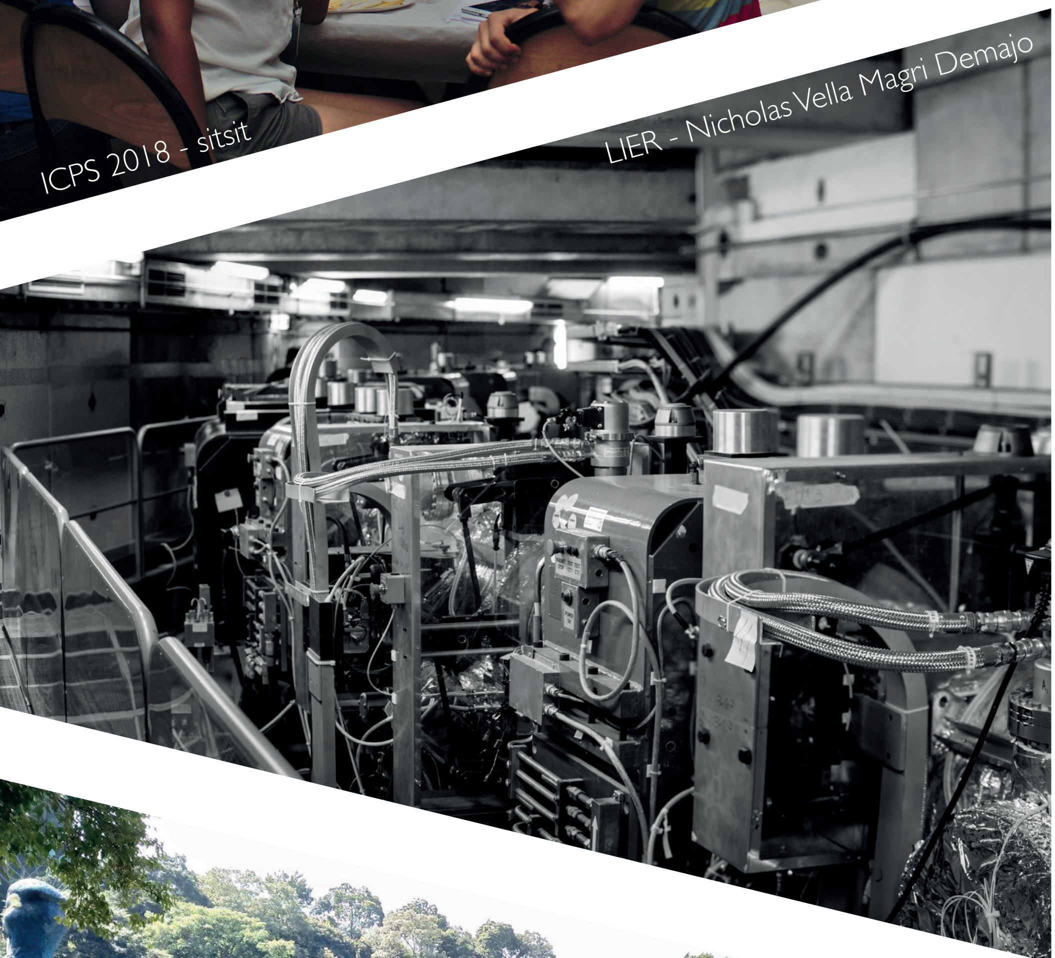

{jIAPS}
2019

ICPS 2018 - sitsit



LIER - Nicholas Vella Magri Demajo

CONTENTS

{jIAPS} 2019

Editor-in-Chief
Hannah Dalgleish
hannah.dalgleish@iaps.info

First distributed
ICPS 2019, Cologne

E-mail
jiaps@iaps.info

Website
www.iaps.info/jiaps
www.jiaps.org

This issue of jIAPS
is dedicated to
Lugy Rivaldo.

Anniversaries

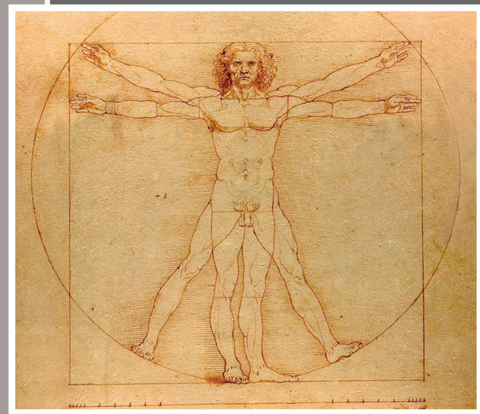
750

Epistola de Magnete, 1558

Petrus Peregrinus de Maricourt's treatise on magnetism

500

Leonardo da Vinci dies

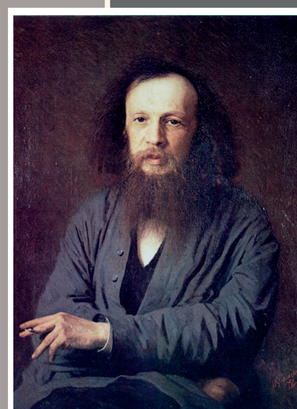


400

Johannes Kepler's third law of motion

150

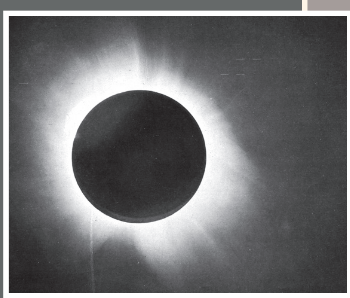
Ivan Kramskoi, 1878



Kramskoy Mendeleev designs the periodic table

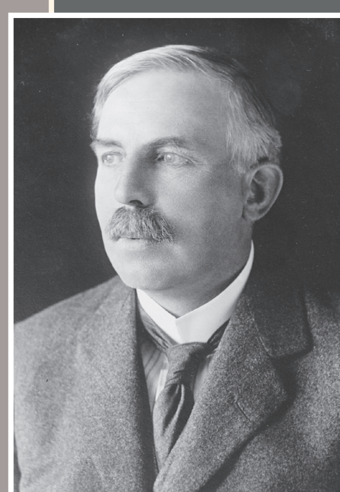
100

Arthur Eddington verifies Einstein's prediction that light bends around the sun



29 May 1919

Ernest Rutherford discovers the proton



50

Neil Armstrong and Buzz Aldrin land on the moon

Aldrin, 1969

Hannah Dalgleish
jIAPS Editor-In-Chief

Wilkommen! It is my absolute pleasure to welcome you to this year's edition of jIAPS. It has been a very exciting year, with many new things in store. Feast your eyes on new articles across a variety of themes, such as outreach, equality and diversity, and the philosophy of physics. You will also find several accounts of the amazing experiences of students who have attended IAPS events all over the world, new and old.

jIAPS 2019 also features the results from the new creative competition, for which we received some stunning and provocative entries. You also made our lives particularly difficult in judging the article competition; there were so many fantastic entries it was almost impossible to decide the winner.

I have thoroughly enjoyed interacting with you all, receiving your ideas and comments via the jIAPS survey at the beginning of the year. We have taken all of your suggestions into account, but let us know if we've missed anything — there is always room for improvement. Please get in touch, whether you have any comments regarding jIAPS or there's anything else you'd like to share, we are always happy to hear from you at jiaps@iaps.info.

If you are reading this at ICPS, have a wonderful time and we look forward to hearing about the rest of your IAPS adventures for the year to come. Now is also a great time to start thinking about getting involved. There are many opportunities with jIAPS, from being the next Editor-in-Chief, to contributing an article, and getting creative! It is not only great for the CV, but a fantastic opportunity to flex your brains in a different way, and think about how your experience of learning physics relates to others.

And last, but definitely not least, enormous thanks are due to both Sofia and Duarte, who have been incredibly helpful and supportive in getting so many new ideas off the ground. Thanks also to the other jIAPS editors and Erik Hörmann for his excellent work in running our new jIAPS social media accounts. Follow us here:

https://facebook.com/jiaps/
https://twitter.com/_jIAPS_

Dear reader, I am also pleased to welcome you to another edition of jIAPS! As with previous years, the sixty-to-seventy-thousand-strong IAPS membership keeps on growing, and by the time of writing, this year we have welcomed new local committees from Kumasi (Ghana), Noida (India), Jambi (Indonesia), St Petersburg (Russia); as well as new national committees from Morocco, and Poland. Hopefully by the time you are reading this, the list will have grown even further! IAPS membership spans across six out of the seven continents, with Antarctica and its research stations providing a fair challenge for recruitment.

The event portfolio similarly spans across a wide range of foci, from the collaborative HistorY and Physics Experience (HYPE), organised together with the International Students of History Association (ISHA), to AstroIAPS, an astronomy focused excursion to the Mexican National Astronomical Observatory. The theme of the 2018 IAPS School Day was particle physics, and you will be able to read about some of the past events on the pages of this journal.

In May, over 30 teams from 17 nations met in Odense, Denmark, to compete in the Physics League Across Numerous Countries for Kick-ass Students (PLANCKS), where a German team proved their knowledge of theoretical physics the strongest. Perhaps fittingly, roughly 400 of you will travel from numerous nations to Cologne this August, to participate in the 34th edition of the IAPS flagship event, the International Conference of Physics Students, where you are likely reading these very words.

To conclude this letter, I want to thank the jIAPS Editor-in-Chief Hannah Dalgleish for skilfully putting together this year's edition, as well as congratulate Mihail Miceski for his winning article of the 2019 jIAPS Article Contest, "The Dynamics of the Love Affair". I encourage you to read his article, as well as the rest of this journal when you have a moment to spare, so that the effort of all the people involved in the making of this journal has not been wasted.

Thank you for being a part of the amazing IAPS community! If you are reading this at ICPS in Cologne, please come and say hello if our paths cross!

Veli-Jussi Haanpää
IAPS President

This year has seen tremendous growth among the membership ranks. Over the past 10 months that the Membership Committee has operated, we have successfully added two National Committees and four Local Committees. By taking our time with each applicant and helping define and build the necessary infrastructure, these committees are set up to be engaged members of the IAPS community. Let's take a moment to highlight these five new committees.

Samuel Borer
IAPS VP + Membership & Alumni Manager

National Committees

Poland

Beginning with the creation of the Polish Association of Physics Students, Poland's existing two Local Committees have found the capacity to merge together. Based in Kraków, Polskie Stowarzyszenie Studentów Fizyki aims to support all the initiatives of its members and local committees. They are planning on organising the annual national conferences, such as the Polish Conference of Physics Scientific Circles OSKNF. They plan on holding their own internal AGM in November, giving the NC leaders a chance to get to know each other and build a fantastic National Committee.

Morocco

Dedicated Moroccan students banded together to form an official Moroccan organisation, the Moroccan Association of Physics (MAP). It is very rare for a National Committee to be born outside of the merging of several Local Committees or the ability to utilise the backbone of a professional physics society - like NC USA uses the America Institute of Physics. MAP has found a way to succeed outside of that paradigm and is working hard to build a solid foundation for their National Committee, hoping to unify the physics students in Morocco.

Local Committees

Noida

India, like several other countries, poses a difficult challenge in forming a National Committee. This makes it particularly fertile ground to build Local Committees around a city that allows for Indian physics students to build a thriving local community among them. LC Noida is a perfect example of this. One of their events, *What if?,* seeks to ask absurd hypothetical questions and then attempt to answer them. They hold documentary and movie screenings, accompanied with a discussion on the themes and ideas presented. Physics students come out for their insane The Scavenger Vortex event, where participants go on a scientific treasure hunt.

Kumasi

Proof that it only takes a few passionate physics students to build a sustainable Local Committee, students from Kumasi, Ghana, were able to form a committee of physics students from their area. Together, they hold physics challenges where they are given a social issue and work to develop solutions. They also hold physics quizzes to challenge the understanding of their members' knowledge and help their members identify areas of strength or improvement.

Jambi

Ikatan Mahasiswa Pendidikan Fisika (IMAPEFSI) applied to take the mantle of representing Jambi, Indonesia on IAPS' international stage. Representing 447 active physics students, they hold huge local events for their physics community. One such event is Physics Star, where they help promote physics and physics education to the surrounding public and try to attract future students to pursue degrees in physics. They also hold a physics Olympiad at the level of international standards to give students an opportunity to test their skills.

Saint Petersburg

2000 students were able to come together to form the first Local Committee in Saint Petersburg. They have a strong focus on professional development for their members, even going so far as to hold career guidance lectures from experts. Understanding the attractive power of history, they also organise lectures on the history of physics and try to use this as a tool to get more people interested in studying physics.

IAPS SPONSORS

EPS

UNESCO
United Nations Educational, Scientific and Cultural Organization

2019 IYPT
International Year of the Periodic Table of Chemical Elements

ICPS: PAST, PRESENT AND FUTURE

The 33rd International Conference for Physics Students (ICPS) brought together 357 students from almost 45 different countries to Helsinki, Finland. The theme this year was particularly potent: changing environments. The topic was difficult to ignore, given that the temperature was above 25 °C for most of the week, when it was expected to be around 15 °C (or less).

We were also in for a special treat, for the International Conference for Physics Alumni (ICPA) was born, an idea that was several years in the making. This meant that anyone who had ever been to ICPS before could return, even if they were no longer a student. ICPA ran alongside ICPS, some events different, others overlapping; in all this proved to be invaluable as the students could meet with the Alumni, network, and discuss future career ideas.

During the welcome ceremony, it was revealed that there was a notable Alumni present, Antti Lauri, who also gave a talk on science communication later in the week. Antti was the Chairman of the last ICPS ever held in Helsinki, in 1999. ICPS has definitely grown a lot since then (~400 versus ~250 students), but it was still amazing to discover that more than 80 volunteers were involved with this year's event (and what a fantastic job they all did!).

A plenary talk on atmospheric particulates given by Professor Markku Kulmala was particularly potent. When asked what can we do as individuals to help prevent global warming he answered: "Consume less; have meetings online instead of travelling; and plant trees," — he himself has planted more than 100,000! A wide range of tours were available at Kumpula ranging from an accelerator laboratory to seismology to meteorology to nanoparticles.

Many expeditions around Helsinki combined with a warm welcom from a Deputy Mayor at City Hall, immediately made us feel at home, with many already thinking about going to study here in the future.

The cultural evening was a night to remember, known as sitsit. It is a traditional Finnish event, where everyone sits down to a meal with plenty of food, drink, and singing. There are many rules which must be abided by, which everyone repeatedly broke. All in all it was a wonderful night, regardless of how terrible we were at singing in Finnish.

The week passed by very quickly. Students presented talks and posters in sessions including astrophysics, quantum phenomena, medical physics, particle physics, and more. Congratulations to the very well-deserved winners of the talks: Alexandre Coates, Valerio Peri, and Biljana Mitreska; and posters: Marko Shuntov, Viola Gelli, Nuno Caçoilo.

Dr Kate Shaw gave an inspirational talk about particle physics and the goings on at CERN, and what future mysteries we face as the scientists of the future. There was also a physics fair, a poster session, a sauna night, the (in)famous national evening (where everyone has the opportunity to taste delicacies from all over the world), excursions (to either the national park, observatory, sea fortress, archipelagos, or the zoo), and an optional trip to Tallinn, Estonia, as an extra day at the end.

By the end of the week we were all exhausted and sad to return home. ICPS 2018 will undoubtedly remain an unforgettable experience for all those who attended.

Hannah Dalgleish
[Edited from an IOP blog, 18th Sept 2018]

The Finnish Summer.
Costume party winner,
Ágica Kis-Tóth from Hungary.

FROM HELSINKI...

…to Cologne…

On August 10th, students will join us for the 34th edition of ICPS! They will explore the region of Cologne and have the chance to meet around 500 enthusiastic physics students from all over the world.

During this jam-packed week, students will hear talks from a total of seven outstanding guest speakers, from the Nobel prize winner Prof. Dr. Klaus von Klitzing to the Director General of ESA, Prof. Dr. Johann-Dietrich Wörner. Participants will learn about a broad range of topics, not only from our prestigious guests, but also from each other. ICPS is a fantastic opportunity for students to practice giving academic talks and poster presentations, putting them in good stead for the future - there will be more than 200 talks and posters! Finally, there is the excursion day, soft skills workshops, and a careers fair, offering everyone a hands on experience with companies and institutes in the region, helping students to make a step forward in their career.

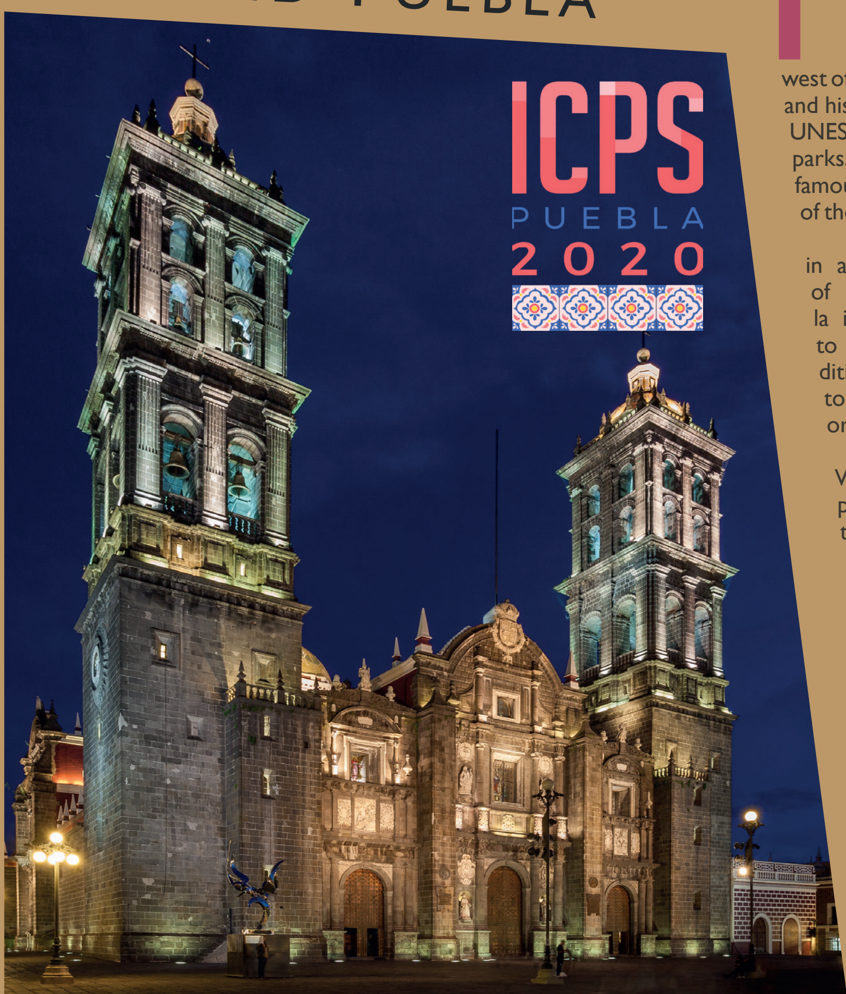
ICPS is also a time for social activities, overflowing with plenty of inspiring discussions with fellow participants. People will experience cultures from across the globe on Nations evening, and get a taste of Germany on a trip to Bonn, Germany's former capital city with a rich scientific and cultural landscape to explore. Participants will also have the chance to discover the Rhineland from the river side during our Conference Dinner on the Rhine.

As Heisenberg already said: "Physik entsteht im Gespräch" or "physics emerges in conversations". This is what IAPS and ICPS are all about: expanding your international network and making new friends.

A huge thank you to all the dedicated students organising and running ICPS voluntarily during the past 2 years - ICPS wouldn't be possible without you! We'll do our very best to make this ICPS a memorable one and we look forward to getting to know you the next few days!

Matthias Dahlmanns & René Hamburger

…and Puebla



For the first time since its conception in 1986, ICPS is leaving Eurasia! Mexico's National Committee, Sociedad Científica Juvenil (The Young Scientists Society), is proud to be the first ICPS host of the Americas. We look forward to welcoming you to your new home next year, in the city of Puebla. Located ~100 km southwest of Mexico City, Puebla has been chosen for its central location, and historical and cultural value. Named a World Heritage site by UNESCO in 1987, the city has plenty of places to see, including parks, museums, over 300 churches and cathedrals, and its world famous cathedral at the center of the city — built by command of the prince Philip II of Spain, it took 72 years to be fully finished.

The OC is working extra hard to offer you a once in a lifetime experience where everyone can get a taste of Mexico (both physically and metaphorically!) Puebla is known for its gastronomical richness, so remember to prepare your stomach (and tongues!) to try our traditional dishes, candies and beverages. Also be prepared to get your hands dirty while making your own pottery or traditional Mexican jewellery during our excursions.

Already excited? Well, in Mexico there's always more! With one of the biggest research centers in Mexico a couple of miles away, we couldn't waste an opportunity to take you on some exciting lab tours. For example, you will have the chance to explore the Large Millimeter Telescope (LMT) and HAWK projects, and interact with some of the collaborators that worked on the recent first image of a black hole. As always, there will be a broad spectrum of physics topics on offer, with a diverse range of guest speakers and workshops. There will be something for everyone, whether you're interested in quantum physics, optics, plasmonics, astrobiology, condensed matter, nuclear physics… and so much more. So gather all your friends and get ready for a full week of physics, fun and a lot of tequila. We'll be waiting for you!

Lamborghini Sotelo
ICPS 2020, Puebla, Mexico
https://scj.org.mx/icps/

Did my heart love till now? Forswear it, sight!
For I ne'er saw true beauty till this night.

FRANK DICKSEE, 1884

JIAPS ARTICLE CONTEST WINNER

The dynamics of the love affair

Mihail Miceski

What is love?

From the earliest of times, wise philosophers have tried to answer this question. Each person, according to their views and opinions, will have a different picture, each stitched from the next. Therefore, it is difficult to find an objective answer to this question.

If we cannot define love, can we find a way to anticipate, describe, or find a connection between feelings and the way people behave? Of course, there are similarities in some people in terms of how they react to love, their feelings toward a person, or the feelings of that person toward them. Here, we will describe a mathematical model to demonstrate a love affair between two love candidates. The model we present is considerably simpler compared to reality, but some interesting results are obtained.

Without a doubt, in the history of literature, Romeo and Juliet are the most famous duo, their tragic history imprinted on our minds. And yet, we will not focus on the tragic death of young lovers, but on how they loved.

This can be portrayed by a mathematical model, consisting of a system of linear equations that describe love or hate between two lovers whose love styles we do not know. We call them Romeo (R) and Juliet (J). The system of differential equations looks like this:

$$\frac{dR}{dt} = aR + bJ \qquad \frac{dJ}{dt} = cR + dJ$$

These two differential equations describe how Romeo's love of Juliet (R) and Juliet's love for Romeo (J) change over time. This is valid because we assume that the love of Romeo/Juliet depends only on his/her own feelings and feelings of the partner. In the above equations, R is a time variable that characterizes the feelings of Romeo to Juliet (and vice versa), and for positive R and J these values signify love, and if they are negative, denote the hatred of one lover towards the other. Consequently, love and hatred are characteristics that intertwine in a love affair. In the equations, 'a' denotes how much Romeo is encouraged by his feelings for Juliet to take on something related to his feelings, while 'b' signifies how he is encouraged by Juliet's feelings to approach her. Accordingly, the 'c' parameter signifies how Juliet is encouraged by Romeo's feelings towards her, and 'd' denotes how much she is encouraged by her feelings for Romeo.

Of these four parameters, four different romantic styles arise. Let's take a closer look at the Romeo style depending on the parameters 'a' and 'b'. The same discussion applies to Juliet, but depends on the parameters 'c' and 'd'.

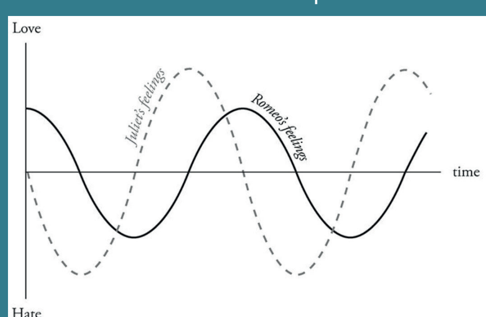
Womanizer (a>0, b>0)
Romeo is encouraged by his feelings for Juliet and Juliet's positive feelings toward him encourage him to approach her.

Complacent (a>0, b<0)
Romeo is moved by his feelings for Julia, but is discouraged by her negative feelings toward him.

Cautious lover (a<0, b>0)
Romeo feels at a loss, but Julia's feelings encourage him.

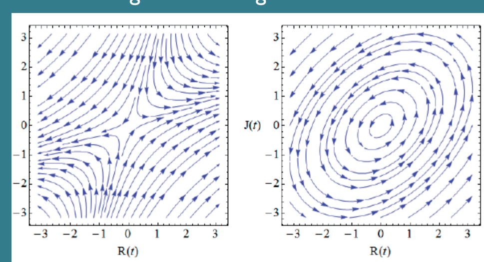
Hermit (a<0, b<0)
Romeo reacts negatively to both his and Juliet's feelings.

Let's now consider some specific cases with



certain parameters. Romeo is in love with Juliet, and she moves away from him when he approaches her. This situation discourages Romeo so that he runs away from Juliet. But then Juliet begins to fall in love with Romeo, so that again he falls for her, encouraged by her affection. We can easily predict that this cycle will be repeated to infinity.

Such a configuration corresponds to the parameters a=d=0, because the love of one depends only on the love of the other. If b>0 and c<0, the dynamics of their romantic behavior can be shown graphically by numerically integrating the differential equation system. If a=0, b=0.8, c=-1.2, and d=0 we get something like this:



Another characteristic case occurs when the lovers have opposite characteristics in relation to the romantic style. This means that c=-b and d=-a:

$$\frac{dR}{dt} = aR + bJ \qquad \frac{dJ}{dt} = -aR - bJ$$

Such a case can end in all combinations of love-hate or in an endless cycle. We realize that the resultant behavior depends largely on the characters of the people entering such relationships, which is described by suitably selected parameters. I hope that this article will spark the reader's interest in nonlinear dynamic systems.

[1] Strogatz, S. H. (1994). Nonlinear dynamics and chaos: With applications to physics, biology, chemistry, and engineering.
[2] Sprott, J. C. (2004). Dynamical models of love, Journal of Nonlinear Dynamics, Psychology and Life Sciences.
[3] Shakespeare, W. (1597). Romeo and Juliet.

My only love sprung from my only hate!
Too early seen unknown, and known too late!
Prodigious birth of love it is to me
That I must love a loathèd enemy

JIAPS ARTICLE CONTEST RUNNER UP

Trampoline physics

Pau Batlle and Adam Teixidó

Jumping on trampolines is both performed by everyone, from young kids wanting to enjoy themselves to Olympic athletes competing for the gold medal. But what happens to the trampoline while it is being jumped on?

Trampolines are physical systems that are relatively easy to model and provide interesting results, and so we will try to simulate a model of a person jumping on a trampoline. A model is a simplified representation of a system that helps us to understand its behavior. First we will describe the model, followed by the results we derive after implementing it computationally.

The trampoline and the action of the jumping person have to be modelled as separate systems. The trampoline is modelled as a rectangular grid where its edges are springs and the vertices are point masses. These masses account for the mass of the trampoline itself. A person standing on the trampoline will provide an external force, causing the masses to move.

In order to find out how someone can alter the trampoline, we need to know how much force they apply while jumping. In [1], the authors monitored the force applied by a person jumping on a rigid surface. Using the data from that article we know the amount of force the person applies to the ground and for how long.

Furthermore, we assumed that the trampoline converts some percentage of the falling speed of the jumper into an upwards speed. As a further simplification, we assume that the person jumping on the trampoline provides the same energy to the system in each jump. Another assumption made is that the force exerted by the person to the trampoline is constant during the time he is touching the trampoline. The jumper is always under the effect of gravity. Finally, the area of effect of the force is considered to be a circle of diameter 25 cm, about the size of a human foot, and the mass of the person is assumed to be 70 kg.

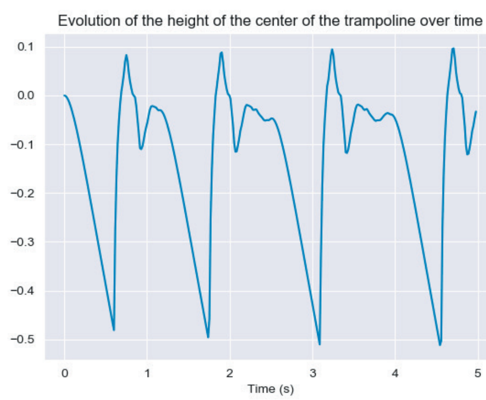
In order to utilise the model, we wrote a Python script to solve the equations and simulate the evolution of the trampoline. We input the parameters of the model (spring constant, mass of the person jumping, etc.) to simulate the system. The script outputs a video of the simulation together with the position of each vertex (i.e. the mass) at all times. Observations of a real trampoline in an amusement park in Barcelona allowed us to estimate the parameters.

Using the program we simulate a person jumping three to four times on a trampoline. Figure 1 shows three frames of the video, at different stages of the jump sequence. You can watch the whole video on Youtube [2]. In (a), the person is about to jump, whereas in (b) and (c) they are in the air. Note the difference between (b) and (c): while the jumper is in the air, the trampoline almost "resets" to its original, flat state after some oscillations. This also happens in reality; see for example [3], video footage of the London 2012 Olympics trampolining event.

The simulations also allow us to track how the height of the centre of the trampoline changes with time (Figure 2), in order to better understand the movement of the trampoline. The graph shows that every jump shows a similar pattern. Additionally, as each jump becomes higher, the time between the jumps also increases, and more oscillations appear in the trampoline. As the jumper lands, these oscillations have almost stopped.

To conclude, we have provided you with an example of the modelling process and its usefulness. Given any reality we want to understand, it is possible to make some assumptions and then create a model. From our example, the model is satisfactory; the simulated trampoline behaves closely to the reality it mimics, even when the assumptions are over-simplistic. Models are a powerful tool by which scientists can have full control of a system and test it under any conditions; the only limitation is the power of the computer and the creativity of the creator's mind.

Figure 2



[1] Linthorne N. P. (2001). Analysis of standing vertical jumps using a force platform. American Journal of Physics 69(11):1198–204.

[2] Batlle P, Teixidó A. (2019). Man jumping on trampoline simulation - ICPS 2019 [online] https://youtu.be/KQKW9O7_tlk

[3] Olympic - Youtube Channel. (2019). Dong Dong Wins Trampoline Gold | London 2012 Olympics. [online] https://www.youtube.com/watch?v=doDA3zT_V-o&t=1012s

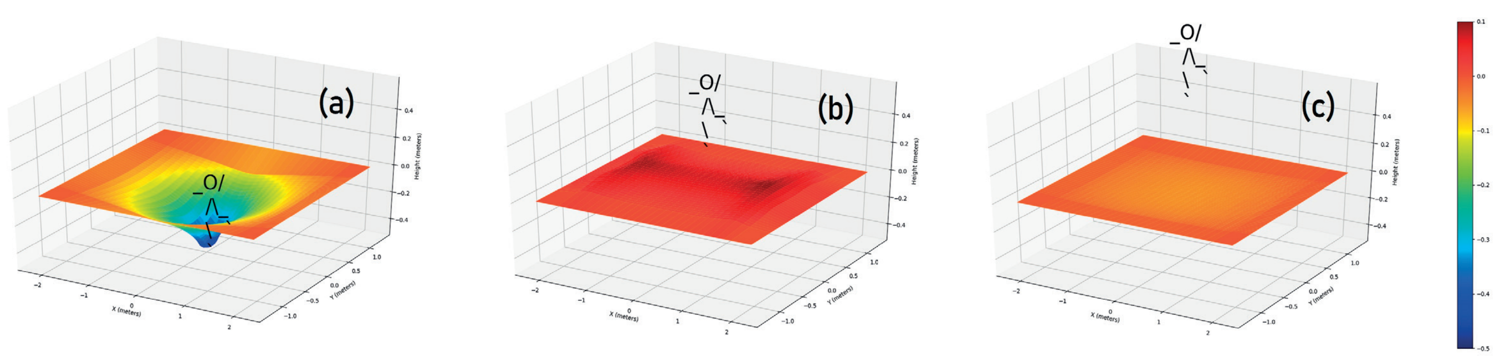


Figure 1

Oh inertia... tell me what you are

Aditya Sengupta

All of us are familiar with Newton's First law of motion, the infamous law of inertia:

> ***The tendency of the particle to remain in a state of rest, or of uniform motion, unless acted upon by an external, unbalanced force.*** [1]

Inertia has a direct correlation with particle mass, also called its inertial mass. But every physics student must have wondered what inertia truly is, in the sense that we have a good idea about the effect it produces but not a descriptive understanding of its mechanism.

This is where quantised inertia (QI) comes in. A fringe theory first proposed in 2007 by Mike McCulloch, QI is based on the concepts of quantum field fluctuations. The theory is otherwise known as the Modified Inertia from a Hubble-scale Casimir effect.

Radiation Origination

Most of us consider a vacuum to be empty space. But in reality, space is filled with quantum fields, each corresponding to the different particles of the standard model. A quantum vacuum exists when all of the quantum fields are in the lowest possible energy state. But even in this state there are subtle fluctuations in the quantum fields, which gives rise to virtual particles i.e. particle and anti-particle pairs that annihilate each other to produce electromagnetic radiation.

If these quantum fluctuations were to occur appreciably close to the event horizon of a black hole, the twin particles would become separated. One gets swallowed by the black hole while the other flies away: Hawking radiation.

The physical interpretation of a horizon is a boundary which separates two regions of space which can't communicate or share information with one another. But imagine a case where quantum fluctuations produced in front of a particle at a horizon are greater than that from the back. The particle would appear to resist acceleration, which we would observe as inertia. This would also be thermodynamically observable, as a phenomenon called Unruh radiation [2].

Beyond the Horizon

This isn't the complete story, however. The (observable) Universe is defined by a cosmic horizon; the distance a particle could have travelled to an observer at the speed of light, since the beginning of time. It is impossible for us to see anything beyond the cosmic horizon — we are faced with an information boundary.

Let's return back to the particle in question, this time located at the cosmic horizon. If the particle accelerates quite slowly, the quantum waves in front of it become very long and damped by the cosmic horizon (i.e. there is inertia). This damping occurs due to a Hubble Scale manifestation of the Casimir Effect, a small attractive force that acts between two close parallel, uncharged conducting plates.

What's the matter with dark matter?

This particular nature of quantised inertia can also provide an explanation of the galaxy rotation anomaly; it can explain why stars far away from the centre of the galaxy don't drift away. Due to their low acceleration, the cosmic horizon could damp the quantum waves, reducing their inertial mass and thus reducing the centrifugal force acting on them. This centrifugal force perfectly balances the inward gravitational pull of the centre of the galaxy. QI can solve the anomaly without introducing the vague concept of dark matter.

QI is so-called, because just like quantised energy, QI provides a minimum value of inertial mass [3]. QI can also predict the effects of many other physical mysteries. For example dark energy (the force causing the Universe to expand); the Pioneer and Flyby anomalies; the Tajmar effect [4]; and the minor acceleration produced in the famous EmDrive (RF Resonant Cavity Thruster) experiments conducted by NASA in 2008 [5].

Despite the theory being able to explain many different phenomena, QI is still considered pseudo-science or fringe theory. In August 2018, DARPA (Defense Advanced Research Projects Agency) announced plans to test quantized inertia with a grant of 1.3 million dollars over a four-year study. Only time will tell if QI can stand up to all it claims to be.

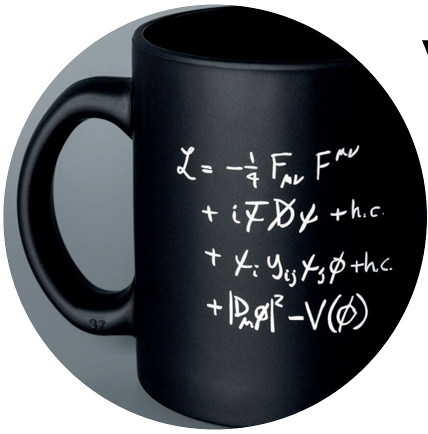
[1] Newton, I., 1687, Philosophiæ Naturalis Principia Mathematica.

[2] Gine and McCulloch, 2016, Inertia from Unruh Tempertatures Modern Physics Letters A. 31, 165107.

[3] McCulloch, M.E., 2010. Minimum accelerations from quantised inertia, EPL, Volume 90, Issue 2.

[4] McCulloch, M.E., 2015. Testing quantised inertia on the emdrive. EPL, Volume 111, Issue 6.

[5] McCulloch, M.E., 2007. Modelling the Pioneer anomaly as modified inertia. MNRAS, Volume 376, Issue 1.



Will we all die because of the Higgs field?

Tamás Álmos Vámi

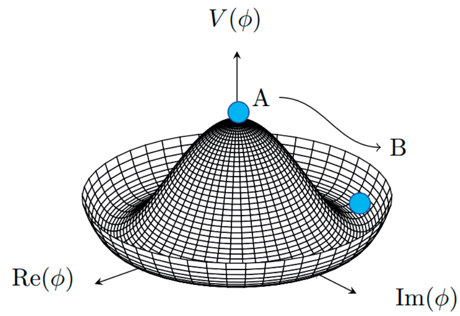


Figure 1

The goal of fundamental physics is to find the main concepts that describe the whole Universe. The state-of-the-art understanding of the world is based on the theory of gravitation, as described in the frame of general relativity, and the Standard Model of particle physics (SM).

The SM is a quantum field theory, that can be written in a concise way on a mug. A field is an abstract quantity that assigns a certain value to every point in space-time, and a quantum field does this in a way that it respects the laws of quantum mechanics and special relativity, too. It is important to note that every particle in the SM is an excitation of their respective quantum field.

How breaking symmetry could be useful

One of the main features of the SM is the Brout-Englert-Higgs mechanism. The mechanism assumes a so-called Higgs field (denoted by ϕ) which, below certain extremely high temperatures, goes through a process called spontaneous symmetry breaking which generates masses for the force carrying particles.

The situation is analogous to a ball on a hilltop. The ball will be unstable and will eventually fall down to the valley. The potential valley of the Higgs field is described by the term $V(\phi)$ in Figure 1 and it has the form

$$V(\phi) = \mu^2|\phi|^2 + \lambda|\phi|$$

where $\mu^2 < 0$ is proportional to the mass of the Higgs boson and $\lambda > 0$ represents self-coupling. This potential is usually referred as the Mexican hat potential (Figure 1).

Status of the Higgs research

The fluctuations in the minimum of this function (Figure 1, point B) lead to a new particle, the Higgs boson, discovered in 2012 by the CMS and ATLAS collaborations at CERN [1,2]. As of now, many properties of the Higgs boson are understood. But the Higgs self-coupling, which determines the shape of the Higgs field potential, is still to be investigated. By studying it one can verify that the Higgs mechanism is truly responsible for giving mass to the force carrying particles and enables us to investigate effects like the stability of our vacuum.

So how stable is our vacuum? It was mentioned earlier that the field wants to be in the minimum energy state. If it is in the global minimum of the function, then the vacuum is stable. But what if the function in Figure 1 continues in such a way that for further ϕ values there is another minimum that has lower energy than the one at point B? This would mean that the Higgs field will want to be in that state! We are certainly in a local minimum of this function, so there has to be a potential barrier to this new minimum. However, how big it is, or if it even exists, we do not know.

What would it mean if the Higgs field gets to this other possible minimum? Well, at the instant this happens there would be a bubble created which expands with the speed of light to rewrite the fundamental parameters of our Universe.

How can we answer these questions?

Luckily, there is a way to study the self-coupling of the Higgs field (and the shape of the potential) and we do not even need to discover any new, heavy particles, we just need to create Higgs pairs. A lot of them!

The challenge is that the processes which create double Higgs bosons are rare. One way is that the colliding protons produce a Higgs boson that splits in two (quantum mechanics allows this); these Higgs bosons decay into particle pairs that are detectable to us (similar to Figure 2).

The good news is that the next upgrade of the Large Hadron Collider, the High Luminosity Large Hadron Collider (HL-LHC), is expected to be a Higgs boson factory, and the study of the double Higgs production is one of the key goals of the program [3], so stay tuned for 2026 — assuming everything goes to plan!

Conclusions

So does the Higgs potential have another minimum? Will the Higgs field spontaneously get to this one? And thus will we all die because of this new state of the Higgs field by a bubble that expands with the speed of light? We have no idea, hopefully the HL-LHC will give us some answers.

[1] ATLAS Collaboration, Observation of a new particle in the search for the Standard Model Higgs boson with the ATLAS detector at the LHC. Phys. Lett. 2012; B716 1

[2] CMS Collaboration, Observation of a new boson at a mass of 125 GeV with the CMS experiment at the LHC. Phys. Lett. 2012; B716 30

[3] Working Group 2 on the Physics of the HL-LHC, Higgs Physics at the HL-LHC and HE-LHC. CERN-LPCC-2018-04. 2019

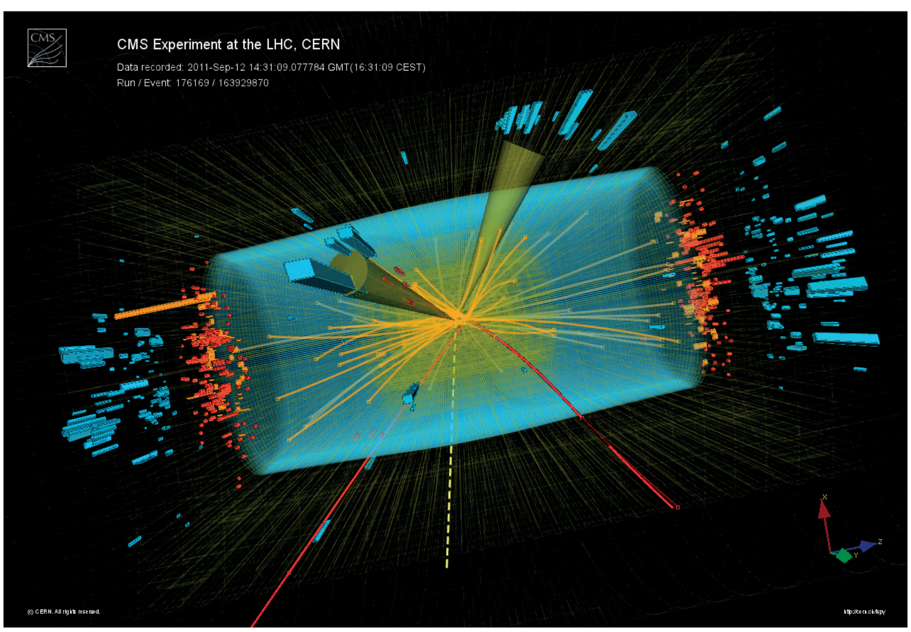


Figure 2

So you want to do a PhD?

Dr. James Kneller

This is a question that gets asked a lot. I started my PhD in Organic Electronics at Queen Mary, University of London four years ago. At the time of writing, I managed to pass my viva a week ago. While it may have worked out in the end for me, a PhD is a trying experience which may not be for everyone. This is why it's important to ask the question, "So you want to do a PhD?"

It's certainly not my intention to put anyone off, a PhD can be a rewarding experience, but it is important to be aware that it will not always go smoothly. There will be ups and downs, just like in life, and it's important to know what you are getting into. This is why every current PhD student will tell you to ask yourself (as only you have the answer) two key questions…

Do you like your project?

This is first and foremost the most important question. You will be spending years of your life on a single topic. If you can't engage with the project you are not going to have a good time. That said there is no such thing as a perfect project, and you are not expected to know the topic of your dreams straight after graduating. Physics is not like the humanities, you are not expected to invent new areas of science right off the bat — so it will be a trade-off over what you like and what's available, but make sure it's in an area you have shown an interest in. By this I don't mean what exam you got the best mark in, but rather the topic you enjoyed learning about the most. There's nothing worse than starting your PhD in condensed matter and after a year realising you'd rather be an astrophysicist!

Do you like your supervisor?

This can be just as important as the first question. You'll be spending a lot of time together and it's important to establish a good working relationship from the start. There are countless horror stories about supervisors who harass their students, to the classic absentee professor who may have a big name but is never there to help. These are two extremes which will likely not be your case, but we all have our own working styles and it's important to find complimentary ones. If you are applying to a new university, I suggest reaching out to current students to gain a real impression. After all, while it is possible to change your supervisor — it can be difficult and may involve starting again in a new field.

During a PhD…

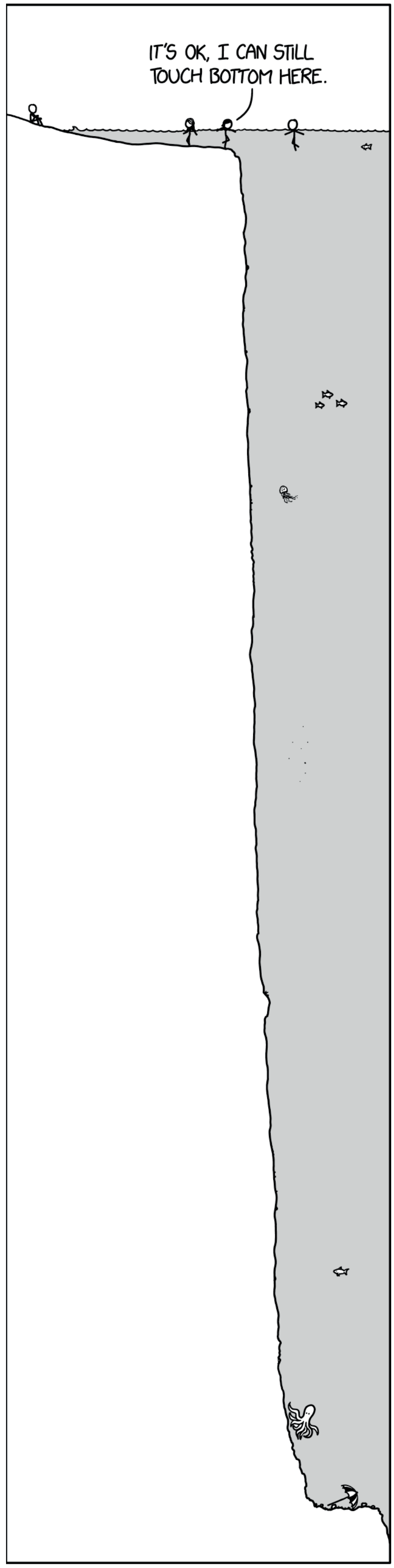
If you are wondering what life is like during a PhD, I always tell people that it's like doing your final year project, but fulltime. If this is something you enjoyed, then go for it! For me, I loved working in a lab and this enthusiasm definitely helped me survive. On average a PhD is 3-4 years, (in the UK the maximum is four), however it'll be down to how much funding you have. You are not expected to be the next Einstein, nor even to achieve any results in your first year — you're still learning! The golden rule is that experiments (or code) never works, which everyone understands.

That said, you are expected to work! Read around, do a literature review etc. There is a point in everyone's PhD where they're not in a good place; depression is surprisingly common amongst PhD students [1] and I haven't met anyone who hasn't experienced impostor syndrome. While these are not good things, it's important to recognise such and not be put off by it — as I can attest to it, it does get better in the end! One way to do this is realise that a good work-life balance is key. For myself it was making time volunteering, joining committees like IAPS and travelling a bit too much — not forgetting the added advantage of many more years of enjoying your favourite conference, ICPS! There are also many opportunities to improve yourself via soft skills workshops and employability training — most PhDs don't end up in academia (this is normal, and does not make you a failure!) after all so keeping the CV up to date is always a handy thing.

If you are reading this and asking is a PhD for you? I can't answer that, but it was for me and in life, I would always recommend going for it to try and see!

[1] Mental health poster, Dr. Zoe Ayres, analyticalsciencenetwork.co.uk/resources

XKCD



I LOVE SWIMMING, BUT OCCASIONALLY I REALIZE I DON'T KNOW HOW DEEP THE WATER UNDER ME IS AND IT FREAKS ME OUT.

The challenges of physics education in Czechia

Karel Kolár

Physics and physics education in the Czech Republic is facing a great challenge — physics is one of the least favourite subjects at schools. In 2005, physics was one of the least favourite subjects, and the situation is not improving [1,2]. A second serious problem is an insufficient number of physics teachers in schools and lecturers at universities, as well as very few students studying physics education. When the average age of physics teachers in Czechia is 51 years old [3], this problem is only going to get worse. Schools are decreasing the number of physics lessons, further worsened by teachers lacking solid physics education. This results in physics students being less prepared for university courses and feeling demotivated.

One possible solution is the promotion of physics and science through various outreach activities. While it is problematic to introduce physics as an attractive school subject, one can appeal to pupils and students in non-formal settings outside of school. This could be in the form of competitions, science shows, science centres, excursions, or camps etc. I have been involved with two different week-long events, which can be a strong motivation for participants to continue their development in physics.

One excellent example is Science Week [4] at the Faculty of Nuclear Sciences and Physical Engineering of Czech Technical University in Prague (Týden vedy na Jaderce). The week is actually in the format of a conference for high school students (or gymnázia; ISCED 3) held once a year in June. Participants arrive on Sunday in time for the opening ceremony, followed by introductory lectures and games. Throughout the week, there are several lectures on how to present scientific work in academia, as well as contemporary science topics. On Monday and Tuesday, the participants work in groups of 2-4 people on one topic which they had chosen. Some groups even have the opportunity to make measurements at the faculty's nuclear reactor or tokamak. They write a short article and present their results during the final part of the conference. There is also one day for excursions and, of course, even a conference reception. Therefore, this event is a tremendous opportunity to experience what it's like to be a scientific researcher in only one week.

Another beautiful example is Week of Applied Physics [5] of FYKOS (The Internet Physics Competition of the Faculty of Mathematics and Physics of Charles University). University students organise this activity for high school students. This week consists of numerous excursions to many exciting places — from car or aeroplane factories to science centres to research faculties. Excursions to CERN was often the primary goal, travelling via Germany, Switzerland and France. In some years, participants stay and visit facilities in Prague and other parts of Czechia. Participants have an excellent opportunity to experience a precious glimpse of why physics is essential, with the chance to meet possible future colleagues. Unfortunately, due to funding limitations, this week is not organised annually.

To get as many more people into physics as possible, it is essential to explore the effects that these outreach activities have on their participants. In general, we find that around half of the students went on to study physics after attending the FYKOS programme. It is never easy to measure the exact impact of such activities as there will always be influences from other activities, school, family, socioeconomic status, gender etc. Also, participants often share their experiences with the organisers; from such testimonies, it can be concluded that this work has meaning to the students, and such activities are worth putting effort into them.

The last idea and call to action: (almost) every physicist should be part of outreach because it is essential to motivate young people for science what is vital for the development of humankind.

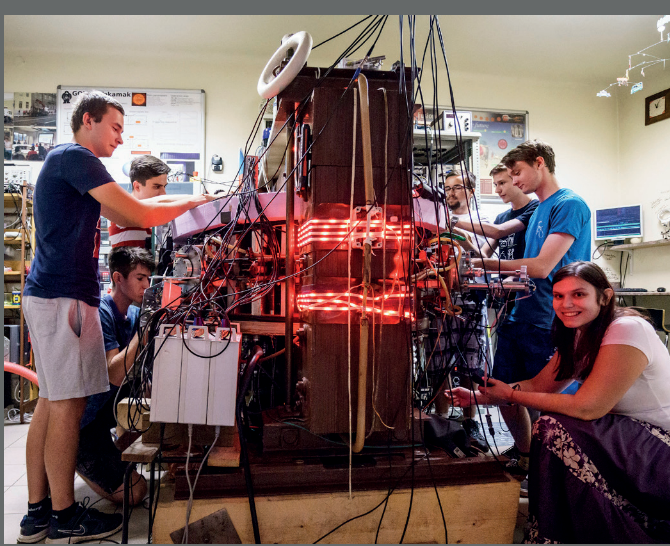
[1] Höfer G, et. al. Výuka fyziky v širších souvislostech - názory žáku: výzkumná zpráva o výsledcích dotazníkového rešení. Plzen: Západoceská univerzita; 2005.

[2] Ceská školní inspekce. Výberové zjišťování výsledku žáku na úrovni 5. a 9. rocníku základních škol ve školním roce 2016/2017 – záverecná zpráva. Praha; 2017.

[3] Maršíková M, Jelen V. Hlavní výstupy z Mimorádného šetrení ke stavu zajištení výuky uciteli v MŠ, ZŠ, SŠ a VOŠ. Available from: http://www.msmt.cz/file/50371 [Accessed 25th May 2019]

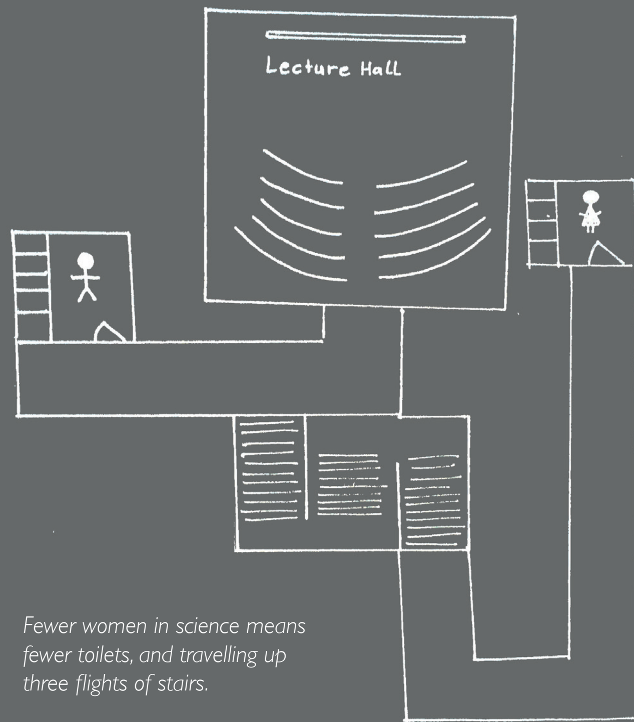
[4] Svoboda V. Týden vedy na Jaderce. Available from: http://tydenvedy.fjfi.cvut.cz/ [Accessed 8th May 2019]

[5] FYKOS. FYKOS' events. Available from: https://fykos.org/events/start [Accessed 8th May 2019]



How toilets relate to equality and diversity

Manuel Längle, Hannah Dalgleish, and Sophie Scharinger



Fewer women in science means fewer toilets, and travelling up three flights of stairs.

Female scientists face discrimination in ways people might not typically imagine: take toilets, for example. The 2016 film Hidden Figures might come to mind, where the protagonist Katherine Johnson — one of the first black women scientists at NASA — had to run a half-mile every time she wanted to use the bathroom. Transgender people have it worse; opponents of transgender equality fight to prevent them from using 'their' toilets, claiming that cis women are in danger of assault or invasion of privacy, despite very poor evidence [1]. At one university in Austria the situation is not as drastic, but only one fourth of loos in the chemistry department cater to women, even though 55% of the chemistry students are female.

At that same very university in the physics department, a mere 30% of students are female, a figure which is often lower in other universities, particularly across the Western world. This situation only becomes more drastic further up the career ladder. In the UK in 2010, only 5.5% of physics professors were female [2]; or 10% in the US in 2014 [3]. Why is this? Is it because men are better at maths and women are scared of equations and experiments? Or perhaps women are drawn to more social subjects because they are simply not made for science? The infamous physicist Alessandro Strumia seems to think it's because women don't like physics and they are less capable [4]. Wait, what's the year again? Right. So what is the reason, really?

For starters, the severe lack of women in physics has nothing to do with ability: on average girls do better at physics A Level than boys [5]. It is also incorrect to state that women don't like physics: how does this explain that 60% of physics undergraduates in Iran are female [4]? Studies have begun to find answers, and unsurprisingly, the reasons are complex and many: women are more likely to leave science due to harassment and bullying [6]; they have to publish more papers than men to be offered the same academic position [7]; and women consistently have less access to key resources and career-advancing experiences compared to men [8]. These are not by all means all the obstacles that women in science face.

What does Diversity mean for Science?

Put simply, if we want to solve the world's biggest problems, we need new ideas and different ways of thinking — and from where do we get this? Diversity. People from different backgrounds have different experiences, and therefore different ways of thinking. Businesses which have a more diverse workforce, for example, have larger profits [9]. Diversity doesn't only mean women, there are also many other disadvantaged groups i.e. ethnic minorities, LGBTIQ+ people, or those from lower socioeconomic backgrounds. But in all honesty, it's not just about maximizing scientific productivity. It's about creating a society where every person has the same chance to contribute to society in whichever way they want to.

So how can we help? The first step is to challenge ourselves and the biases that have been ingrained in us from an early age, known as unconscious bias or implicit association. We are all subject to learned stereotypes that are automatic, unintentional, deeply ingrained, universal, and able to influence our behaviour on a daily basis. It's easy to see where our unconscious biases lie by taking this simple test: https://implicit.harvard.edu/implicit/uk/.

Some of these biases are introduced by companies seeking to make larger profits. From a very young age children are indoctrinated with stereotypes and rules on how they are supposed to act based on their sex: girls like dolls, and boys like trains and trucks and building things. These biases feed into society at large, and academia is no exception.

Also consider the social pressures that women face regarding family obligations [10]. Unconscious bias goes both ways: why shouldn't men be suited for social work or childcare? Imagine if children were expected to be raised equally by both parents, and not only their mother. The minimal (or complete lack of) paternity leave is yet another barrier that stalls the careers of women as opposed to men — so why not offer equal paternity and maternity leave?

We have built a system which discourages women from going into science and we have to change it. Everyone has a responsibility to improve diversity, and it's not just up to the minorities to fight for it. As the scientists of the future, we all have a role to play, to better understand the biases we have ourselves, and to create awareness, so that we may all create a better and more fruitful future together with the best chance of solving humanity's greatest problems. If we can all overcome our biases, then maybe, one day, there will be an equal amount of toilets for everyone.

But there's another solution to the toilet problem. Instead of asking "Why are there more toilets for males?", let us ask "Why are there separate toilets for different sex?". In Scandinavia it is normal to have unisex toilets. Everybody waits in the same line. Transgender people don't have to worry about which bathroom to use; together, we can all enjoy a relaxed ride on our personal throne and put toilet inequality behind us.

[1] Anti-Trans 'Bathroom Bills' Are Based On Lies. Here's The Research To Show It, Brian Barnett, Huffington Post (2018).

[2] Statistical Report: Academic Physics Staff in UK Higher Education Institutions, IOP (2012).

[3] Women in Physics and Astronomy, AIP, 2019

[4] Women in physics: Why there's a problem and how we can solve it, Valerie Jamieson, New Scientist (2018).

[5] Why not physics? A snapshot of girls' uptake at A-level, IOP (2018).

[6] Sexual Harassment of Women: Climate, Culture, and Consequences in Academic Sciences, Engineering, and Medicine. National Academies of Sciences, Engineering, and Medicine (2018). S Washington, DC: The National Academies Press.

[7] Nepotism and sexism in peer-review. Christine Wennerås & Agnes Wold, Nature 387, pages 341–343 (1997).

[8] Women in physics: A tale of limits. Rachel Ivie, Casey Langer Tesfaye, Physics Today 65, 2, 47 (2012).

[9] Why diversity matters. Vivian Hunt, Dennis Layton, Sara Prince, McKinsey&Company (2015).

[10] The 5 Biases Pushing Women Out of STEM. Joan C. Williams, Harvard Business Review (2015).

Science Within Reason

Why a commitment to rationality depends upon people as well as procedures

Megan Anderson

Scientists today struggle to balance their research interests with academic reality. While researchers are excited to understand how the Universe works in all of its mysterious ways, the funding to do so is often severely limited. Furthermore, the pressure to publish deters researchers from pursuing riskier projects which are less likely to generate valuable results instantly.

The tension is not new; financial and societal pressure have always existed within the realm of science. Though the decisions made within science are often accepted as purely rational, it is far more nuanced in practice. Philosophy can be used as a tool to better understand these abstract ideals, and the philosophy of science in particular is valuable for explaining why science is presented as being "reasonable".

While science has traditionally been understood in the context of reason, more recent work has highlighted historical and societal dimensions as well. Imre Lakatos sought to explain science as both entirely reasonable and entirely dependent upon its social context [1]. He made significant progress, yet, as discussed by Paul Feyerabend [2], the theory lacked a rational method for choosing whether or not to continue pursuing research at any given time. Feyerabend's criticism reveals that the scientific method relies on the rationality of scientists, and also implies that people from all walks of life should pursue scientific fields; people from different backgrounds and experiences approach problems in different ways, each contributing value to the discipline as a whole. Thus, the Lakatos-Feyerabend debate explores the limitations of rationality within science and provides context for why inclusivity within scientific fields matters.

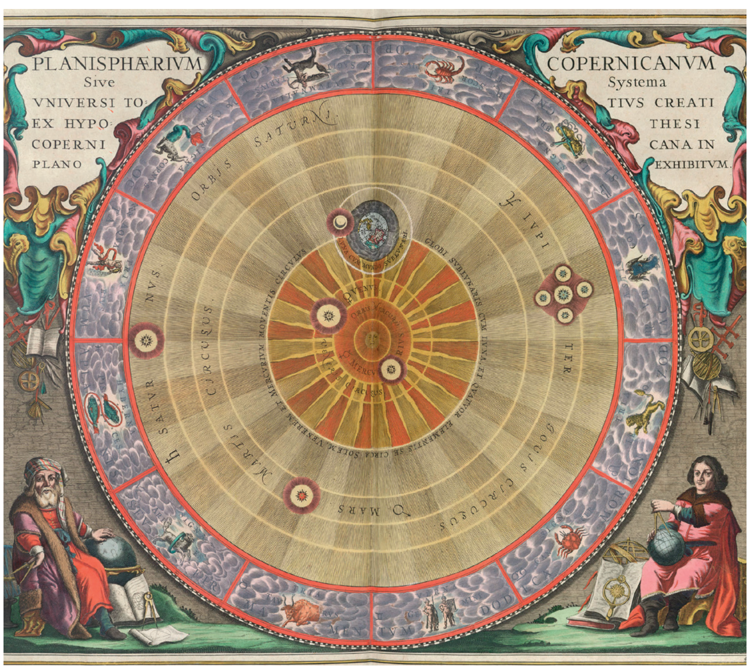
Lakatos described science using the concept of 'research programmes'. He claimed that these are the structures that guide and direct scientific inquiry, and they can generally be viewed as theories. Research programmes affect the questions scientists ask, the experiments they run, and the data interpretations they use. He distinguished between successful and unsuccessful research programmes based on their ability to deal with anomalies. Geocentrism versus heliocentrism, for example, each had serious implications — not only on astronomy but society as well. Geocentrism had been the accepted theory for centuries, but astronomical research in the Renaissance-era found that their data was discrepant with the theory. The conflicting data might first be brushed aside as anomalies, but geocentrism's inability to account for those anomalies eventually proved fatal to its continuation as an active theory [3].

While the distinction between successful and unsuccessful research programmes is relatively simple when made in retrospect, it becomes problematic when made in the middle of the process. Any research may look very promising initially before ultimately failing and vice versa. Furthermore, most research programmes go through phases of success and phases of failure. This creates a challenge for scientists who are forced to take a gamble every time they encounter a hurdle in their research. If the programme is continued, there is a chance that the research will turn out to be unsuccessful, and, vice versa. From another perspective, a false result in science is important, and advances the field with the knowledge that an idea doesn't work.

It might be tempting for Lakatos to advise against continuing research programmes that appear unsuccessful given the larger amount of risk, yet he recognizes that risk is necessary for progress. Many current theories were highly risky in their early days of formulation. When the theory of quantum mechanics was first developed, it postulated the existence of subatomic particles without having the scientific tools for their proof; nevertheless, the scientists continued their studies without experimental data. Now that the research programme has proven successful, the risks were not only justified but laudable.

Therefore, due to risk, Lakatos argued that he could not give advice to scientists. Though Lakatos' conclusion sounds harmless enough, Feyerabend believed that the gap in rational advice indicated a loss of rationality overall [2]. He argued that a lack of rational method for encountering risk meant that any decision made by a scientist could be justified; a scientist cannot predict the outcome of a research programme based on reason. Consequently, Feyerabend argued, "anything goes" within Lakatos' account of scientific inquiry.

Feyerabend's criticism is weakened when compared to scientists today. The educational requirements, training procedures, funding sources, and peer-review processes within disciplines shape the decisions made by scientists and create a standard of professionalism within the field. However, the Lakatos-Feyerabend debate reveals the subjective side of science. While reason can and should be used in research, the production of scientific knowledge depends upon social practices alongside rational procedures, supporting the need for a diverse population to pursue scientific work. As recognized by Lakatos, individual perspectives have power within even the most rational of enterprises. Thus, with greater awareness of what counts as "reasonable," our scientific standards can be maintained even as we expand our scientific community.



ANDREAS CELLARIUS, 1660

[1] Lakatos I. The Methodology of Scientific Research Programmes. Cambridge University Press; 1978.

[2] Lakatos I, Feyerabend P, Motterlini M. For and Against Method. Chicago: University of Chicago Press; 1999.

[3] Zahar E, Lakatos I. Why did Copernicus's research programme supersede Ptolemy's? In: Worrall J, Currie G (eds.) The Methodology of Scientific Research Programmes: Philosophical Papers. [Online] Cambridge: Cambridge University Press; 1978. p. 168–192.

Mafihe-jDPG Exchange October 2018

EDITED BY MAFALDA MATOS

FORSCHUNGSZENTRUM JÜLICH

Twenty degrees centigrade, sunshine. The weather was unexpectedly pleasant during the autumn physics school of the Hungarian (Mafihe) and German (jDPG) student associations held in Aachen last year. We arrived on 4th October, in time for dinner, and as we were only eight participants — half German and half Hungarian — it was easy to get to know one another. Afterwards, we enjoyed the journey back to our hostel via the historical centre, cathedral and city hall, attesting to the famous and extensive history of Aachen.

We spent the first day at the Jülich Research Center, a one hour bus ride away. An opening lecture and campus tour demonstrated the great variety of topics being researched there. From the efficient and safe cleaning of nuclear waste, to the production of algal fuel, to neuroscience and mapping out the human brain; all complemented by an impressively large supercomputer aiding their experimental research.

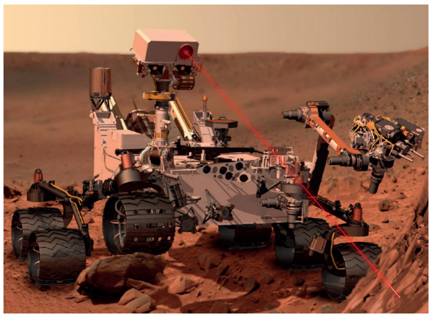
After lunch, we visited the Ernst Ruska-Centre and saw two high-precision electron microscopes. Reaching atomic resolution is a challenging feat; the instruments need to be in a vibration-free environment and specially air-conditioned building. Other non-trivial tasks include testing building materials for the inner surfaces of fusion reactors. Carried out at the Institute of Energy and Climate Research, the reactor has to be heated to millions of degrees to produce the plasma needed for nuclear fusion. At the end of a long but exciting visit, we listened to talks about quantum computation and learned about the most recent advances in the field. Back to Aachen, we recapped the whole day at dinner in a cosy restaurant and looked forward to the program of the next day.

The Fraunhofer Institute for Laser Technology specializes in 3D printing with plastic and metal. Located on the Melaten research campus, we had a nice view overlooking the sheep-run. There they evaluate, in cooperation with the teaching hospital, the use of 3D printed artificial bones and joints. This research allows the components to be personalised to each patient with very little effort. We also learned how such a 3D printer works and in which sections of industry this method is already applied. In the evening, we enjoyed our final dinner together and one of the last warm and sunny evenings in the historical centre of Aachen.

On Sunday, participants had the chance to share their own research; it was a lot of fun discussing physics at student level. Then it was time to bid each other farewell. Four days, eight people, much fun, interesting physics, a great atmosphere and new friends. We are looking forward to the continuation of the exchange program by jDPG and Mafihe in 2019.

Kiel-Odense Exchange 2018

EDITED BY MAFALDA MATOS



NASA

Physics students from Odense (Denmark), Groningen (Netherlands) and Kiel (Germany) held a meet-up in Kiel. Odense and the latter have been meeting for several years, so it is starting to look like a tradition. The SDU (University of Southern Denmark) students joined too, making the trip over in a Nissan — five guys, one car!

Importantly, the visit began with filling our stomachs and caffeinating our blood. Afterwards, we rushed into a talk about Curiosity, the rover which has been in operation on Mars since 2011, and the heaviest vehicle that has ever been on Mars. We learned about one instrument in particular, the Radiation Assessment Detector (RAD), whose job is to characterise the radiation environment found inside the spacecraft during the journey and while on Mars. Prof. Robert Wimmer-Schweingruber took us through the launch of the rocket up until the landing, and explained how we can detect radiation from the ground and the air.

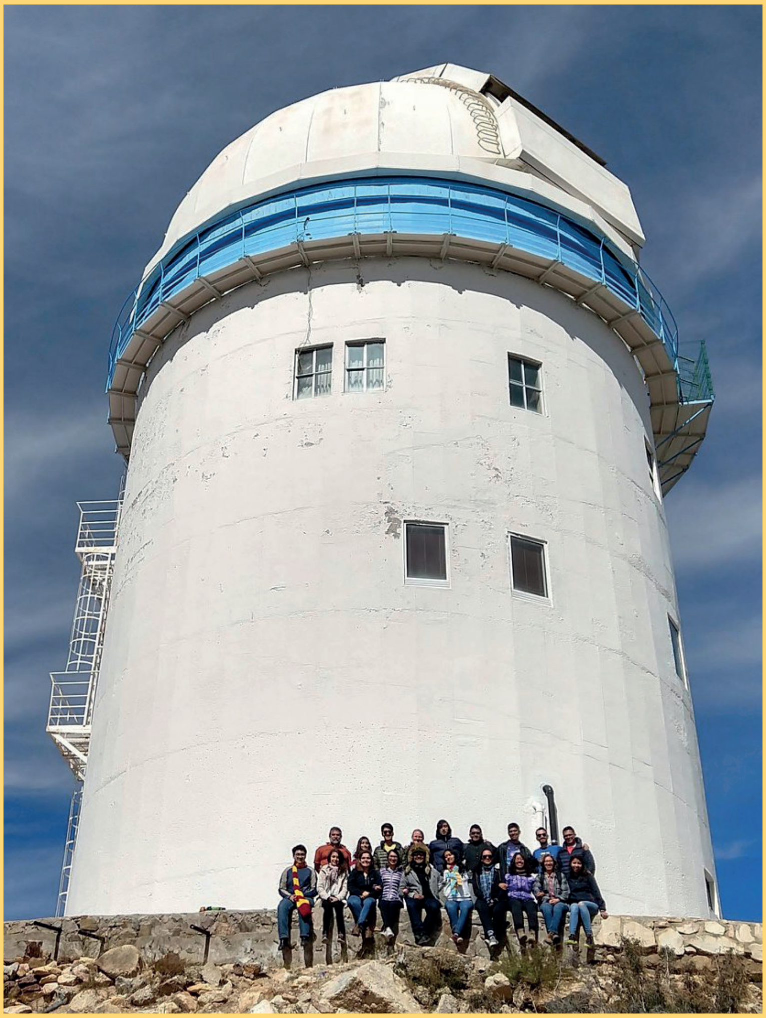
In the evening we enjoyed getting to know one another over snacks, German beer, and a few games of poker. The next day, still a bit sleepy, we saw how plasma behaves under atmospheric pressure, and how this research has helped the industry. Prof. Kai Roßnagel then shared some interesting research related to Röntgen (i.e. X-ray) lasers. He discussed how such lasers can use relativity and how DESY (Deutsches Elektronen-Synchrotron), a particle accelerator in Hamburg, could make a Röntgen laser by accelerating particles close to the speed of light. This laser could for example be used to look at crystal structures with very high resolution.

After lunch, excited as ever, we visited the solar wind laboratory which is still under construction. The lab contains a chamber where artificial solar winds are created in order to test and calibrate equipment before going to space. We also discussed how these sorts of experiments can be financed.

For the rest of the exchange we squeezed in some theory on magnets as well as a trip to Geomar, a marine science centre. A PhD student gave us a tour and shared her research with us and we got to visit an aquarium where we saw some local fish. The day ended with some socialising at the beach with a barbecue and a good swim. We shared music, played in the sand, had a couple of beers and went back to university at sunset. Eventually the meet-up sadly had to come to an end, which we did over brunch, before saying our farewells and making the journey home.

AstroIAPS
October 2018

IAN CASTELLANOS



The night sky has fascinated humanity since humans came to be. On our quest to try to understand the nature of the Universe, we look up and ponder. Shining brightly as points on a black canvas, we created fantasies and myths, tales about brave heroes and maidens in danger. For millennia, we had only our eyes to unravel the mysteries of the sky; our ancestors found patterns and cycles, which helped them to farm the land and navigate the oceans, knowledge passed down generation after generation.

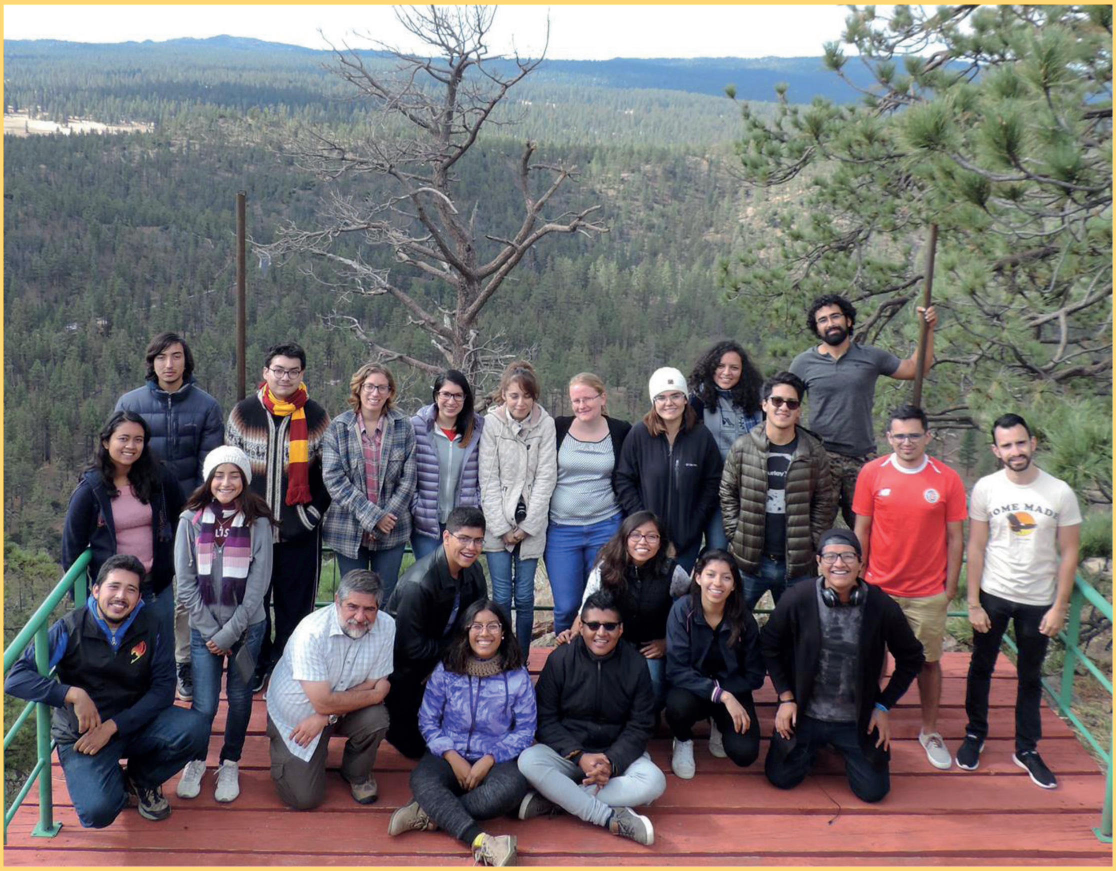
Now things are different. We have telescopes and supercomputers helping us to search for answers to the Universe's greatest secrets. But there's another side to the coin: our significant advances in technology are polluting the darkness of our skies.

Why Ensenada? Why Mexico?

Of the few places where astronomers can still study the night sky, one is located at the south of Ensenada in the mountains of Sierra de San Pedro Mártir (Saint Peter the Martyr). To make the most of the little light pollution, the National Autonomous University of Mexico (UNAM) built the National Astronomical Observatory here, almost 3000 m above sea level, and a perfect setting for AstroIAPS.

Thirteen students from three countries came together for five days to visit Ensenada and the National Astronomical Observatory. They stargazed, had guided tours, and received two lectures: one from an astrophysicist and the other a cosmologist. Back in Ensenada they toured the Center for Scientific Research and Higher Education at Ensenada (CICESE), the Center for Nanosciences and Nanotechnology (CNyN) and, of course, the Institute of Astronomy at UNAM. They were able to learn first-hand from researchers how the instruments work, and their important role in physics, as well as its relevance in the international community.

It was a very unique experience with a positive impact on every one of participants. We will continuously improve this event to ensure those who wish to come to Ensenada can have the best experience this city and its surroundings have to offer.



"We were expecting cold weather at the observatory, and sure did we find cold weather. Throughout the day our whole bodies were shaking; not even the god-like sunshine was able to warm our bones."

"AstroIAPS was a great opportunity to connect young scientists to different institutes and future mentors from around the world, as well as a chance for reflection and self discovery."

Ian Gómez

IAPS School Day
November 2018

ANA ALEXANDRA
SOUSA OLIVEIRA

Physics. What is it? Why should we study it? Even more importantly, why is studying physics awesome?

These were some of the questions the physics and engineering students of PhysikUP at the University of Porto were trying to answer. We had challenged ourselves to participate in the IAPS School Day, an annual event supported by IAPS across the globe. We had the pleasure of sharing our knowledge and excitement for physics with two secondary schools in Portugal: Monserrate Secondary School and Santa Maria Maior Secondary School.

Physics is often misconceived as being boring and difficult. So it was crucial for us to show its good side, and that a future in physics is bright. With physics we can explore and understand the Universe, and develop more efficient technologies. We learn critical thinking and problem solving skills, as well as computer programming, essential for many jobs today. So we decided to share our experiences of studying physics at university, and the opportunities we've had as a result. We also discussed the great variety of fields which are open to physicists, and how there's a very high chance of finding a good and rewarding job.

But what was the theme of the School Day, I hear you ask?

Particle physics!

This is no easy task, however. How can we explain such a complex concept to school children — the world of particles — when our human eyes cannot even see them. We had to find a way to demonstrate how particles work in as engaging a way as possible.

Luckily, we had an answer: CERN, the European Organization for Nuclear Research. Everyone has heard of CERN. With some spontaneous inspiration, we had an ambitious idea to make an accelerator, and with this, the Homemade Accelerator was born.

But first the students needed to get an idea of what particle physics is; we talked about the Standard Model, which elegantly describes the elementary particles of matter and the forces by which they interact, and how it successfully explains almost all experimental results. This was a good way to link to CERN's enormous impact on our progress and understanding of particle physics.

Now with some context, we could move on to the fun part: building a Homemade Accelerator. It was circular, with various coils distributed along the tube, each separated by 10 cm. We put an optic detector next to it, and controlled the circuit with an Arduino UNO R3.

Not everything went according to plan, but that's OK! In science it's important to recognise that we make mistakes and sometimes we fail — it's how we learn. This exemplifies how scientists are creative and motivated, testing new ideas each time a new challenge appears, and continually overcoming those hurdles time after time. That is what being a physicist is about. That is what makes studying physics awesome.

GIPE

ITALIA

November 2018

ELISA GARABELLO

Following the success of the first edition in Hamburg in 2017, it was Italy's turn to host the German Italian Physics Exchange (GIPE). From November 5th-8th, 39 students from the young German Physical Society (jDPG) and the Italian Association of Physics Students (AISF) gathered in Trieste.

Located in the North-East of Italy, Trieste is a city that combines Italian Culture with a European heritage. GIPE aims to foster enthusiasm and curiosity in the young physicists' minds and establishes new networks between German and Italian students. This often leads to exchange opportunities which go beyond this single event.

With the city's unique atmosphere as a beautiful backdrop, the event opened at the Physics Department of University of Trieste, with lectures on Solid State Physics and String Theory. In combination with the home students, there was also a poster session, where participants presented work on various topics, from future particle detector upgrades to the geometry and expansion of the Universe. We ended the first day with a buffet, concluding in a convivial atmosphere.

The following morning, we were welcomed by the International School for Advanced Studies (SISSA). Since 1978, they have been a scientific centre of excellence within the national and international academic scene. After a series of talks, participants engaged in a round table with some researchers, dedicated to what embarking on a PhD entails. We then moved to the International Centre for Theoretical Physics (ICTP), founded by Nobel Laureate Abdus Salam in 1964, with the aim to enhance international cooperation through science. They combine world class research with a global mission of building science capacity in the developing world. In this unique centre, located between the Adriatic sea and Miramare Natural Park, the student talks took place, before leaving the floor to Dr. Scandolo and Dr. Scardicchio, who respectively presented ICTP's peculiar nature and ambitions, and future perspectives on quantum simulation and computation. Dott. Kucharski and Dott. Gebauer, gave an insight on their studies on climate modelling, and on the storage of renewable energy in chemical bonds. Finally we dined at ICTP's canteen, provided also with a piano — a couple of participants delighted us with a little concert.

On Wednesday, we visited the synchrotron ELETTRA, which specialises in generating synchrotron and free electron laser light. This topic applies to many research fields, from materials to medical sciences. We also saw the Trieste Division of the National Institute of Nuclear Physics, before learning about the wide spectrum of career opportunities for a physicist, presented by representatives of the Area Science Park (ASP). ASP perform many activities, including sustaining start-ups - the experience opened our eyes to what the future may hold.

The event culminated in a typical Italian pizza, which lived up to everyone's expectations. The night continued - in similar fashion as every night before - with beer and fine wine in local bars and typical osterie*, recommended by the local students. On our final morning before we left, the Trieste AISF Local Committee guided us around some of the historical beauties that the intense programme schedule and pouring rain of the previous days had prevented us from appreciating.

All considered it was another great edition of the German Italian Exchange Programme, an initiative focused on the importance and advantages of international cooperation; an opportunity to create new and lasting bonds across different nationalities and backgrounds. Everyone left feeling ambitious and enthusiastic — if you are curious to know the next location for the 3rd GIPE in Germany, you need only stay tuned to future IAPS events news.

*An osteria in Italy is a typical informal place serving local wine and simple food specialities, that tend to be cheap.

Lights of Tuscany

April 2019

ELISA GARABELLO & NICOLÒ ANTOLINI

On Thursday, April 11th, the Italian National Institute of Nuclear Physics in Pisa opened its doors to ~40 IAPS members, for the Opening Ceremony of the 3rd edition of Lights of Tuscany (LoT).

One of the most successful international initiatives organized by the Italian Association of Physics Students, LoT focuses on the topics of optics, photonics, atomic physics, and their broad applications in many research fields (e.g. quantum information and biology). Alongside its rich scientific content, the event is characterized by great culture, since LoT is shared between two historical cities, Pisa and Florence, both central stages of Italian Renaissance.

To begin, two lectures on quantum information and THz lasers were given by Dr. Morsch and Dr. Tredicucci, followed by a poster session. Here, some young physicists had the chance to present their works to their peers, with a typical Italian aperitivo in hand.

The morning after, we visited VIRGO, a large interferometer at the centre of the recent discoveries in the field of gravitational waves. This was followed by visits to some of the most advanced research facilities of the territory: the labs of INFN and University of Pisa, the National Enterprise for nanoScience and nanoTechnology (NEST), the National Institute of Optics (INO) and Institute of Biophysics (IBF).

In the evening, AISF (Pisa) treated us to a short night tour, starting from Haring's murals to the famous Leaning tower, disseminated with stops for historical anecdotes and beer in the local pubs. A great opportunity to socialize and say farewell to Pisa, before heading to the historical Nonfinito Palace in Florence.

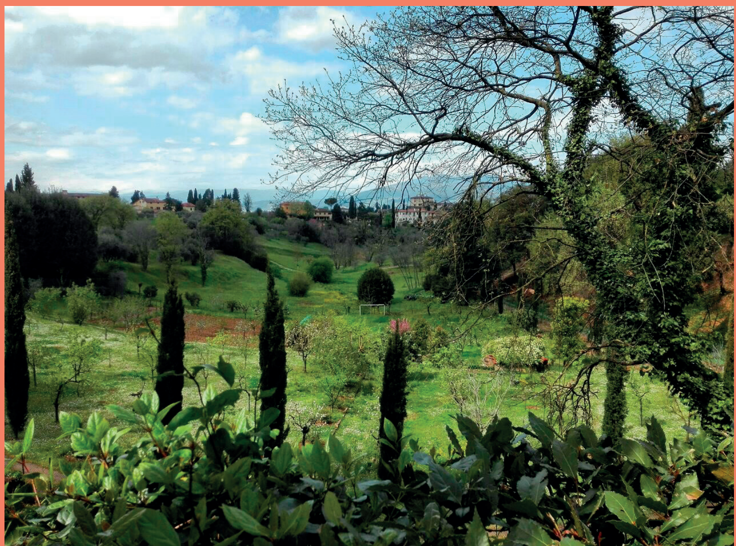
After some student talks, we heard about opportunities for future physicists in the labour market from local companies. We also had the chance to chill out on the hostel terrace, in company of a glass of red wine, followed by walking along Arno and enjoying the Florence night-life.

On Sunday the scientific program went on hiatus, while the day was dedicated to some of the unique beauties that Florence has to offer. We weren't deterred by the unfortunate rain which refused to stop. We toured the city centre in the morning, then visited Villa il Gioiello in the Tuscanian hills, where Galileo Galilei once lived.

Some were less adventurous and sheltered in the Art Gallery of Uffizi, to appreciate the masterpieces by Donatello and Leonardo Da Vinci among others. Later that evening, the protagonist of the social dinner couldn't be anything other than pizza!

Our final day was entirely devoted to lectures and lab tours in the University of Florence and the European Laboratory for Non-linear Spectroscopy (LENS), guided by researchers and volunteers from AISF (Florence). We learned about the research activities carried out in the Institutes and how to get engaged in future projects.

To sum up this whole experience in a few words, from our participant Duarte: "An awesome blend (or, in quantum terms, superposition) of science, culture and socialisation between Physics students!"



iaps2CERN April 2019

MARGARET ROSENBERG

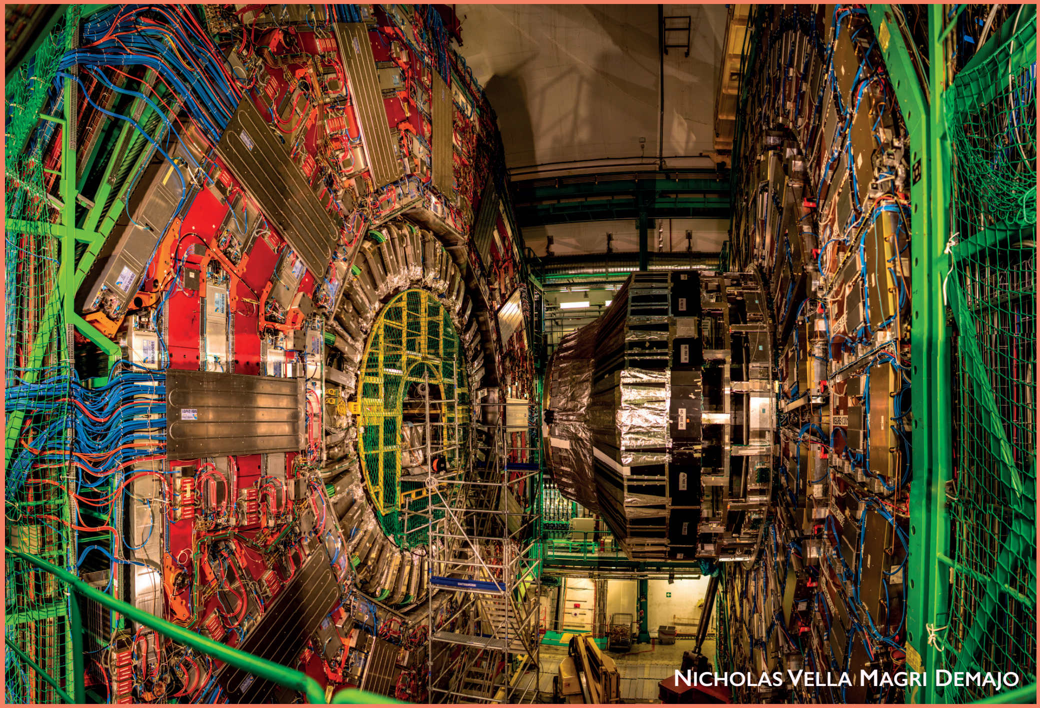
Jyri Eerola

Given CERN's reputation for cutting-edge science, it's not hard to believe that iaps2CERN is one of the oldest {iaps} activities! This year's edition took place from the 24-27th of April.

It kicked off by placing the fascinating sociological scene of 35 physics students from a variety of countries next to the more traditional wildlife dioramas of the Natural History Museum of Geneva. Although the torrential rains cast a bit of a damper on the city tour, most physics students were able to see Geneva's historical center. I say most since our route took us past the Jet d'Eau first, which immediately prompted a subset of participants to try and design a PLANCKS problem around it. That evening, we inhabited the hostel's basement/bomb shelter for a Welcome Night get-together. Unbeknownst to the organiser, the hostel had at some point begun to store old mattresses in the room, which made for excellent couch islands.

We left for CERN bright and early the next day, to pick up our badges and visit the ISOLDE facility. This collaboration is dedicated to studying the properties of atomic nuclei, especially for medical applications in CERN's MEDICIS program. Later, we visited one of CERN's research and development facilities, RD51. As they focus on new techniques for gaseous detectors, we first heard an introductory lecture on the subject, then a tour of the lab containing prototypes to be installed on the next hardware upgrade.

While that concluded the science for the day, next a fascinating dynamic emerged, previously observed but not yet chronicled. First, the main organiser has the unenviable task of announcing that indeed, Nations Evening shall take place after a day filled with a hefty scientific program. The participants lament, coupled with a sudden fear of starvation (despite the high caloric value of most "beverages" brought along). The celebrations start slowly, with shyly scattered, weakly interacting participants, until a sudden frantic burst of cooking transforms the scene into a large, chaotic family reunion serving Norwegian brown cheese alongside Moroccan chicken.



Nicholas Vella Magri Demajo

Getting out of bed the morning after Nations Evening is not always easy, but in this case it was well worth it. Something that's a little hard to describe about CERN is its amazing atmosphere, a captivating enthusiasm that makes you want to attempt things you'd never thought possible. One great way to work at CERN (for physics students) is via the summer student program, which the participants learned about during their visit. We also heard (former) PhD, summer, and technical students at CERN giving short presentations on their path and experiences.

Despite their great presentations, we almost abandoned the speakers halfway through their lunches since we had to rush to iaps2CERN's first-ever tour of the Antimatter Factory, an experience never to be forgotten!

Harkening back to previous editions, we gave students time to explore the Microcosm, Globe and — the unofficial fixed point of the program - the gift shop. After a quick break, we reunited at the Giant Chess and Checkers at Parc de Bastions. Some participants engaged in serious bouts, others came to regret the strategy of replacing pieces with fellow physics students — unlike in Harry Potter, they are not afraid to die, but get mortally offended by being underutilized. Although the upcoming night was a free evening, most of the participants met up to devour Swiss fondue and generously volunteered to help the organizers polish off the remaining party supplies in another basement after party.

On our final morning, the core of our intrepid group continued on to tour the UN building. Since it was a Saturday, we had the building almost to ourselves and could explore at a more leisurely rate, including a (psst don't tell security) chance to view the room-that-shall-not-be-named.

Unfortunately, as always, there comes a time to say our farewells and return to the slog of our daily lives. But thankfully, we have made many new friends from across the world, and we will always have iaps2CERN close to our hearts.

HOLGER RIBERGAARD HEEBØLL
ANDERS FREDERIKSEN

The Physics League Across Numerous Countries for Kickass Students (PLANCKS), was most recently held in Odense, Denmark. 146 students participated from 17 countries. The program was filled with fun social, cultural and scientific events.

The participants arrived Friday, 16th of May, in time for a Welcome Symposium featuring many interesting talks, all live-streamed and available on our Facebook site, "PLANCKS 2019 Odense, Denmark". Everyone particularly enjoyed Colin Wright's talk about the Unexpected Maths of Juggling, including live demonstrations! There were also other talks throughout the week: parallel sessions from local researchers; a talk on the Anomalies of the Standard Model; and even a lecture by the Nobel Laureate, Wolfgang Ketterle, on Bose-Einstein condensates and the weird behaviour of very cold matter.

The competition itself entailed 4 hours of problem solving in teams of 3-4. Questions covered topics from beam splitters to black holes to topological phases, and much, much more. The students were all rewarded with lots of food, and a live band followed by a DJ.

Congratulations to the winning teams:
1st: 4-Vectors (Germany)
2nd: CV5 Irreducibles (Serbia)
3rd: Komfur (Denmark)

Beyond the competition, there was much more fun to be had, from a traditional Danish "fredagsbar" (Friday bar) with beer to a BBQ with roasted pig and other delicious options. There was also a guided tour of Odense city centre, and an opportunity to visit Newtech, a laser sorting company, as well as Albani, a local brewery. The company visits were followed by tours to the Hans Christian Andersen (famous Danish writer of fairy tales) museum.

The PLANCKS 2019 Organising Committee thanks all participants and volunteers for a great event!

JAMES KNELLER

PLANCKS is *the* physics competition of the year; a time for fun with your friends while solving interesting physics questions. As the second biggest IAPS event, PLANCKS has grown beyond just a physics competition into a multi-day symposium complete with guest lectures, cultural visits, social events, and company tours.

In 2020, the next edition of PLANCKS will be held in London, in the new Institute of Physics (IOP) building. It is not only in the city centre but also the new Knowledge Quarter, next-door to the Google, DeepMind and Youtube headquarters (which we'll hopefully get to visit). Even better, it will be the IOP's 100th anniversary, and they are especially proud to host us — they are all hands-on deck to make this the best competition yet!

While PLANCKS has grown beyond its roots, the competition itself is still at the heart of the event. The UK question panel is comprised by a core base of professors who are known for producing not only hard questions to answer, but also interesting ones; while a challenge is a good thing, fun physics trumps all. So save the date (May 7th - 10th 2020) and join us at the 8th PLANCKS competition.

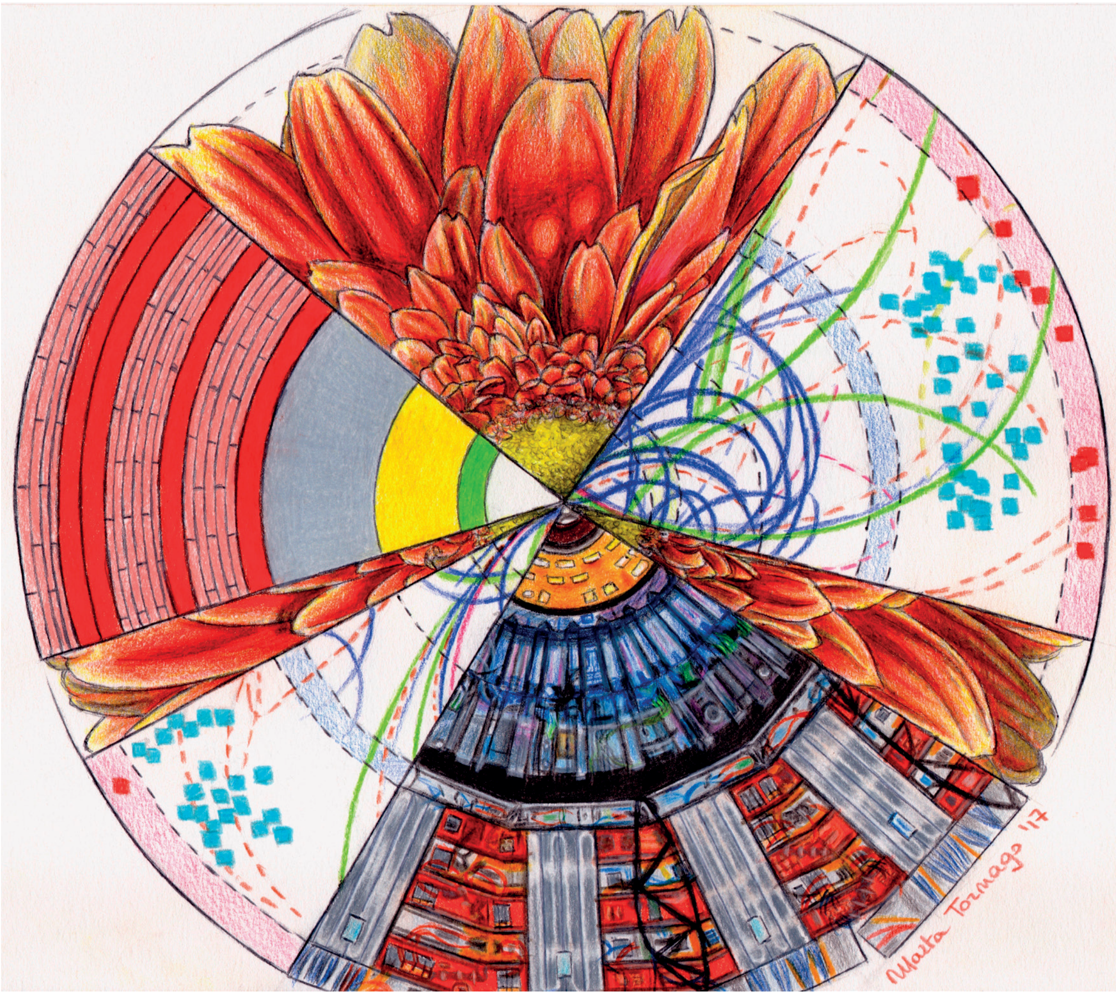
We'd also like to increase the number of national preliminary competitions taking place around the globe. What is a preliminary you ask? Well, it is a mini-PLANCKS which takes place within your own country. For the past two years, the UK preliminary has thrived with over 20 teams, but most prelims are smaller affairs. Some countries have 2-3 teams, some incorporate it within their national conference, while others hold it remotely at different universities. Preliminaries can take many forms, and we invite you to organise one yourself. Any country can easily host one, even if it's over a pint at your local pub.

To find out which format works best for you, we are planning a series of online workshops introducing all the organisational information you might need to get your country preliminary off the ground. These will be held during the first week of September, November and January. Just remember, the more preliminaries there are then the more questions there are to share! A key part of PLANCKS is linking the preliminaries together, and the UK is currently working on a new system which aims to do this. This has the added benefit of sharing the workload between the countries, making it easier for everyone. The UK preliminary will be held in mid-February and all are welcome to organise their preliminaries at the same time.

If you are reading this article and you are not sure if your country has a preliminary, then why not make your own? Contact me james.kneller@iaps.info if you wish to bring the greatness of PLANCKS to your hometown!

Bunches of Flowers - or Particles?

Marta Tornago



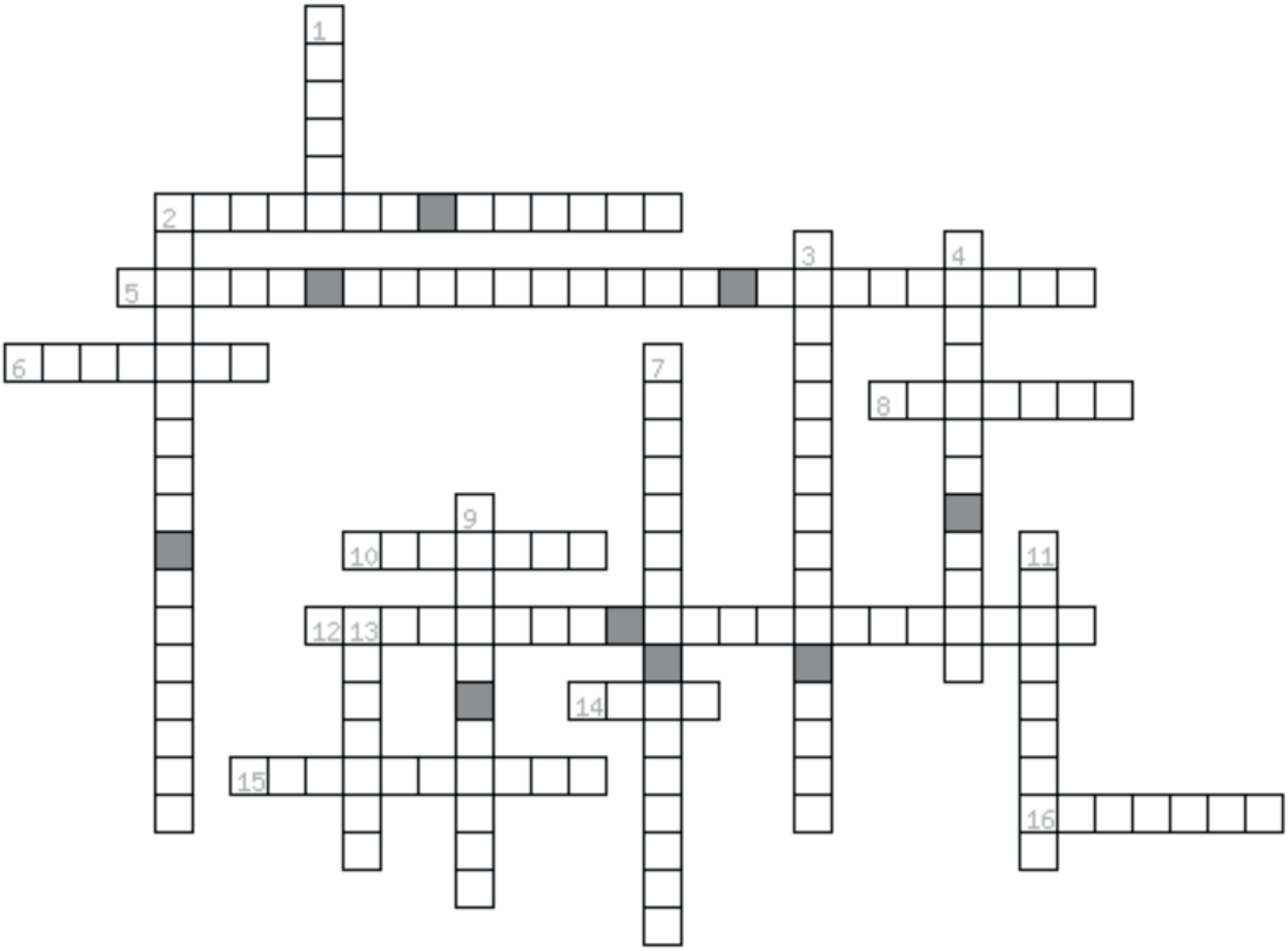
When a professor from the CMS Collaboration described the products of a bunch crossing at LHC like a blossoming flower, I was inspired to draw a disk in which a flower, an event display and the CMS sections are all together, with the aim to convey the wonders of Particle Physics.

Aurora Borealis

Nicholas Vella Magri Demajo

Created with 3D software and rendered in Arnold, I was inspired to bring some surrealism to this image. I added fog and mysterious elements into the scene to create a different perspective to what we usually see.

ANNA SZMALENBERG



DOWN

1. Romantic style // if converted into an adjective, describes operator in quantum mechanics.
2. All quantum fields in the lowest possible energy state.
3. How to model a trampoline as a physical system.
4. Event aimed at encouraging and familiarising school kids with physics.
7. IAPS Schools Day 2018 theme.
9. Standard Model Particle discovered by CMS and ATLAS collaborations.
11. IAPS event for astrophiles.
13. Röntgen laser location.

ACROSS

2. Theory based on quantum field fluctuations which can do away with the problem of dark matter.
5. ICPS 2020 astronomy excursion.
6. Science described via the concept of "research programmes".
8. ICPS 2018 location.
10. Two regions of space which cannot communicate or share information with each other.
12. ICPS 2018 theme.
14. Acronym for the best physics conference in the world.
15. Institute for Laser Technology specialising in 3D printing.
16. Annual physics-related competition organised by IAPS.