimental method with its observational and analytical protocols, and the use of mathematics in formalising them. This revolution led to the awakening of Sciences in Europe throughout the middle ages till the Renaissance.

▲ The eye according to Hunayn Ibn Ishaq. From a manuscript dated ca. 1200.

A millennium ago, the works of the Arab scholar Al Hassan Ibn Al Haytham represented a revolution in Optics that would gradually propagate through medieval Europe, but most importantly, they represent the birth of the experimental method as scientists practice it ever since.

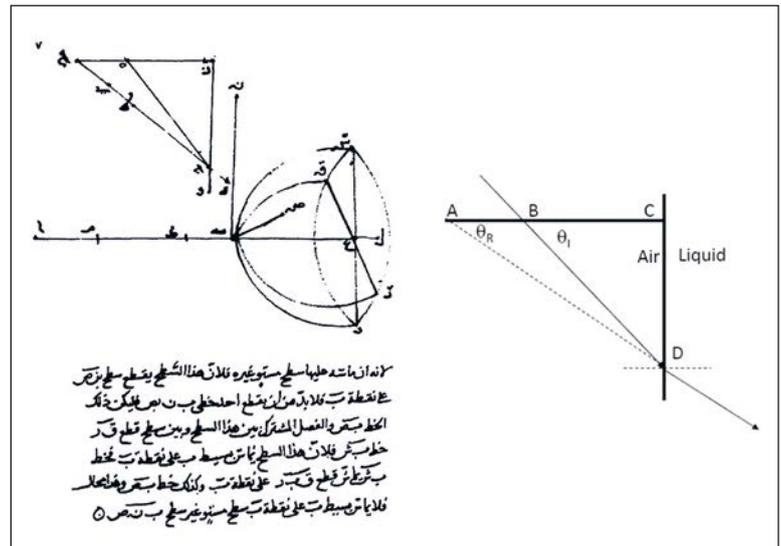
The ancient Greeks were more interested in the phenomenon of Vision rather than the nature of Light. Their theories can broadly be classified into: Extramission

theories, specifically attributed to Euclid (325 - 265, BC) and the mathematical School of Alexandria, in particular Claudius Ptolemy (c. AD 100 – c.170), which required that visual rays or illuminating particles be emitted by the eye. Euclid established the laws of reflection and his Optics is mainly based on the concept of visual rays that propagate linearly, the visual cone, with the eye as its origin and the contours of the observed object as its base and the visual angle formed by the rays reaching its edges.

Intromission theories, whose most prominent advocate was Aristotle (384-322, BC), postulated that objects continuously send-off microscopic replicas of themselves that travel to the eye. They avoid some obvious problems of the extramission theory, e.g. that near and far objects are simultaneously visible the moment the eye is opened. A third approach, defended by Plato and Galen, and to a certain degree also by Aristotle, proposed that light emitted by the eye engages in some way with the intervening air and the aforementioned replicas. All these theories, which prevailed till the end of the first millennium AC, shared the fundamental premise that physical contact between eye and object is needed for vision.

The fall of Rome in 476 and the advent of Islam (570-632) represented major social and political events that would profoundly transform Knowledge and Thought. Islam's rapid expansion, first under the Omayyad dynasty with Damascus as its capital, then from 750 till 1250 under the Abbasid dynasty with Baghdad as its capital, would lead to profound changes in the development of ideas. In 786, Haroun Al Rashid became caliph in Baghdad and initiated an intense intellectual activity marked by the translation of Greek texts. His son, Al Mamun (813-833) created in Baghdad one of the first centres of scientific research in History, the famous Beit al-Hikma (House of Wisdom). A frenzied intellectual activity prevailed with the translation, study and commentary of the texts by the Greeks, Persians, Indians, etc., in an atmosphere of openness to and respect of all religions (Muslims, Christians, Jews, Zoroastrians, Sabians, etc) and origins (Arabs, Persians, Greeks, etc). This is exemplified by Hunayn Ibn Ishaq (808-873), a Nestorian Christian, trilingual (Arabic, Syriac and Greek) who was an authority in the translation of Greek works and a great Scholar. He wrote ten treatises on the eye and among other findings, he determined that the sensitive organ of the eye lens is located at its centre. During this time, three key scholars emerged in the development of Optics as a science: Yaqub Ibn Ishaq Ibn Sabah Al Kindi (801-873), Al-Alla Ibn Sahl (940-1000), and Abu Ali al-Hassan ibn al-Hassan Ibn al Haytham (died after 1040).

Al-Kindi amended Euclid's extramission theory by considering visual rays as three-dimensional prints produced by the observed object. Two important theoretical and experimental manuscripts authored by the Bagdad mathematician **Ibn Sahl** were discovered three decades ago in Damascus and Tehran by the historian of Science Roshdi Rashed, who analysed them in great detail [1-3]. They report, among others, mechanical methods of continuous drawing of conics. Ibn-Sahl not only considered burning (curved) mirrors, but lenses. He contributed the first mathematical description of burning lenses, including plane-convex and biconvex lenses. This brought him to consider the problem of the refraction of light, which he treated for a flat surface separating two media (see figure 1 left), leading to the formulation of



the law of refraction five centuries before Willebord Snell and René Descartes.

The upper left inset of his drawing in figure 1 is reproduced in the right panel. Ibn Sahl refers to the ratio of the lengths: DB/DA, which he states is a constant for the crystal, and recognizes it as the ratio of the sines of the refracted (θ_R) and incident (θ_I) angles, and therefore the ratio of refractive indexes.

The above works paved the way to the major scientific revolution initiated by **Ibn al-Haytham** (known as Alhazen or Alhacen in medieval Europe). Born in Basra (Iraq), he spent most of his time in Cairo, under the reign of Fatimid Caliph al-Hakim, who showed strong interest in science and philosophy [4]. Alhazen worked at the famous Al-Azhar University, then a major centre of academic inquiry [5]. He left nearly 100 titles, in mathematics, Optics, Astronomy, Philosophy, Astrology, Statics and Hydrostatics and various other subjects. His main achievement is the *Kitab Al Manazir (Book of Optics)*, which represents a revolution in science. Indeed, for the first time, the conditions of light propagation and those of vision are separated. Light becomes a physical object and Optics is no longer a “geometry of perception” [6]. Underpinning this development is the link he established for the first time, between mathematics and natural phenomena: “Our subject is obscure and the way leading to knowledge of its nature difficult; moreover our inquiry requires a combination of the natural and mathematical sciences” [7]. This approach goes well beyond optics and aims at “inventing the means and the procedures to apply mathematics on the ideas of natural phenomena” [6].

Ibn-Al-Haytham introduced novel concepts, such as: light rays and light bundles as a set of straight lines propagating independently from each other, at a very high but finite velocity, or the incidence of light on matter creates reflection. He explained refraction by the velocity of light being affected by the density of the medium. He also introduced the vectorial description of light propagation.

▲ FIG. 1: (Left) Ibn Sahl and the law of refraction: the planar convex lens from Ibn Sahl's treatise "On the Burning Instruments" (Public Domain, courtesy of Milli Library, Tehran). (Right) a reproduction of the upper diagramme of the left panel showing a decomposition of the ray trajectories (see text).

Kitab Al Manazir is the first real science textbook, combining experiments with mathematical validation. It is a series of Books dealing with specific subjects regarding light [8]. The historian of Science, Abdelhamid I. Sabra, edited the first critical Arabic version of the first 3 books and their translation into English, and Roshdi Rashed the critical edition of parts of the 7th book [7,9]. Books I to III are devoted to the theory of vision, the physiology of the eye and the psychology of perception. The correct model of vision is presented: a passive reception by the eye of rays reflected from objects, but also physiological explanations of visual perception and optical illusions [10]. Books IV to VII contain a complete formulation of the laws of reflection and a detailed investigation of refraction, including experiments involving angles of incidence and deviation. They also contain “Alhazen’s problem”, which consists in determining the point of reflection from a plane or curved surface, given the centre of the eye and the observed point, and is solved by means of conic sections. Other optical works include *Daw’al-qamar* (“On the Light of the Moon”), *al-Hāla wa-qaws quzah* (“On the Halo and the Rainbow”), *Sūrat al-kusūf* (“On the Shape of the Eclipse”), and *al-Daw’* (“A Discourse on Light”). The latter presents a discussion of optical illusions, visual perception, rainbows, atmospheric density, various celestial phenomena (the eclipse, twilight and moonlight), refraction, catoptrics, the dioptré, spherical and parabolic mirrors, etc.

By giving ascendancy to observations rather than to postulates, by dissociating the physical object from the perception and by the mathematical formalization of observations, Ibn-Al-Haytham introduced the mathematical language (and its intrinsic logic) as a structuring element of science.

Kitab Al Manazir had a profound influence on the work of most scholars till the Renaissance. The first translation into Latin was by Gerard of Cremona (1114-1187) under the title *Perspectiva*. The Silesian monk Erasmus Ciolek Witelo (1230 - 1275) will actively advocate Ibn-Al-Haytham’s works and ideas in Europe. John Peckham (c. 1230 – 1292) wrote a manual for teaching optics, inspired from *Kitab Al Manazir*. Fourteen translations of the latter are identified in Europe, six of them in Great Britain. The last version will be published in 1572 by Friedrich Risner in Basel, over five centuries after Ibn Al Haytham’s death. The experimental method will only later be fully formalised by Roger Bacon (1561-1626) with the *Novum Organum* and René Descartes (1596-1650) with *Le discours de la Méthode*. Finally, Ibn-Al-Haytham’s works in optics will also influence artistic activity till the XVIIth century, as he remained a reference in painting thanks to his works on perspective [11-13]. His discoveries are also invoked in the most celebrated medieval novels: *Le Roman de la Rose* (Guillaume de Lorris and Jean de Meun) and *The Canterbury Tales* (Geoffroy Chaucer).

Knowledge has never been the product of a single group, civilization or country. It is a transformative process characterised by a continuous flow of ideas, explanations, experiments and rationalizations that move over time and through space. The rise of science in Europe since the renaissance is part of this flow and cannot be disjointed from what preceded it during the eight centuries of the Arabic civilization. ■

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Azzedine Boudrioua, expert in Organic Photonics, was involved in the International Year of Light 2015 celebrations as coordinator of the Ibn-Al-Haytham International Working Group.

Majed Chergui is director of the Lausanne Centre for Ultrafast Science and founding editor-in-Chief of Structural Dynamics.

Roshdi Rashed, Emeritus Research Director in the CNRS and Honorary Professor at Tokyo University, is a world leading expert in Arabic sciences.

References

- [1] R. Rashed, *Isis* **81**, 464 (1990) - doi:Doi 10.1086/355456.
- [2] R. Rashed, *Optique et mathématiques. Recherches sur l'histoire de la pensée scientifique en arabe.* (1994).
- [3] C. Houzel, *Arabic sciences and philosophy* **17**, 109 (2007).
- [4] R. Rashed, *Science* **297**, 773 (2002) - doi:DOI 10.1126/science.1074591.
- [5] H. Corbin, *History of Islamic philosophy.* (Kegan Paul International ; In association with Islamic Publications for the Institute of Ismaili Studies, 1993).
- [6] R. Rashed, *Light-based science: technology and sustainable development* Vol. in press (ed A. Boudrioua) (CRC, 2017).
- [7] A. I. Sabra, *The Optics of Ibn al-Haytham.* Books I-III, On direct vision. (Warburg Institute, University of London, 1989).
- [8] R. Rashed, *Geometry and Dioptrics in Classical Islam*, London, Al-Furqān Islamic Heritage Foundation, 2005. (2006).
- [9] R. Rashed, Kindī, Y. q. i. l. ā. A. Y. a.-., Ibn ʿIsā, A. m. & Lūqā, Q. ā. i. *L'optique et la catoptrique.* (E. J. Brill, 1997).
- [10] B. Steffens, *Ibn al-Haytham : first scientist.* 1st edn, (Morgan Reynolds Pub., 2007).
- [11] D. Hockney, C. M. Falco, *P Soc Photo-Opt Ins* **5638**, 1 (2005), doi:10.1117/12.580846.
- [12] D. Hockney, C. M. Falco, *The science of optics: recent revelations about the history of art.* Nature of Light: Light in Nature **lv** 8480, doi:Artn 84800a 10.1117/12.956447 (2012).
- [13] C. M. Falco, A. L. W. Allen, *The optics of Jan van Eyck and Ibn al-Haytham.* Proc Spie **8481**, doi:Artn 84810I, 10.1117/12.929920 (2012).

FROM ASTRONOMY TO THE CLINIC: ADAPTIVE OPTICS BASED VISUAL SIMULATORS

■ Maria Viñas – <https://doi.org/10.1051/epon/2020302>

Adaptive optics based visual simulators with deformable mirrors, spatial light modulators or optotunable lenses are increasingly used to simulate vision through different complex multifocal lens designs. Their final utility in the clinic relies on their capability to predict visual performance after an ocular surgery.

From Astronomy to vision

Adaptive Optics (AO), a technology originally developed to image stellar objects with ground-based telescopes eliminating the degrading effects of the atmospheric turbulence, has more recently expanded applications into ophthalmology [1].

The eye is an optical instrument that projects scenes of the visual world onto the retina. However the human eye is far from being a perfect optical system, and, as a consequence, the images projected on the retina are blurred by diffraction, scattering and ocular aberrations. Since AO was first applied to the eye [2], its use to measure, correct or induce ocular aberrations has increased dramatically, and it has even made its way into the clinic. Wavefront sensing and AO have been applied to the understanding of the optical quality of the eye, and its change with refractive error, accommodation, aging in the normal eye, diseases and treatment (refractive surgery, cataract surgery, contact lenses, etc).

Conversely, AO has allowed probing the visual system under manipulated optics, either with fully corrected optical aberrations [3], through the optical aberrations of another subject or scaled/rotated versions of their own [4], or a phase pattern simulating a given correction (*i.e.* an intraocular lens (IOL), contact lens (CL) or a corneal treatment) [5]. AO visual simulators are particularly attractive to test vision in patients with new optical designs, prior to delivering surgical corrections to the patient or even manufacturing the lenses.

Providing patients the visual experience before implanting an IOL or fitting a CL is particularly relevant for multifocal corrections for presbyopia (the age-related loss of the ability to dynamically focus near and far objects). Multifocal corrections work under the principle of simultaneous vision, projecting simultaneously focused and defocused images on the retina. These corrections generally

provide multifocality at the expense of reducing optical quality at all distances. Visual simulators allow undertaking systematic studies of visual performance testing multiple lens designs (programmable in the adaptive optics active element), which can be directly compared by the patient. As clinical instruments, AO visual simulators can help demonstrating the patient the experience of multifocality and can guide the patient and eye care practitioner in the selection of the most suitable correction.

Adaptive Optics based visual simulators

In AO based visual simulators, an active optical element, typically a deformable mirror (DM) or a spatial light modulator (SLM), reproduces the equivalent phase map of a certain optical design in a plane conjugate to the subject's pupil plane, while the observer is looking at a visual stimulus. DMs allow simulating smooth optical designs, or to induce certain amounts of aberrations, while controlling the aberrations of the subject. In contrast, spatial light modulators (SLMs) are capable of reproducing abrupt phase maps due to their high spatial resolution, and to increase the effective phase range through the use of wrapped phase representations. Moreover, static simulation of a multifocal design can be obtained by placing the real IOL in a cuvette filled with water in a conjugate pupil plane projected in the eye.



As clinical instruments, AO visual simulators can help demonstrating the patient the experience of multifocality and can guide the patient and eye care practitioner in the selection of the most suitable correction. ”

A novel approximation to simultaneous vision simulation is the use of optotunable lenses working in temporal multiplexing mode (SimVis technology) [6]. These custom electronically driven lenses can produce fast periodic foci variations at speeds greater than the flicker fusion threshold of the human visual system, delivering seemingly static images on the subject's retina that emulate the effect of the multifocal correction. The simulation of multifocal corrections relies on evaluating the through focus energy distribution of the correction, from the knowledge of the spatially varying pupillary power distribution, and programming in the optotunable lens the corresponding time-varying focus changes.

AO visual simulators based on different active optical elements are increasingly used to simulate vision through different multifocal lens designs. An example of these type of systems is the multi-channel polychromatic AO visual simulator of the Visual Optics and Biophotonics lab (Madrid, Spain). The visual stimulus in this system is seen (by a camera or a patient) through different active optical elements in 4 separate channels: (1) a reflective deformable mirror (DM); (2) a reflective phase-only spatial light modulator (LCoS-SLM), (3) a simultaneous vision simulator based on temporal multiplexing of an opto-tunable lens (SimVis); and (4) a real IOL in a cuvette. The DM, SLM, SimVis and real IOL in a cuvette are placed in conjugate pupil planes of the system and allow visual simulation of complex multifocal designs.

An interesting question is whether this simulation correspond with the vision obtained through the physically manufactured real IOL tested on the same eye [7]. Comparison, on bench and in patients, in the same multi-channel AO visual simulator, of through focus (TF) optical and visual quality produced by real multifocal IOLs (M-IOLs) and their

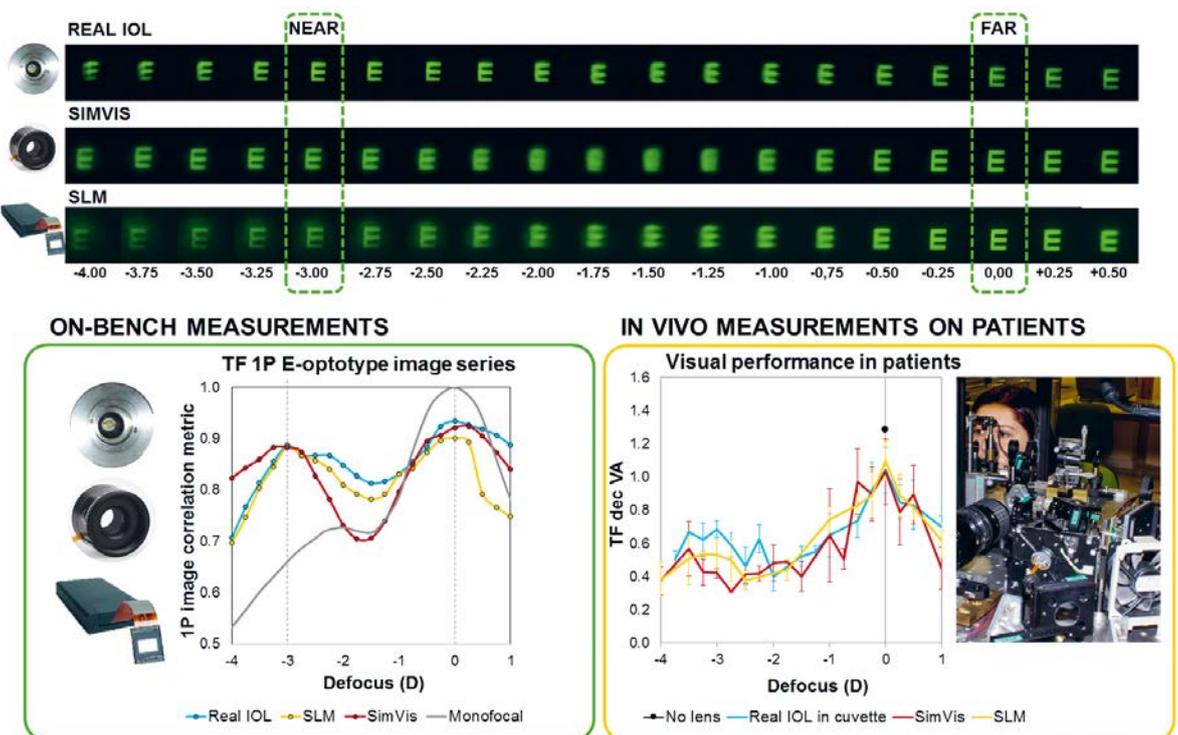
corresponding visual simulations using different active optical elements can help answering it. Optical quality metrics obtained from on-bench TF E-letter images (1P) and in vivo TF decimal Visual Acuity (VA) on patients shows similar TF visual performance (Figure 1) for a bifocal refractive M-IOL. TF curves show a general good correspondence between the through-focus performance with the real and simulated M-IOLs, both optically (on bench) and visually (measured VA in patients). Visual simulations in an AO system capture largely the optical and visual performance obtained with projected real and simulated IOLs.

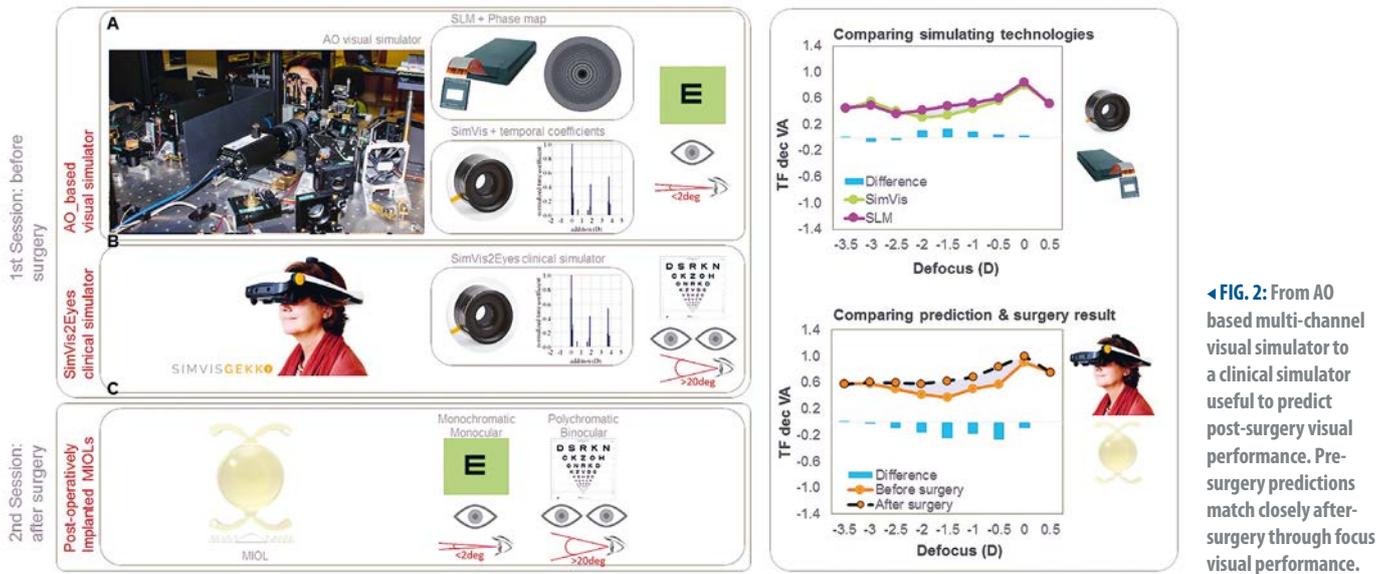
From the lab to the clinic: predicting post-surgery vision

Reflective-DM or SLM-based visual simulators are mostly limited to experimental environments, given their relatively high complexity and dimensions, although some have made their way into commercial products. In these devices the visual experience is limited to stimuli projected in a display, subtending a relatively small visual field, in many cases monocularly. Ideal visual simulators in a clinical environment should be see-through, allowing a direct view of the real world and should display a larger visual field. Moreover, the ultimate utility of visual simulators, no matter the technology behind, relies on their capability to allow patients to experience vision before IOL implantation, since tested IOLs are designed to replace the natural crystalline lens. For that reason, to evaluate the limits of a clinical visual simulator it is necessary to compare directly the in vivo predicted and post-operative through focus visual quality in patients.

Figure 2 shows the pipeline of the validation process of a wearable see-through binocular clinical visual simulator (SimVis Gekko, 2Eyes Vision, Madrid, Spain) developed for

► FIG. 1: Through-focus optical and visual quality on bench and in vivo on patients through a real and simulated multifocal intraocular lens (Bifocal refractive) measured in a multi-channel AO visual simulator. All simulating technologies, SLM, SimVis and real IOL in a cuvette, show similar through-focus visual performance, both on bench and in vivo.





◀ **FIG. 2:** From AO based multi-channel visual simulator to a clinical simulator useful to predict post-surgery visual performance. Pre-surgery predictions match closely after-surgery through focus visual performance.

the pre-surgical simulation of presbyopic corrections[8], where in vivo pre-operative simulated TF visual performance is compared with post-operative vision after implantation of a M-IOL in patients[9]. The comparison is made in patients that are implanted with diffractive trifocal lenses (the FineVision POD E, by PhysiOL), using two different simulating technologies (SLM and SimVis technology) and 2 different simulation platforms, an AO based visual simulator and the clinical simulator. When comparing the different simulations techniques pre-surgery, a similar TF visual performance is found between the TF VA with the SLM (pink line) and the SimVis (green line) simulation in the AO platform. The clinical simulator based on SimVis technology (orange line) predicts well the post-surgery TF performance (black dotted line).

In general, visual simulators are able to predict the relative multifocal performance of a specific IOL design, since TF visual performance pre-surgery (simulated IOL) and TF visual performance after-surgery (real IOL) show good correspondence. Visual simulations are useful programmable tools to predict the relative visual performance with multifocal IOLs, both in an AO environment and in a large field of view clinical binocular device. ■

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SimVis technology is protected by 4 licensed patents: P200930055, P201331436, P201531397 & P201730854

MV and some of her co-authors (Daniel Pascual, Vyas Akondi, Carlos Dorronsoro and Susana Marcos) have financial interest in the company 2EyesVision, proprietary of SimVis technology

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References

- [1] S. Marcos *et al.*, *Vision research* **132**, 3 (2017)
- [2] Liang, D. R. Williams, and D. T. Miller, *Journal of the Optical Society of America. A, Optics, image science and vision* **14**, 2884 (1997)
- [3] S. Marcos, L. Sawides, E. Gamba, and C. Dorronsoro, *Journal of vision* **8**, 11 (2008)
- [4] P. Artal, L. Chen, E. J. Fernandez, B. Singer, S. Manzanera, and D. R. Williams, *Journal of vision* **4**, 281 (2004)
- [5] M. Viñas, C. Dorronsoro, A. Radhakrishnan, C. Benedí-García, E. A. LaVilla, J. Schwiegerling, and S. Marcos, *Biomedical optics express* **8**, 2055 (2017)
- [6] C. Dorronsoro, X. Barcala, E. Gamba, V. Akondi, L. Sawides, Y. Marrakchi, V. Rodríguez-Lopez, C. Benedí-García, M. Viñas, E. Lage, and S. Marcos, *Optics express* **27**, 2085 (2019)
- [7] M. Viñas, C. Benedí-García, S. Aissati, D. Pascual, V. Akondi, C. Dorronsoro, and S. Marcos, *Scientific reports* **9**, 1539 (2019)
- [8] C. Dorronsoro, J. R. Alonso-Sanz, D. Pascual, M. Velasco-Ocaña, P. Perez-Merino, and S. Marcos, *Optica* **3**, 918 (2016)
- [9] M. Viñas, S. Aissati, M. Romero, C. Benedí-García, N. Garzon, F. Poyales, C. Dorronsoro, and S. Marcos, *Biomedical optics express* **10**, 5801 (2019)



LET'S TAKE THIS DISCUSSION ONLINE

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With the lockdowns caused by the COVID-19 pandemic, researchers turn to online conferencing. While posing new challenges, this format also brings multiple advantages. We argue that virtual conferences will become part of our regular scientific communication and invite community members to join the movement.

Your routine has changed drastically over the course of the last couple of months due to the lockdowns following the novel coronavirus outbreak. You now mostly stay at home, hopefully safe and healthy. Your classes are now taught online, and you probably had to quickly figure out how to run them at all. If you do experiments, your lab is either closed or operates at a much lower capacity. Your travel plans are cancelled. Still, despite all this, you have likely attended a scientific presentation or have even given one yourself. The only difference is that it happened online, perhaps as part of a virtual conference.

Virtual conferences were gaining momentum even before the coronavirus crisis due to multiple advantages over traditional in-person gatherings. With the increasing concerns about greenhouse emissions, many prefer to limit their long-distance travel. For some community members with limited mobility, either for family, health, or budget reasons, traditional in-person conferences are off limits altogether, and online events are the only available option. Online events are also free from most of the expensive and time-consuming aspects of conference organisation: finding a venue, arranging lodging and catering for the participants. With planning and logistics out of the way, virtual conferences can be organised much faster and can easily respond to the latest scientific developments (see a comparison of typical timelines in the figure). Since online events are easier to attend and since they accommodate hundreds of participants, they are also more inclusive. If the talks are recorded and published, they reach an even broader audience.

The Virtual Science Forum

The idea of organising virtual conferences brought us together—a group of geographically and academically diverse physics researchers. We started exploring the opportunities and challenges of online conferences in late Summer 2019, well before the COVID-19 pandemic. We decided to keep our organisation open for anyone to join, and all of our documentation and notes were public from the very beginning, with the thought that these should benefit anyone trying to work towards the same goal. After several discussions we committed to developing a community platform for online conferences, which we now call the **Virtual Science Forum**.

Once we started brainstorming how to organise online events, we realised that a lot of the usual assumptions about scientific meetings do not apply anymore. Already the sizes of the events are very different: while a typical workshop will have anywhere between 50 and 100 participants, an online conference session can easily attract 500 attendees. On the other hand, the median duration of a traditional conference is a full working week, while the duration of an online event is limited to a few hours because it needs to fit into the daily routines of participants spread across multiple time zones. The interactions during the session are also very different: the speaker cannot see the audience and has no way of receiving immediate feedback. Because mediating the interaction between the audience and the speaker becomes much more important, and because of the larger audience size, the moderators play

a more important role in ensuring that everything goes smoothly. Finally, offline conferences allow ample time for informal discussion between the talks and during coffee breaks: this valuable aspect of scientific meetings needs to be accommodated separately.

A typical workshop will have anywhere between 50 and 100 participants, an online conference session can easily attract 500 attendees.

To help the community members orient themselves in a new setting, we prepared basic guidelines for all online event participants: organizers, moderators, speakers, and audience members. Once we felt sufficiently confident, we ran a trial workshop with our direct colleagues as both speakers and the audience. We used this test run to try out different formats of interaction between the audience and the speaker, resolve unexpected technical problems, and collect the impressions from a broader group of colleagues. To our delight, we found that videoconferencing has now matured to accommodate high quality live talks, where every viewer gets the front row experience. After this experiment we were ready to hit the ground running. In fact, the cancellation of the APS March Meeting became a catalyst for our first virtual session, which we organised in just a few days. Now we are continuing to work in a steady pace: we improve the platform and organize a biweekly colloquium series. We also actively invite community initiatives to organise virtual conferences on our platform, and we are excited to already have the first of such conference applications in progress. Our experience with organising online conferences and colloquia has shown that they provide a stimulating environment and foster fruitful discussions.

With more and more people getting used to online meetings and seminars—and with online conferencing software continually improving—we expect that online scientific events will become commonplace. Our effort towards online conferences was not the first and is certainly no longer one of few. Such events are now organised by many science departments and research institutes. Emerging organisations like

Online Conference planning

- Planning & Application	1 year before 2 months before
- Book venue	8 months before N/A
- Reach out to speakers	6 months before 6 weeks before
- Announce	4 months before 4 weeks before
- Select attendees	3 months before N/A
- Flights/accommodation	2 months before N/A
- Run the event!	

◀ FIG: A conference organizer checklist.

researchseminars.org aggregate the information and distribute announcements in order to help navigate the rapidly growing volume of online events.

We conclude with a call to action: give virtual conferences a shot!

Online conferencing is emerging right now because there are no alternatives until the pandemic is over, lockdowns are lifted, and travel is restored. While our hand is currently forced, we hope that the research community will grow accustomed to this long overdue change and will see the value of virtual conferences in their own right. This is why we conclude with a call to action: give virtual conferences a shot! Start with attending the events you like: it has never been easier. Or perhaps you have an idea for a good event to run? Now is your chance—go for it, and know that we are here to help. ■

Website: <https://virtualsecienceforum.org>

About the Authors

The authors are members of the Virtual Science Forum, an open, collaborative, and volunteer-run initiative to facilitate online scientific seminars. They work at academic institutions spread across North America and Europe and donate their effort to make a positive impact on the research community.





SUBMARINE SEISMIC TOMOGRAPHY USING OPTICAL FIBRES

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The repurpose of the available telecommunication fibre optical network as a seismic monitoring tool has been recently tested with very promising prospects. Optical fibre networks possess all the ingredients to become the next generation seismic monitoring system, offering high performance at minimum deployment and maintenance cost, especially at hardly accessible regions such as the oceans' bottom.

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Seismic tomography is a technique employed for imaging the subsurface of the Earth. It is based on the acquisition of surface seismic waves, which can be produced by the movement of tectonic plates, earthquakes, volcanic eruptions, or any ground trembling event. The acquired data is employed in an inverse engineering process, creating three-dimensional images of wave propagation anomalies that can be interpreted as structural or compositional variations. Seismology studies have additionally fostered the emergence of applications that boost social and economical sectors, such as resource exploration, ground motion prediction, development of effective early warning systems, and more.

Nowadays, seismic data recording almost uniquely depends on seismograph networks deployed around the world. Seismograph networks are arrays of precisely

synchronised point seismographs. They are capable of providing spatio-temporal information susceptible to be smartly analysed via special digital signal processing to reveal information beyond earthquake monitoring. However, the density of this kind of stations worldwide is still low (with sensors separation of several km), as the cost of deployment and maintenance of larger and denser networks results unsustainable. In general, the vast majority of the seismic arrays are distributed onshore, close to populated areas. Yet, oceans cover 71% of the Earth's surface. The implementation of seismographs and seismic arrays offshore remains a challenge from both technical and economical points of view. Hence, the low density of stations together with the poor coverage across oceanic regions result in a biased and poorly sampled analysis of the seismic activity. In addition, the lack of significant seismic

instrumentation offshore makes it more complicated to explore the mechanisms that launch disastrous oceanic events such as tsunamis.

In the last few years, the idea of leveraging the existing telecommunication optical fibre networks for distributed seismic monitoring has proliferated across the research community. Conventional telecom optical fibre cable can be readily used as distributed acoustic sensors (DAS), allowing for the fully distributed monitoring of acoustic vibrations. The final goal is to develop a novel conception for ubiquitous seismic monitoring systems with high capacities and minimal investment.

Why distributed optical fibre sensors?

Optical fibres have proven to be outstanding vibration or strain distributed sensors, mainly for applications where large surfaces need to be monitored. As a sensor, an optical fibre provides high sensitivity, robustness, long lifespan and cost-effectiveness [1]. The whole length of the fibre (currently reaching operation ranges up to 100 km) acts as an array of intrinsically synchronised point sensors separated by the spatial resolution (~10 m), providing up to three orders of magnitude better resolution than the one achieved by traditional seismograph networks, and only requiring a single interrogation unit. Another important advantage of optical fibre sensors is their capacity to perform remote sensing, allowing the interrogation unit to keep a safe placement away from harsh locations and providing minimal intrusiveness in their deployment. This is particularly interesting for sub-sea ground motion monitoring. Nowadays, there exists a vast network of fibre-optic cable deployed all over the planet, often running over vast unmanned areas, and sometimes even in very remote and hardly accessible areas like very deep underwater regions in the middle of the oceans. This situation assures a fairly good spatial resolution and surface coverage for seismology analyses with minimal deployment cost. An optical fibre used as a DAS exploits the Rayleigh backscattering occurred in the fibre in combination with optical time domain reflectometry (OTDR) technique [1], [2].

DAS for underwater seismic monitoring

Numerous DAS-based seismological research works have been developed within the last four to five years, using either dedicated fibre installed for a particular study or pre-installed telecommunication dark (unemployed) fibres. The excellent sampling provided by DAS has provided unaliased sampling of seismic wavefields along cables, revealing high-resolution imaging of seismic structures such as fault zones or basin edges, as well as information not provided by conventional seismometers, such as the direction of the seismic energy [3], [4]. Besides, the use of advanced processing techniques



Fibre-optic cables deployed over the planet form a huge sensor network

including template matching or machine learning have allowed to detect order of magnitude more seismic events than traditional seismic networks [5]. It was not until the end of last year when a few works were published almost simultaneously on the use of DAS in oceanic environments [6]–[8], presenting accurate observation of different ocean phenomena. In spite of their short lifetime, the achievements reached to date prove a great potential handling the three major areas of local and regional seismology: seismicity monitoring, structure imaging, and hazard assessment. Further improvement in the technology is still required to target global seismology, although the prospectations are very favourable.

State-of-the-art research at the University of Alcalá

In 2016, the Photonics Engineering research team at the University of Alcalá (UAH) pioneered the development of a DAS system based on the use of interrogation pulses with a linear frequency modulation along their width, also termed as linearly chirped pulses [9]. This system has a similar performance than a conventional DAS (using unmodulated optical pulses) but with several important benefits. First, the use of linearly chirped pulses provides robust shot-to-shot linear measurements of acoustic vibrations using intensity-only detection (without the need of optical phase recovery like conventional DAS). Hence, the required number of photodetectors is reduced in fourfold, along with the complexity associated to their synchronisation and unevenness. Besides, circumventing the phase demodulation process solves an important shortcoming of traditional DAS, which is the high sensitivity to intensity fading

▼ FIG. 1: Prototype of the chirped-pulse DAS developed by the UAH.



points related to the interferometric nature of its operation. Additionally, the combination of linearly chirped pulses with a mechanically isolated reference fibre allows correcting the vast majority of the laser phase noise issues, permitting a drastic reduction of the laser coherence requirements. Those advantages imply a substantial cost saving in terms of number and quality of components required in the system without a major compromise in the performance. This architecture has attracted the interest of two manufacturers in the sensing domain (Omnisens [<https://www.omnisens.com/>] and Aragon Photonics [<https://aragonphotonics.com/hdas-distributed-acoustic-sensing/>]), who have licensed this technology.

One of the pioneering submarine seismic monitoring studies using DAS was precisely based on the use of chirped-pulse (CP-)DAS [7] (Fig. 1). This work was developed by the UAH in collaboration with the Spanish National Research Council (CSIC) and the Seismological Research Lab in Caltech. **In this work, a complete analysis of ocean dynamics is performed, including observations of microseismicity due to ocean waves, local surface gravity waves and even an earthquake occurred more than 16,000 km away from the fibre location** (Fig. 2). All this is achieved from 1 hour recording of strain data from a telecommunication preinstalled shallow fibre (< 40 m deep), where the background strain noise due to ocean waves is extremely high. Further analyses are currently being performed by the UAH group and different collaborators around the world, attempting long time recordings (along several weeks/months) at different ocean depths. The goal is to test the performance of the CP-DAS in different submarine environments and explore long-term oceanic phenomena detected by the fibre, reaping all the benefits of this novel and promising strategy for seismic tomography studies. ■

About the authors

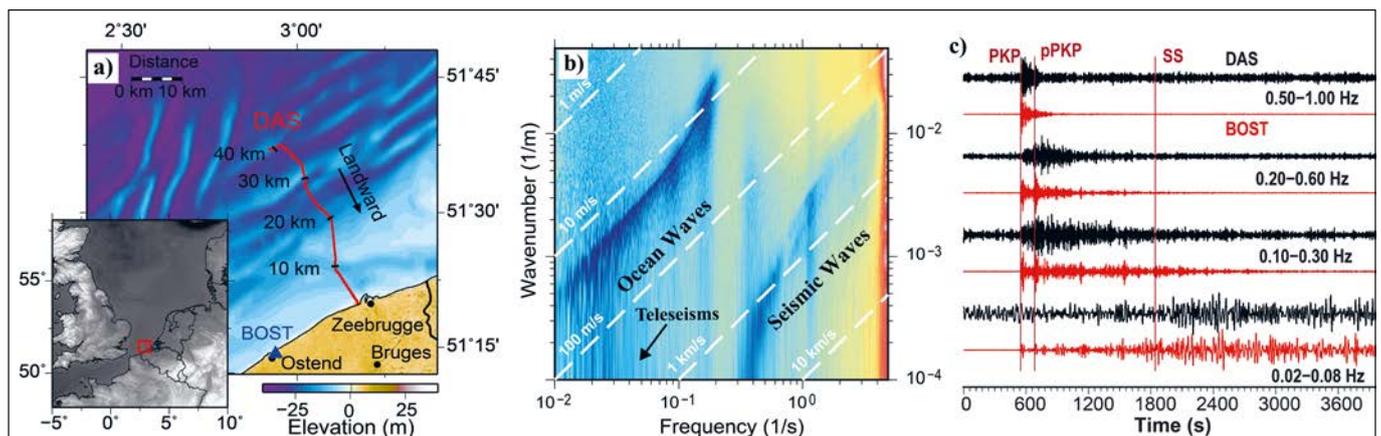


María R. Fernández-Ruiz, Sonia Martín-Lopez and Miguel Gonzalez-Herraez are with the Photonics Engineering Group at the UAH, as postdoctoral researcher, associate professor and full professor respectively and **Hugo F. Martins** is with Instituto de Optica of CSIC as postdoctoral researcher. The group initially gained visibility with an ERC grant for distributed temperature sensing and since then has extended its core-research into DAS. The group's state-of-the-art research and results in DAS have been internationally recognized by several conference awards as well as international scientific and industrial projects/works of relevance.

References

- [1] A. H. Hartog, *An introduction to distributed fiber sensors*. Florida (USA): CRC Press: Boca Raton (2017)
- [2] Y. Muanenda, *J. Sensors* **3897873**, 1 (2018)
- [3] J. B. Ajo-Franklin *et al.*, *Sci. Rep.* **9-1328**, 1 (2019)
- [4] P. Jousset *et al.*, *Nat. Commun* **9-2509**, 1 (2018)
- [5] Z. Li and Z. Zhan, *Geophys. J. Int.* **215-3**, 1583 (2018)
- [6] A. Sladen *et al.*, *Nat. Commun.* **10-5777**, 1 (2019)
- [7] E. F. Williams, M. R. Fernández-Ruiz, R. Magalhaes, Z. Zhan, M. Gonzalez-Herraez, and H. F. Martins, *Nat. Commun.* **10-5778**, 1 (2019)
- [8] N. J. Lindsey, T. Craig Dawe, and J. B. Ajo-Franklin, *Science* **366-6469**, 1103 (2019)
- [9] M. R. Fernández-Ruiz, L. Costa, and H. F. Martins, *Sensors* **19-20**, 1 (2019)

▼ **FIG. 2:** (a) Distribution of the telecommunication optical fibre employed as a distributed seismic sensor. The fibre connects the city of Zeebrugge (Belgium) with a wind farm located 40 km away from the shore. (b) The raw strain variations recorded by the fibre are processed using 2D linear filtering, as signals from different origins (e.g. ocean waves, microseisms or teleseisms waves) are clearly isolated in a frequency-wavenumber (f-k) representation of the recordings. (c) An earthquake produced in the Fiji Islands (> 16,000 km away from the fibre under test) was also recorded, and the signal detected by the DAS was compared with the signal recorded from a nearby seismometer (BOST), showing an excellent matching.





THE ERIC CONSORTIUM

A NEW TYPE OF EU RESEARCH INSTITUTION

■ Carlo Rizzuto – Università di Genova – DOI: <https://doi.org/10.1051/epn/2020305>

The European Research Infrastructure Consortia (ERICs) are changing the landscape of the European Research Area. ERICs are set-up by EU Community law to establish and operate open access Research Infrastructures in all fields of science, based on national and international funding. The 20 + ERICs have now a major impact in extensive fields of research.

Why the ERICs?

The need to interact freely without borders in science has given birth to a large number of international entities, mainly Associations or Scientific Societies, in Europe. EPS is one of them. A further step are organisations to build, own and operate excellent Research Infrastructures (RI) open to all interested researchers to perform research with resources unavailable to single Countries. Europe needs this to compete with other large federated parts of the world.

After the 2nd world war, this has stimulated setting up CERN, ESO, ESA, EMBL and ICTP [1] through Intergovernmental Organizations (IOs) each based on an agreement between national Governments. This has ensured stable long-term planning and funding and some benefits such as tax exemptions and attractive personnel employment - a key component to their success.

However, IOs for new infrastructures became increasingly difficult in Europe from the 1970's, due to the procedure requiring multiple parliamentary approval by

increasingly short-lived parliaments, and the increasing rigidity of research budgets. ILL and ESRF [2] in Grenoble were possible but adapting national laws thanks to France as a supportive host Country.

It then turned out to be difficult to find other Countries ready to take the burden of hosting a new RI, while requirements were growing and this needed a solution.

A group of scientists and policy makers, supported by the European Science Foundation, proposed in 2000 to involve all EU Countries in implementing European RIs, helped by the evolving European Union with a stronger budget in Research. The Council of EU Research Ministers approved setting-up, in 2002, the European Strategy Forum for Research Infrastructures (ESFRI). All EU Member and Associate countries are now implementing a European RI Roadmap, covering all scientific disciplines. Countries choose which RIs to support, and bid for their hosting. A detailed account of this has been published in EPN in 2019 [3].

The ERIC

Having ensured coherence in planning, next bottleneck was the timely setting-up by several Countries. The EU basic law could now be used. Upon proposal by ESFRI, the EU has approved in 2009 a “Regulation”, valid as a national law in all EU member countries [4]. This allows the ERIC (European Research Infrastructure Consortium) as an International Organisation in the EU legal system, without a new international agreement each time. Members of an ERIC are Countries or IOs. Its setting-up requires minimum three EU Member or Associate Countries (at least one Member). Observer Countries or IOs are allowed without voting rights. Non-EU Countries can be members or observers accepting EU rules. 21 ERICs have been set-up so far [5]. The Statutes allow new members to apply, and numbers are increasing in most ERICs.

Each ERIC has the main purpose to establish and operate a RI on a non-economic basis. It may have limited economic activities *provided they are closely related to its principal task and they do not jeopardise the achievement thereof*. The common approach is open access for users who commit to publish their results. RIs with a limited capacity for access offer at least part of it based solely on the quality of the proposals selected by independent peer review, even coming from non-ERIC-member Countries. The policy is defined in a Charter at EU level [6].

The nature of the ERIC as an International Organisation allows some benefits, as the possibility to have own flexible procedures and tax exemptions for procurement for institutional use of the ERIC.

Compared to IOs, contracts for staff are within national laws (employment is not yet within the EU law), and funding commitments by the Members are less firm than for IOs which are based on parliamentary approval. Funding of time-limited projects is possible on the EU budget.

When setting-up an ERIC, participating Countries/IOs can, in principle, agree on additional benefits. The EU Regulation defines, in fact, a standard template to be completed and adapted in a flexible way to fit a specific RI and its Members, in particular defining the scope of the ERIC’s activities and the commitments for resources. Fixed are two Governing Bodies: the General Assembly of the ERIC Members (similar to Councils of IOs, the decision-making) and the Director or Board of Directors, executive body and legal representative of the ERIC, appointed by the Assembly. Additional consultative Bodies, as a Scientific/Technical Advisory and an Administrative/Finance Committee are possible. Other aspects to be defined are voting rights and procedures, liabilities, selection and hiring of staff, etc.

▼ Table 1: Some of physics-related ERICs

NAME AND WEBSITE NUMBER OF MEMBERS (M) AND OBSERVERS (O)	EXTENDED NAME AND RESEARCH SCOPE
CERIC: ceric-eric.eu (8 M)	Central European Research Infrastructure Consortium, offers integrated international access and operation of Analytical and Synthesis facilities for Materials and Biomaterials with focus on Centre East Europe.
EMSO: emso.eu (8 M)	European Multidisciplinary Seafloor and water column Observatory, a network of observatories installed in European seas providing key data on marine ecosystems, natural hazards and climate change.
EPOS: epos-ip.org (12 M)	European Plate Observing System will provide a better understanding of the physical processes controlling earthquakes, volcanic eruptions, tsunamis, tectonic movements and other geo-hazards.
EURO ARGO: euro-argo.eu (12 M + 1 O)	Euro Argo is the European part of a global array of autonomous instruments deployed over the world ocean and reporting near-real time subsurface ocean properties to a wide range of users via satellite.
EUBI: eurobioimaging.eu (13 M + 1 O)	Euro-Biolmaging offers open access to imaging technologies, training and data services in biological and biomedical imaging.
EU SPALLATION SOURCE: europeanspallationsource.se 10 M + 4 O	European Spallation Source is the world's next-generation neutron source under construction in Lund, Sweden. A high-power linear proton accelerator will create neutron beams to probe structures and dynamics of materials.
INSTRUCT: instruct-eric.eu (14 M + 1 O)	INtegrated STRUCTural biology is a distributed research infrastructure for structural biology, and provides access to cutting edge instrumentation (ultra-high field NMR, super-resolution cryo-EM, X-ray, protein production etc.).
JIVE: jive.nl (7 M)	Joint Institute for VLBI will develop the most accurate timing distribution infrastructure in the world enabling cutting-edge applications of VLBI (very long baseline interferometry) and radio astronomy technologies.

Code: Environment, Biomedical, Physics and Engineering

Compared to the IOs, the Members of the ERIC may delegate one or more “Representing Entities” *as regards the exercise of specified rights and the discharge of specified obligations* of the Member such as the right to define the scientific programs or the obligation to provide parts of the contributions. Other fixed provisions regard reporting to the European Commission and to the ERIC Members.

To set-up an ERIC is simpler than for an IO. It requires (at least) three Countries to ask the EU Commission to set it up, with a draft Statute and a Technical Scientific document outlining scope and organisation. These are subjected to a first assessment allowing for clarifications and/or corrections (Step 1). The final proposal is then submitted formally to the Commission and its internal checks (Step 2). When approved it is published by the European Commission in the EU official Journal (with all required translations), and is immediately valid in all EU member Countries [7].

In absence of major disagreements, the whole procedure may last less than one year, compared to several years needed to achieve approval of an IO by several Parliaments.

The evolving landscape of the ERICs

In Table 1 there is a sample of physics-related or physics-intensive ERICs. More Physics-related ERICs are in the pipeline (*e.g.* ELI and CTAO [8]).

While previous international RIs were mainly large “one or few-sited” facilities, most of the new RIs respond to research needing either to collect geographically distributed data, or to integrate diverse techniques, or to access (remotely or physically) repositories of data, documents or samples: these are defined as “distributed”. A good example is EPOS, allowing to access geophysical data in 256 smaller RIs covering most geophysical active areas in Europe. Access is through a single address and an integrated set of core services ensuring interoperability and compatibility of the data (Fig. 1, courtesy of EPOS-ERIC).

The concept of RI includes now instruments, collections and data banks distributed in several sites, and the access by external users can be “physical” (personal access), “remote” (sending samples, or remote control of instruments) or “virtual” (web-like access to data banks or computing facilities). The vocabulary has evolved in different ways in different RIs, local facilities being defined as “nodes”, or “partner facilities” or “hubs” or “offices” ... *etc.* Many interesting facilities by different owners and their networking require sometimes a careful balance between coordination at national level and links at international level.

This variety may be complex, but a common element is a central governance/seat ensuring a joint planning of the resources and a “one stop” service to the external users. The need to offer to external users an effective point



Europe needs excellent Research Infrastructures to compete with other large federated parts of the world

of access requires most distributed and multi-site RIs to integrate capabilities of different existing national or local facilities.

This stimulates management methods allowing a coherent activity between facilities in different countries under different legal and fiscal constraints. An effort to allow better employment for staff in different Countries is now ongoing. A new integrating pension scheme, RESAVER [9], for staff moving in Europe, has been set-up on proposal by EIROFORUM and ERF [10].

The implementation of the ERIC frame is still in its infancy, and several aspects are still being defined, from complete applicability of tax exemptions to full participation in internationally funded projects *etc.* The impact of the ERIC on the European Research Area will make it a more structured and attractive space. ■

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References

- [1] These are all well known in physics and direct info on their origin and institutional structure is available in their web sites
- [2] ILL, the Institute Laue Langevin and ESRF, the European Synchrotron Radiation Facility, are at top world-level research infrastructures.
- [3] Rossi G., *Europhysics News* 50/1, 14 (2019)
- [4] <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1464858864496&uri=CELEX%3A32013R1261>
- [5] See also: https://ec.europa.eu/info/research-and-innovation/strategy/european-research-infrastructures/eric/eric-landscape_en
- [6] https://ec.europa.eu/info/files/charter-access_en
- [7] See <https://op.europa.eu/en/publication-detail/-/publication/c6647f05-874e-4cdd-af70-22ade4759930/language-en>
- [8] ELI and CTAO see details in the reference of note 8
- [9] See <http://www.RESAVER.eu>
- [10] EIROFORUM, is the Forum of the Intergovernmental and some of the “international Umbrella” organisations, see <https://www.eiroforum.org/> ; ERF AISBL is the Association of international level RIs see <https://erf-aisbl.eu/>



EPS ACTION PLANS FOR REDUCING THE GENDER GAP

■ **Luc Bergé** – Chair, Equal Opportunity Committee and EPS President elect – <https://doi.org/10.1051/epn/2020306>

Several new initiatives have been developed by the EPS in order to promote a better inclusion of women in the European physics community, to highlight their pivotal roles in research and teaching, and thereby attract more female researchers among the next generation of scientists. Because a perfect parity has not been reached yet, efforts in guaranteeing fair recognitions and safe careers for women will have to be sustained in the coming years. This is a very challenging task, but this is the pride of the EPS to lead it until its very end.

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Among the proposals for the ERC grants and other PhD training programmes published in the Open Calls for Horizon2020, at least seven of them are directly or indirectly concerned with gender issues [1]. Today, in the European Union (EU) and beyond, the question of bridging the gender gap not only underlies societal projects, but it also deeply permeates the ethical rules

and good practices of all scientific proposals. The initiatives to fight against the gender gap are numerous with North-American countries and UK as pioneers in the field [2]. A related issue is the respect for women physicists in conferences. A dedicated survey recently reported alarming statistics about gender-based harassment, bullying and discrimination at scientific meetings. About 60% of the respondents claimed having experienced troubles in their career [3]. This justifies the “codes of conduct” edited by learned societies such as OSA and APS and blooming in the conference areas. Fixing a set of rules outlining the best practices for attendees, these codes aim at expelling unprofessional behaviour from meetings that must be places of mutual exchanges



**Efforts still have to be maintained
to recruit more women in physics. ”**

for the advancement of science. All these actions are accompanied by a solid programme of surveys looking at the increase of women as plenary/invited speakers or their inclusion into the highest ranks in the organisation committees [2]. They are also completed by specific summer schools or training courses for tracking sexual misconduct and reducing unconscious bias in education [4]. Similar initiatives exist in many European institutions, such as the European Platform of Women Scientists (EPWS) and the Gender Equality Network in the European Research Area (GENERA) that act to overcome the under-representation of women in physics [5]. In the trans-national context, the project “Gender Gap in Science”, supported by several learned societies, measures the gender gap over all the continents [6]. In the European context, surveys again emphasise a weak proportion of women in the highest grades of academic institutions: The “She Figures 2018” publication reported about 38% of women PhD against 18% of A-level positions in all countries of the EU.

Against this background, the Equal Opportunity Committee (EOC) of the EPS [7] engaged in various action plans that aim at promoting role models, monitoring gender fairness in physics and spreading a code of conduct to favour the best practices in EPS conferences.

Promoting Role Models

The Emmy Noether Distinction is the flagship of the EPS gender policy. It was established in February 2013 to enhance the recognition of noteworthy women physicists having a strong connection to Europe through their nationality or work. It brings exceptional women to the wider attention of the scientific community, policy makers and the general public. The distinction is awarded twice per year. The attribution criteria are twofold. On the one hand, they are based on personal achievements in research, education, management and outreach. On the other hand, the Laureate has to be recognised by her peers as a role model in the physics community. Nominations are received from all over the world and are supported by Nobel laureates and past presidents of the most prestigious learned societies. Information about the winners is published through all the EPS media channels.

The monitoring project for Gender Fairness in physics

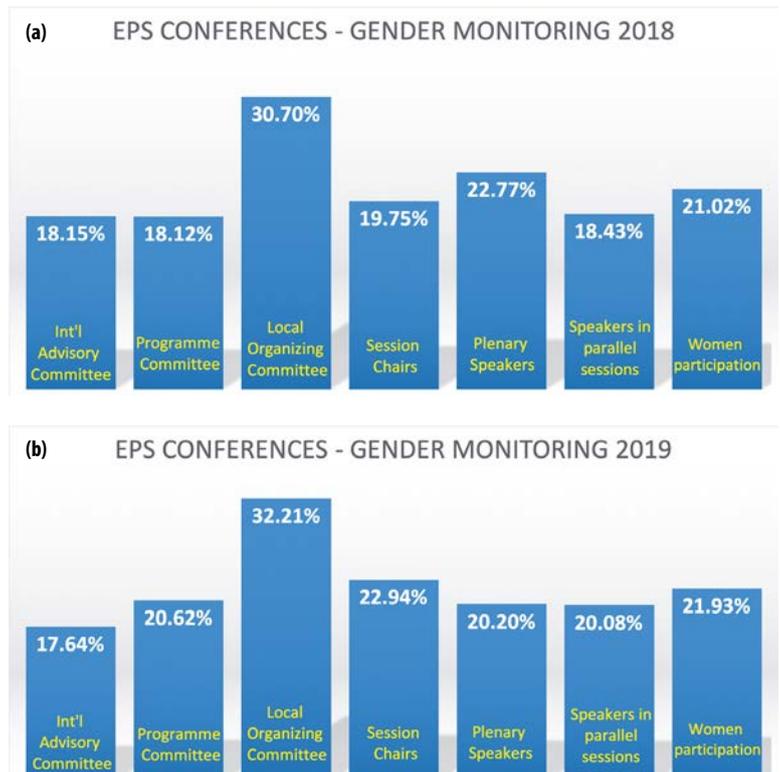
A fair development of our physics community requires the participation of women scientists at conferences, as speaker, committee member and/or organiser. In 2018, a regular survey was put in place on women’s participation in conferences organised by the EPS Divisions and Groups (D/Gs). The EPS invites the organisers to collect information on the fraction of women in the organising committees, such as the programme committee, international advisory committee and local

ROLE OF DIVISIONS AND GROUPS

To reinforce our internal cooperation on gender fairness, the Chairs of the Divisions and Groups are invited to directly exchange with the EOC by appointing a member of their Board to be in charge of gender issues. Today, this delegation applies to about 1/3 of all the EPS Divisions and Groups. The role of the EOC Delegates is to help their D/G in nominating at least one woman to the EPS awards and to participate in the Emmy Noether Distinction jury. A general recommendation to the D/Gs is to think in priority of women scientists when deciding on plenary speakers for their meetings.

organising committee and the fraction of women among the plenary speakers, invited speakers and chairpersons, together with the total number of attendees and that of women participants. By tracking such statistics over time, the EPS is expected to provide valuable input into policy discussions regarding gender equality in Europe and to take proper corrective actions. The data collected in 2018 from 15 returned surveys already showed that between 18 and 30% of the speakers or organisers were female scientists (see FIG. 1a). About 20% of them were committed at the highest level in the organisation of conferences or invited for plenary or keynote talks. Note that this percentage is close to the rate of participation of women in the conferences probed, which suggests that efforts still have to be maintained to recruit more women in physics. The 2019 statistics based

▼ FIG. 1:
Statistics extracted from the Monitoring Project for Gender Fairness in Physics in 2018 (a) and 2019 (b).



INTERVIEW SERIES IN E-EPS

In 2019, e-EPS started a new series of interviews of role-model women physicists with an interview of Donna Strickland, awarded the 2018 Nobel Prize in Physics, followed by portraits of Andrea Blanco-Redondo (Sydney University, Australia) and Ágnes Kóspál (Konkoly Observatory, Hungary). More interviews in the series will follow in the coming months. The idea is that these interviews may inspire young women to pursue an enjoyable career in physics.

on 16 filled-in surveys displayed similar trends, although a marked fall in the number of plenary speakers suggests taking the necessary measures to reverse this tendency in the coming years (see FIG. 1b). On the whole, these numbers are encouraging, but they are far from showing a perfect balance, which invites us to continue the present monitoring and keep a vigilant eye on their evolution. In particular, the higher participation of women in the local organising committee seems to confirm prejudices about the serving role of women.

A Code of Conduct for the EPS conferences

Recently, in 2020, the EPS endorsed a “Code of Conduct” that aims at prohibiting any act of discrimination and harassment, sexual or moral, during EPS-related events. The Code follows the rules of good practice already posted by several scientific societies overseas. It plans to assist victims and witnesses in reporting all cases of unprofessional behaviour and to act timely either on the conference site or by using a dedicated online portal (CodeOfConduct@eps.org).

The EPS policy states that all participants, including attendees, speakers, exhibitors and all other stakeholders at EPS meetings shall conduct themselves in

a professional manner contributing to the advancement of science. This excludes any form of discrimination, harassment or retaliation. Participants will avoid any inappropriate actions or statements based on the ability status, age, educational background, ethnicity, gender identity or expression, marital status, nationality, political affiliation, race, sexual orientation, or any other characteristics protected by anti-discrimination law. Unprofessional or harassing behaviour of any kind will not be tolerated, during the conference sessions as well as outside the session rooms on the conference site. Victims and witnesses will be given the possibility to report all cases in a safe and protected way. Upon receiving a report of misconduct, the EPS will mandate a prompt investigation by competent mediators. Sanctions range from verbal warning, ejection from the meeting without refund of fees, to notifying appropriate authorities. Adhering to this Code will be mandatory for both Europhysics and EPS-Sponsored Conferences, where roll-ups informing participants of this policy will be available. ■

About the Author



Luc Bergé graduated in mathematics and physics from the Universities of Toulouse and Paris-Sud, Orsay, France. He holds a PhD and a Habilitation thesis in theoretical physics. He is director of research, head of laboratory at CEA (French Commission for Atomic Energy and Alternative Energies), member of the Executive Committee of the EPS, Chair of the EPS Equal Opportunity Committee and 2020 President-elect of the EPS.

REFERENCES

- [1] “List of Open Calls within the Horizon2020 Framework” – January 2020 – <https://ec.europa.eu/info/research-and-innovation/funding/>
- [2] R. Ivie and S. White, *La physique au Canada* 71, 2 (2015); See also <https://genderinnovation-standford.edu/> and <https://www.thejunoproject.co.uk>
- [3] S. Marts, “Open Secrets and Missing Stairs: Sexual and Gender-Based Harassment at Scientific Meetings” www.smartsconsulting.com (2017) DOI: 10.13140/RG.2.2.14861.33767
- [4] M. Erlemann and L. Schiestl, “Diversity in the Cultures of Physics: A European Summer School Curriculum”, Erasmus+ grant program of the European Union – Freie Universität Berlin – September 2019.
- [5] <https://epws.org>; <https://genera-project.com>; <https://gender-gap-in-science.org>.
- [6] https://ec.europa.eu/info/publications/she-figures-2018_en
- [7] In 2019 the EOC was composed of 7 members among whom Martine Bosman, Nadia Martucciello, Ana Proykova, Elisabeth Rachlew and a representative of the Young Minds Action Committee.

inspiring physicists

CALENDAR
2020



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 Chiara Marletti
 Barbara Marzetti
 Maria Stokanovska-Cala
 Patricia Bakkerau
 Kazuko Kato
 Catalina Clara Curran
 Maria Geppert-Mayer
 Nyssa Dekker
 Barbara Strauss
 Becci Barrojo-Yuillas
 Anne Thielert

INSPIRING PHYSICISTS

Several links with national societies and the European Platform for Women Scientists (EPWS) were reinforced during the past two years. In cooperation with Claudine Hermann (EPWS) and Gina Gunaratnam (EPS), a calendar named “Inspiring Physicists”, displaying the winners of the Emmy Noether Distinction and outstanding women figures in science, was widely disseminated in 2020.

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Pillars of Creation

In 2020, NASA's Hubble Space Telescope is celebrating its 30th anniversary in orbit. Its image of the towers of gas and dust in the Eagle Nebula (M16), known as the "Pillars of Creation" is one of the most famous ones. It was made in 1995, but the telescope revisited the Pillars in 2014 revealing a sharper and wider view of the structure in this visible-light image. The new image was taken with Hubble's versatile and sharp-eyed Wide Field Camera 3. The anniversary of the Hubble Telescope will be celebrated throughout the year. Use #Hubble30 on the social media to follow the anniversary activities. Unfortunately, the program will be disturbed by the coronavirus pandemic.

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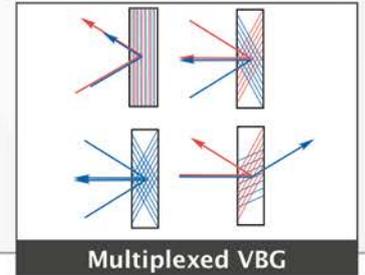
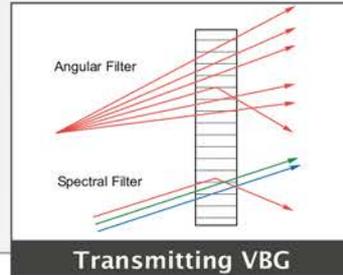
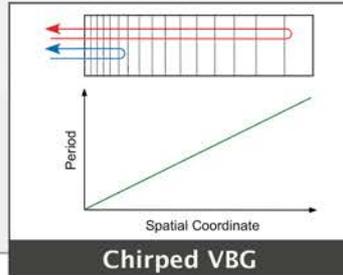
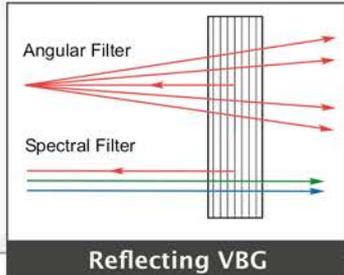
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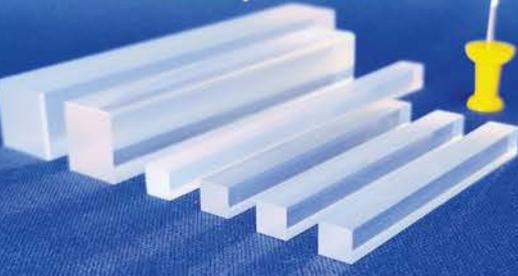
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