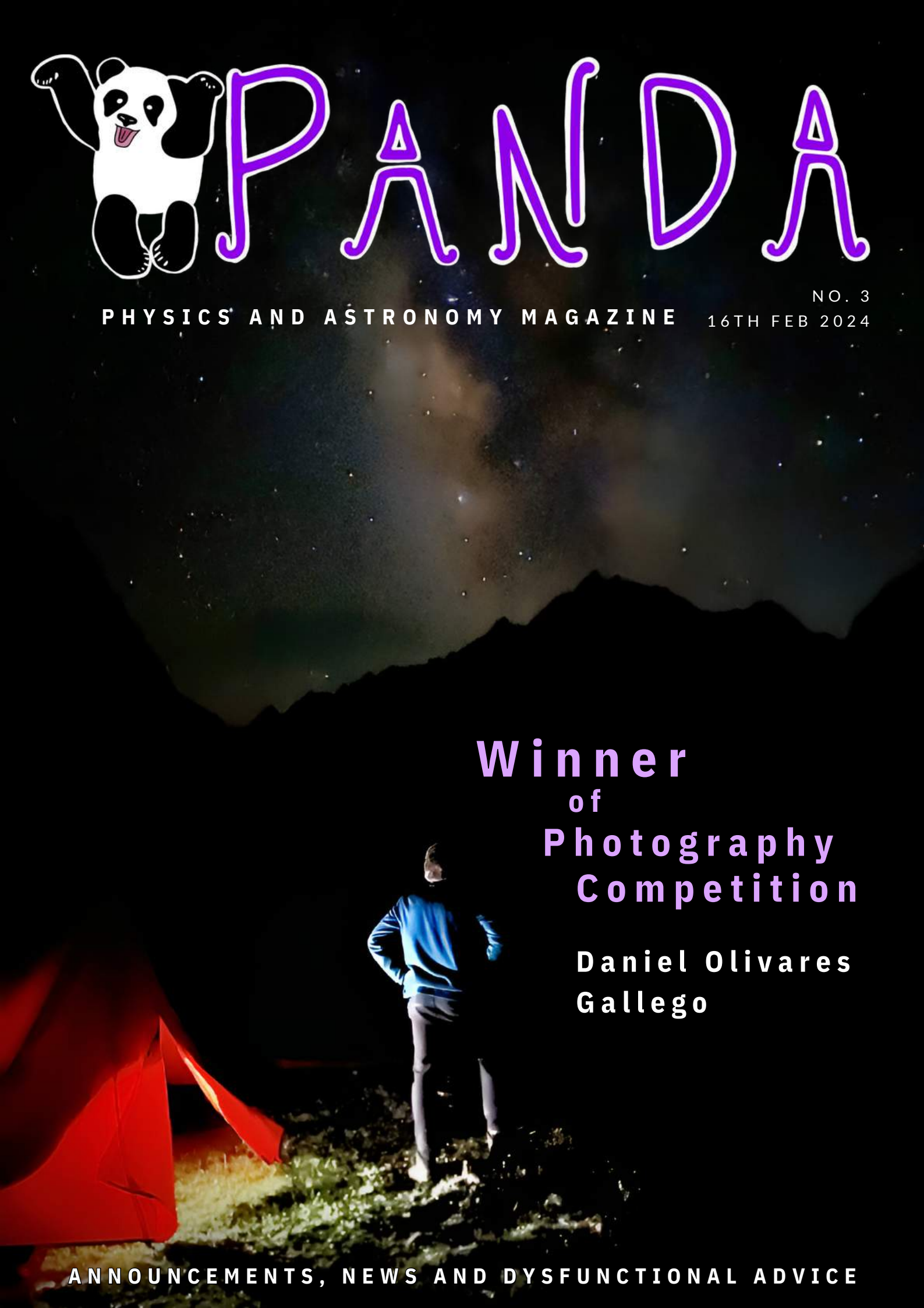
PANDA

PHYSICS AND ASTRONOMY MAGAZINE

NO. 3
16TH FEB 2024



Winner of Photography Competition

Daniel Olivares Gallego

ANNOUNCEMENTS, NEWS AND DYSFUNCTIONAL ADVICE

Dear Reader,

A new semester has come, the wheel has turned and the PANDA magazine has reemerged from a state of three-year hibernation*! With a collection of breathtaking photos, unique articles, insightful interviews, and amazing poetry, this issue is late to come but long to last! Excitingly, this will also be the first edition to exist both digitally and in print.

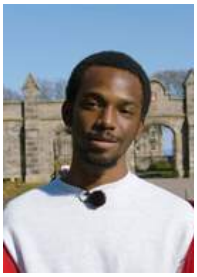
Do you want to find out how one of General Relativity's biggest contenders was both supported and cast into doubt within our very own department? Learn about students' perspectives on gender inequality in Physics? Get to appreciate the spike in the solar cycle through poems about the Aurora Borealis? Read on! From recent scientific news to memes, we have something for everyone.

With that, we'll let you turn the page, and we hope that you'll enjoy reading the magazine as much as we loved crafting it.

Welcome to issue 3!

The PANDA Magazine Team

Samuel Allen



Joel Beckles

Rosie Gittings

Muse Mekonnen

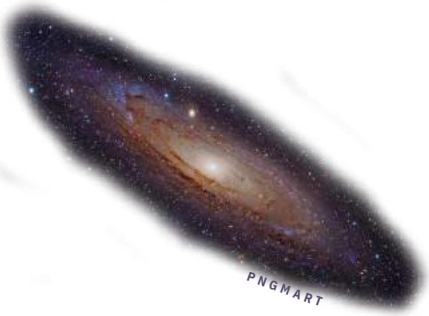
Celine Parro Ricci

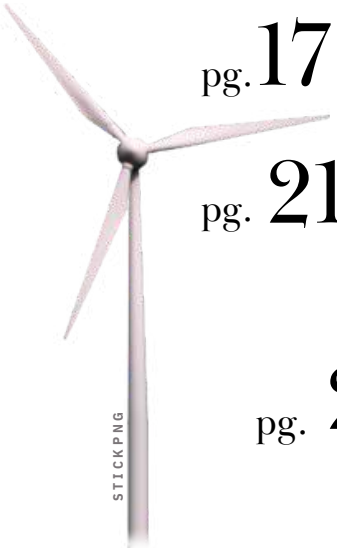
Niya Petkova

Owain Thorp

*Yes, we know. For the biologists out there, real pandas don't hibernate, but this is no ordinary PANDA.

Contents





Put a Face

Prof Ian Bonnell

Head of the School of Physics and Astronomy

Here are some names and faces of people you're likely to see in the School of Physics and Astronomy (some of whom you might only know by email). Those pictured here, however, only form a fraction of the list of important roles within our School.

Prof Jonathan Keeling

Deputy Head of School of Physics and Astronomy

Anna Conti

School President of Physics and Astronomy

PHOTOS TAKEN BY CELINE PARRO RICCI

to the Name

Dr Janet Lovett

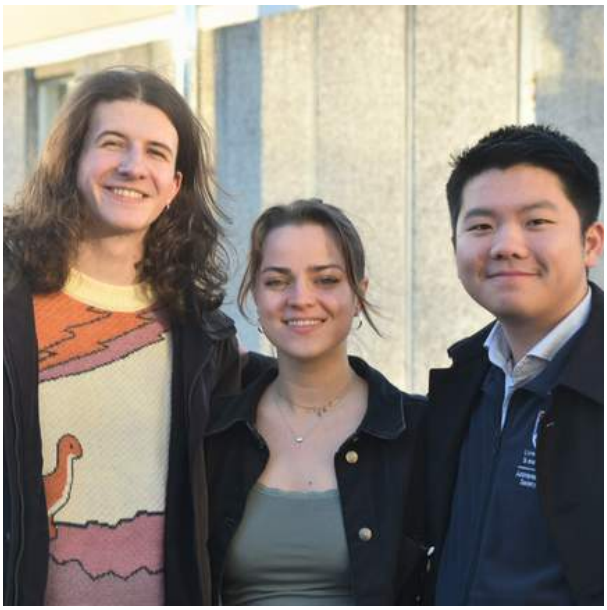
Director of EDI

Dr Sebastian Schulz

Wellbeing Officer

Mrs Linda Cousins

Secretary



Rory Brown (left)

President of EASy

Lilla Barta (middle)

President of Physoc

Supakorn Nikko Juengsophonvitavas

President of Astrosoc

Poetry Competi

PHOTO FROM THE PHOTOGRAPHY COMPETITION BY: SUPAKORN NIKKO JUENGSOPHONVITAVAS

Dawn

BY: ANONYMOUS

We set out to find St Andrews' finest poets to craft verses that capture the essence of the Aurora Borealis.

tion Winners

I knew a lad with fireworks in his eyes:
the fairest shades of pink and blue and green
this world had seen. Like northrin, star-split skies
they'd gleam, and dance, and whisper worlds unseen.

Through icy space, through forests black, they'd catch
a wand'rers glance, and draw like fishhooks in
his drifting gaze, then spark like steel to match
raw wonderment and send his Soul a-spin.

Through rainbow drapes and dancing light you'd fall
still stood stock still, and frozen fast you'd sink
as into bogs, as into snow; he'd call
you in, enrobed in eye-bright, dazzling wink.

By day, mellow and morose, each iris
scarcely glittered. Sun-faded, soft as sands
were sleep littered; they flicked their dark eyelids
and through the waking hours gave no command.

Yet on the gloam, as streetlights stole the roads
like solar flares, like plasma globes, like God's
descending grasp: his eyes awoke and glowed
in gasps of truth; struck sharp as lightning rods

and seized my heart: that angel's pulse in flame
to burn away my reason, my knowledge
of all earthly words, and each mortal name
had no meaning, no dark matter, no edge.

Had I felt since, my skin no chiller than
those nights, by his eye-lights, bare to cosmic
winds lifting my heavy chin: Him, the man
who washed this moon-white skin in colours thick—

who sang of comets through his humming silence;
who burst the black to iridescent light;
whose eyes burned with supernovic violence;
who sent this fledgling spirit's form a-flight—

had I then known the quiet dawn that comes
in hallowed dreams, in struggling lids, in lead
ripples of sheet soft sleeping fingers strum
till waking, in cold snow; his eye-light fled—

had I then known the madness of the morn
that followed those nights of firework displays,
I would have closed my eyes, and blinded, scorn
those taunting lights: and not be left these greys.

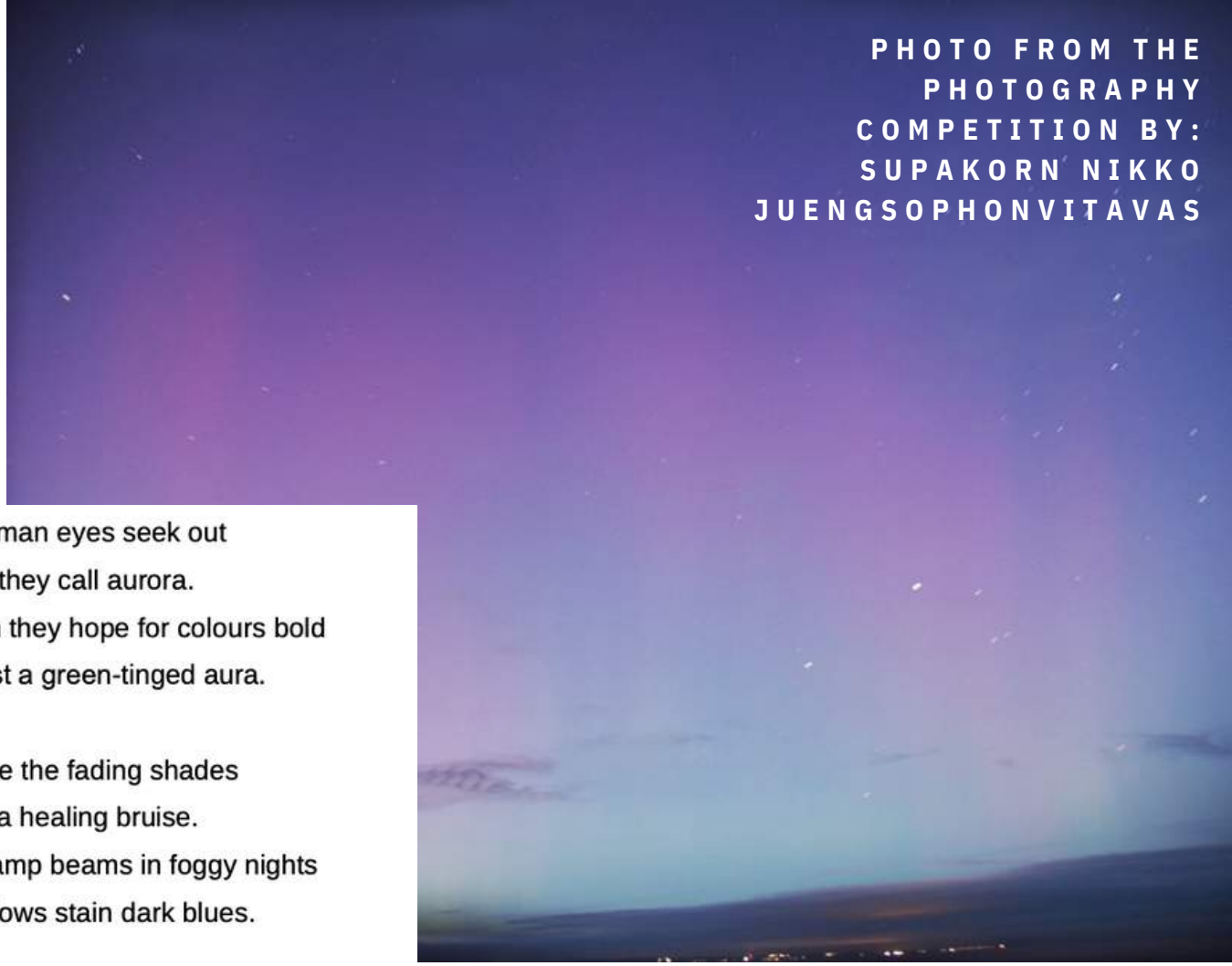


PHOTO FROM THE PHOTOGRAPHY COMPETITION BY: SUPAKORN NIKKO JUENGSOPHONVITAVAS

Hungry human eyes seek out
That thing they call aurora.
But though they hope for colours bold
There's just a green-tinged aura.

An aura like the fading shades
Which tint a healing bruise.
Or street lamp beams in foggy nights
Where yellows stain dark blues.

In truth, you wouldn't know it's there
Without an oblong screen.
Just like the one you're looking through
It turns the beams bright green.

Through it, you see the fleshy sky
With pink and lilac skin.
Where freckled stars are shining bright
A moony mole within.

Who knew the universe could shine
Through things we hold in hands?
A bridge to let us touch the sky
While feet remain on land.

And so, although it's hard to find
Those colours in the air.
I've seen how they bring light to dark
I know they're always there.

BY: MIRIAM KENNEDY

PHOTO FROM THE PHOTOGRAPHY COMPETITION BY: SOUMYABRATA BANIK

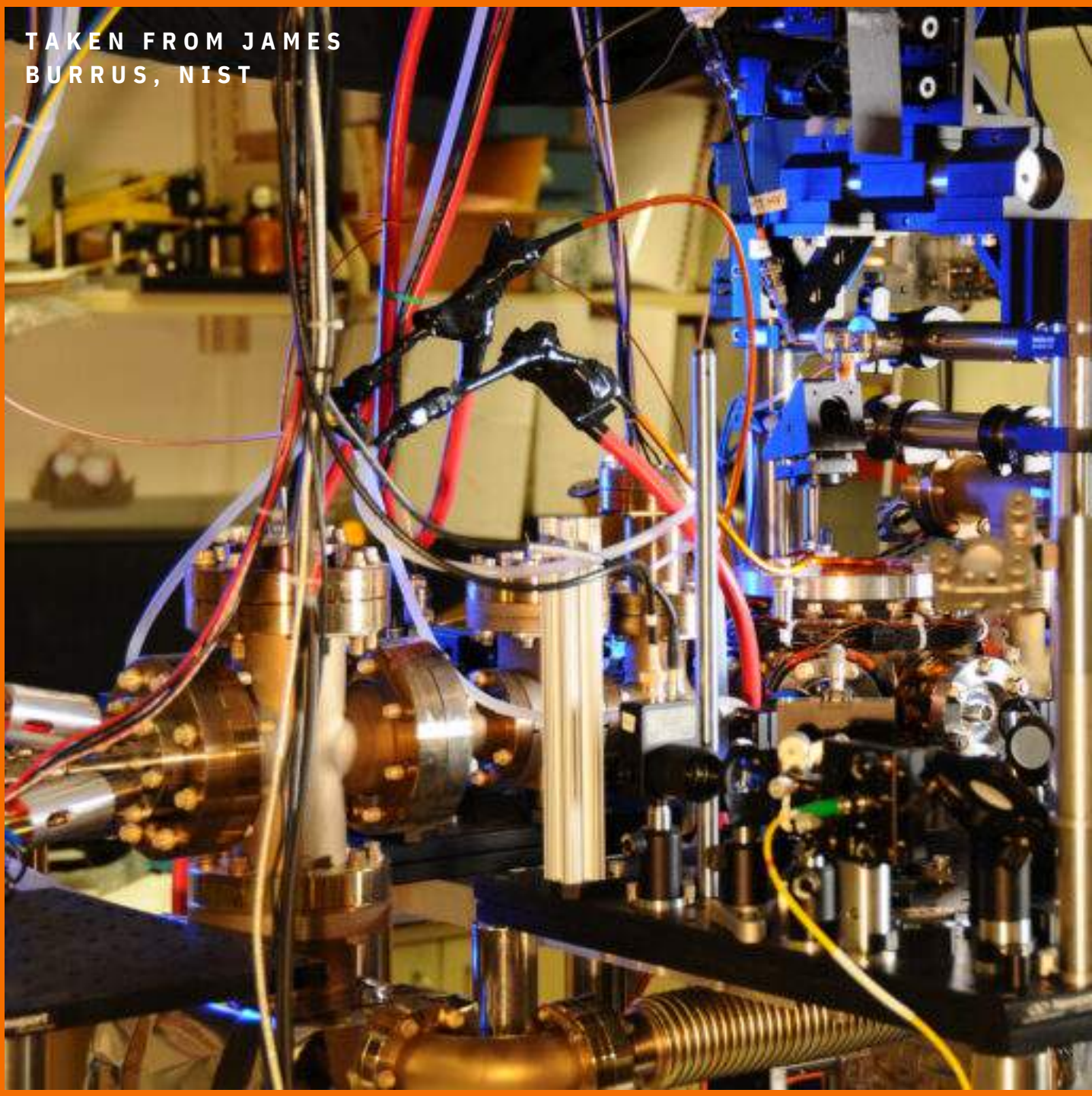
The sky is splitting open. Its blood is spilling out
And staining red and green its loose bandages made from clouds,
The sea is screaming, begging for a visitor tonight,
But the water is invisible,
The same shade of black as the sky,
It would be just as hard for one to swim as for to fly,
Because the waves above our heads are more than fifty times as

The crowd all gasp in pain but tell the others that it's glee,
They know that what they're working for is everything they see,
The misty curtain falls away, revealing what they fear,
That art can't be made by design,
That while the way they are is fine,
They'll never be the ones who get things right,
And by the time they're back at work the lights will disappear.

BY:
ANONYMOUS

The city in the background looks like something from a dream,
We travel there in sleep. All these moments in between
Are our real waking hours when the sky is drenched in blood,
The horizon is a razor's edge
Which separates the mind from flesh,
Every second spent on this beach is spent drowning,
Because our mouths are hanging open for the gently twinkling flood.

The radiation's gossamer; The sand beneath is leather,
The fabric fades, but not the heaps of dust, which last forever,
All the clocks go backwards while we look the other way,
When we return, no time has passed,
And nothing of tonight will last,
Nobody a year from now will remember
The seven hundredth time that we all talked about the weather.



TAKEN FROM JAMES BURRUS, NIST

On Large and High

Numbers Frequencies

BY NIYA PETKOVA

It's the all-familiar story again: at the heart of human and panda civilization, a clock ticks away the fabric of spacetime and paces the world. We've seen it happen in antique shops, movies, bamboo forests and childhood memories, the only difference being that now the clock runs 9 billion times faster. [1] Instead of a pendulum and an old rusty dial, the machine lies in a tangle of optical fibres and is surrounded by the soothing buzz of high-tech equipment. The device that has been evolving for centuries on end has now become so accurate that it was recently utilised to test the predictions of string theory.

The high frequency of atomic clocks is not only perfect for setting the universal time standards but can also give us a peek at the world of ultralight bosonic dark matter. The proposed particles have a mass of less than 1 eV/c2, which corresponds to a de Broglie wavelength that could cover up a whole planet. [2]

But surely, if such bosons truly exist, they must intervene with the world around us?

Indeed, one of the predictions of string theory is that the interactions between ultralight dark matter and particles from the Standard Model should lead to changes in some fundamental constants such as the fine-structure constant, [2] a prospect that would have made Paul Dirac incredibly happy. Over 80 years ago, the English physicist noticed a curious similarity between the age of the Universe and the ratio of gravitational and electrostatic forces between elementary particles. This relationship led to his Large Number Hypothesis (LNH): the idea that physical constants should slightly evolve as the Universe grows older. [3] Unfortunately for him and many string theorists, such shifts have never been observed, and recent searches with hypersensitive atomic clocks that can measure changes in the fine-structure constant to a great precision have come to no avail. [2]

TAKEN FROM ESA/HUBBLE & NASA, A. RIESS ET AL.

The *Death* of *MOND*?

BY JOEL BECKLES, WITH EXTENSIVE COMMENTARY PROVIDED **BY DR. INDRANIL BANIK**

A recent publication [1] in the Monthly Notices of the Royal Astronomical Society (MNRAS) featuring authors from the University of St Andrews has sent shockwaves through the astronomical community. One of General Relativity's contenders for the theory of gravity, **Milgromian Dynamics**, has suffered a massive, and possibly decisive, blow.

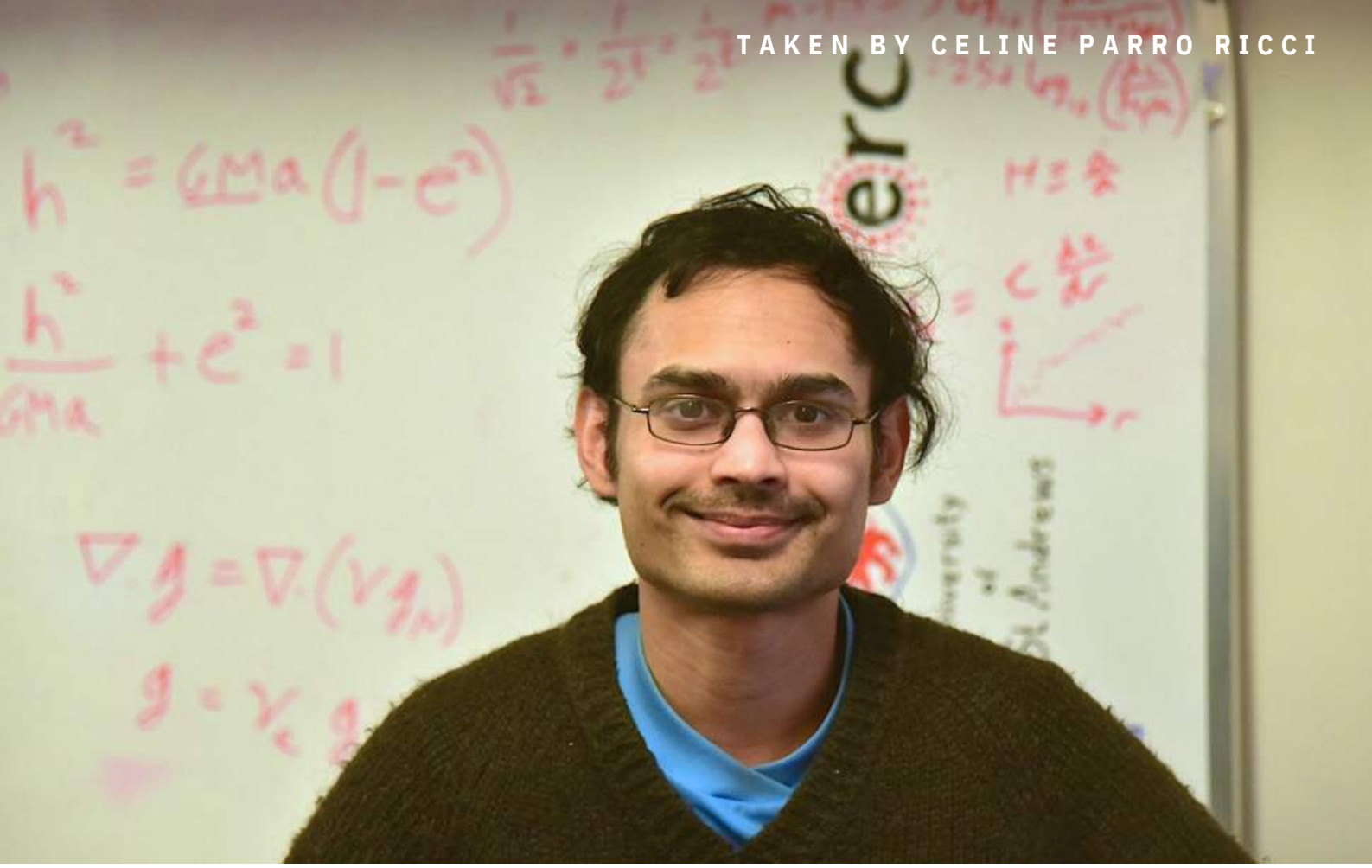
The results of a very thorough test of the predictions of Milgromian Dynamics, also known as Modified Newtonian Dynamics (MOND) have been published by our very own Dr. Indranil Banik (lead author) and Dr. Hongsheng Zhao, along with international collaborators. The evidence presented suggests that MOND is in very strong conflict with observational data. In this article, we get exclusive insights from Dr. Banik, who is a Galaxy Dynamics Research Fellow at St Andrews.

The Birth of MOND: Why Modified Gravity Laws were First Considered

Milgromian Dynamics, often referred to by the acronym MOND, was a theory put forward (in publication) by physicist Mordehai Milgrom in 1983. Interestingly, a conference was held in St Andrews in commemoration of the theory's 40th anniversary in June 2023 [2]. Roughly speaking, the original theory aimed to remove the need for dark matter in our understanding of galaxy dynamics.

MOND initially sought to explain a popular mystery in astrophysics: why stars' orbital velocities remain fairly constant with distance away from their galactic centre. Normally, one expects a body's orbital velocity to be slower the further away it is from its centre of orbit. (Think of the effect of string length when rotating a ball on a string.) In this regard, the dynamics of galaxies presented an unexpected result to astrophysicists. The most popular proposal to resolve this issue is that there is something affecting galaxy dynamics other than the visible matter we observe: dark matter. MOND, however, suggests something different: that the **laws of gravity differ from Newtonian expectations at extremely low accelerations** in a manner which can explain the observed orbital velocities of stars.

Over the past 40 years, the theory and variants thereof have been developed by many scholars, including Dr. Banik. A good summary of these developments is provided by Banik and Zhao, 2022 [3].



Testing MOND

Many tests of MOND have been discussed previously and there has been debate over the years about different aspects of the theory's validity. Dr. Banik explains, however, why the latest evidence presented by him and his collaborators can be considered so decisive:

"MOND postulates that gravity departs from classical expectations below an acceleration scale a_0. This means it predicts anomalous behaviour not just in galaxies but even on stellar scales. In particular, widely separated binary stars (wide binaries) in the Solar neighbourhood are expected to orbit 20% faster than expected in Newtonian gravity."

"Instead of rehashing the technicalities, I will take this opportunity to explain some aspects which are not often discussed. The wide binary test is a particularly critical decisive test of MOND. Since I have been working on MOND for almost a decade, it was always clear that emotions would run high with such a decisive test. This meant a very high risk of moral hazards.

I therefore took extreme precautions to mitigate the moral hazards associated with the wide binary test.

The main thing was to fix the analysis protocol as much as possible in advance of the actual test, so we were not tempted to alter modelling choices to try and change the result. For this purpose, the detailed plan was posted on https://arxiv.org/abs/2109.03827 at the start of my current postdoc [4], whose main objective is to implement the wide binary test.

This plan mostly focuses on the computational cost of the test and how much memory it will use, since the test is also rather numerically taxing. But certainly an important consideration was to fix the protocol as much as possible. In the paper, I have explained that some very minor changes and simplifications were made to this protocol because the actual Gaia DR3 worked a bit differently to what was expected, with some things working better than expected – making us use alternative protocols that are better in order to exploit this."

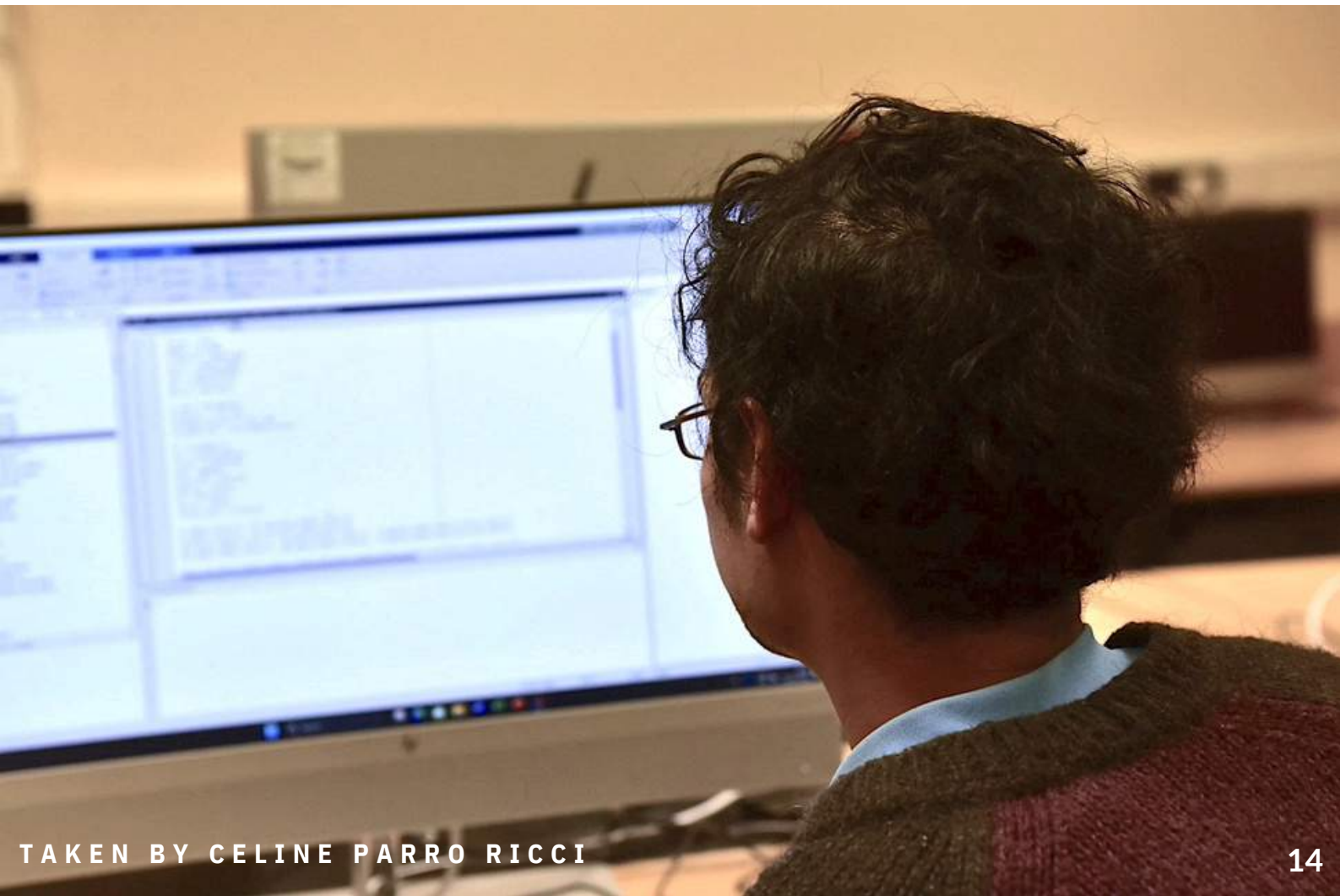
Diving Deeper

To further understand the analysis of this test of MOND, a basic introduction to the concept of Bayesian statistics might be useful. When thinking about probability, one might think about the likelihood of an event occurring (e.g. rolling 4 on a 6-sided die) over a large number of samples. This is known as frequentist statistics. In this approach, probabilities are assigned to specific outcomes. In contrast, Bayesian statistics assigns probabilities to hypotheses. This framework allows us to consider how probable it is that a hypothesis is correct – very useful for testing the validity of MOND. Bayesian statistics assumes some prior probability distribution based on pre-existing knowledge. This prior distribution is then modified by compromising with real-world data to create a new probability distribution known as the posterior. [i]

Dr. Banik explains to us the significance of the posterior in the tests of MOND when considering a key model parameter known as α_grav:

> "The most important thing was that the criteria for various possible outcomes were clear in advance. If the posterior on the α_grav parameter strongly clusters near 0, this means Newtonian gravity is preferred. If α_grav clusters near 1, then MOND is preferred. A different value would mean some other gravity law is in operation, or there are some other issues with the wide binary test. A priori, it was expected that the result would be either 0 or 1, even though values in the range -2 to +3.6 were allowed. It was assumed that the posterior would be tight enough to reliably distinguish between 0 and 1, so both gravity laws would not simultaneously be consistent with the wide binary test."

i. For a relatively gentle introduction to Bayesian statistics, see these articles: Understanding the Differences Between Bayesian and Frequentist Statistics - International Journal of Radiation Oncology, Biology, Physics (redjournal.org) and A Gentle Introduction to Bayesian Analysis: Applications to Developmental Research - Schoot - 2014 - Child Development - Wiley Online Library.

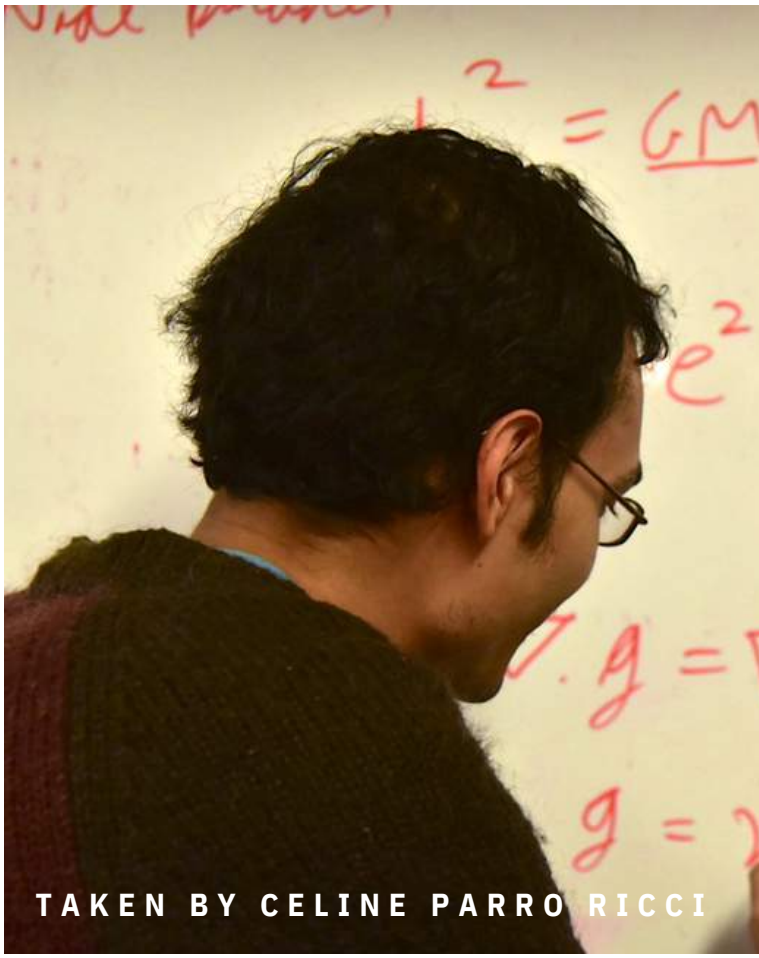


TAKEN BY CELINE PARRO RICCI

The Big Result: The Meticulous Work Behind Testing MOND

Conducting an analysis to such a level of rigour as described above was not a trivial task. Dr. Banik describes in detail his discovery of the fate of MOND and the impact it had within the astronomical community:

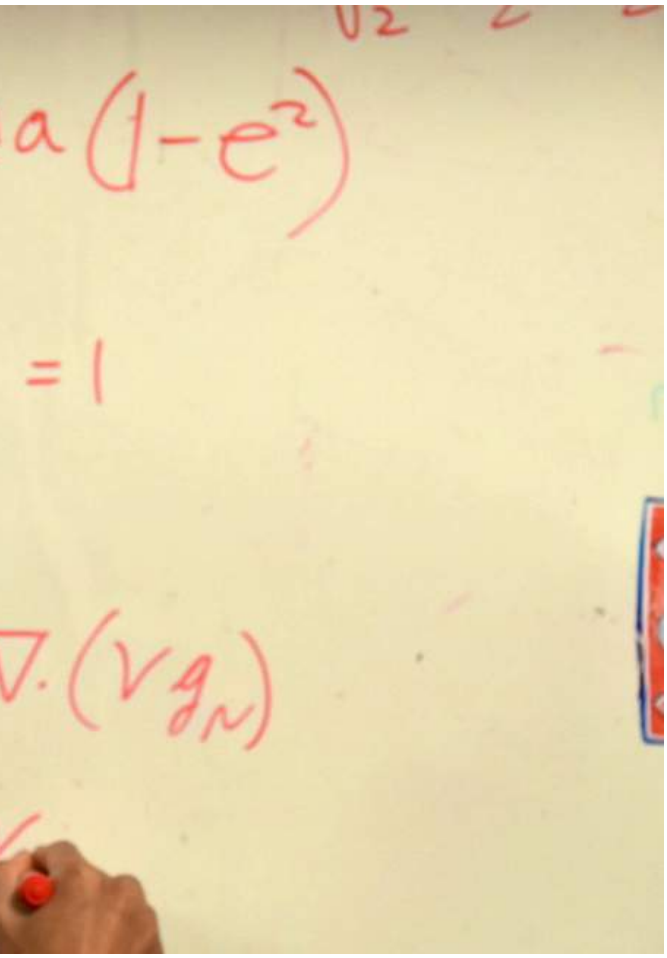
"A clear Newtonian result became apparent in the evening of fifth November 2022, with Newtonian gravity preferred over MOND at about 20 sigma confidence. The posterior on α_grav was consistent with 0 at about 1 to 2 sigma confidence. This result was reported to the other authors. Given the significant implications, the head of department was rapidly informed. It has taken a while to write up the results and get them peer reviewed, but the basic result has barely changed. The wide binary test is the most complicated statistical hypothesis test I have ever conducted, by a very large margin. The main stage is an approximately eight hundred line block of Fortran code that determines the absolute binomial likelihood of each model. This is done at a marginal cost of about two seconds, so a full length one hundred thousand element Markov Chain Monte Carlo analysis takes a bit over two days. The calculations were done on a computing cluster in Bonn, which is well suited to the test. Parallel programming is used, assuming about sixty cores are available, as was typically the case (this is half the cluster, letting other users work on the cluster as well). It has recently become clear that the failure of MOND on the sub-galactic scales of wide binary stars is also apparent in Cassini radio tracking data of the Earth-Saturn distance. MOND predicts some anomalies here, for much the same reasons as it does for wide binaries. This is observationally excluded at about eight sigma confidence thanks to timing of signals between Earth and the Cassini spacecraft, getting the relative distance very precisely. Therefore, MOND does not work on scales smaller than about one parsec. MOND also fails significantly in galaxy clusters, where it predicts too little gravity in the inner regions and too much gravity in the outskirts."



The Death of MOND (?)

The paper by Banik et. al. revealed a conflict between MOND and observational data by amounting to 16 times the uncertainty [1]. Evidence to this extent seems to strongly suggest that this alternative theory of gravity is fundamentally flawed. Dr. Banik shares his thoughts on the matter:

"In the future, I will not be working further on MOND given these insurmountable difficulties. Once the Solar System results [6] are published in about six months to a year by another group I am not involved with, MOND will not be an investable proposition. Theories that fail Solar System constraints are automatically uninvestable. While this is not the outcome that I envisaged when I first started working on MOND a decade ago, I am proud to have conducted such a detailed test of what at the time was a very plausible hypothesis. The failure of the only viable alternative to dark matter on galaxy scales significantly strengthens the case for galaxies having their own dark matter halos."



Moving Forward: Modified Gravity and the Hubble Tension

General Relativity (GR) still appears to be our strongest model of gravity. Although modifying the standard model of gravity has proven problematic in the realm of galaxy dynamics, the possibility for modifications to gravity at far larger scales has not been ruled out. Dr. Banik alerted us to another of his recent publications [6] where he and collaborators propose that our model of gravity may be modified at very large scales to resolve another mystery in astrophysics known as the Hubble Tension. Simply put, the Hubble tension is a disagreement within the astrophysics community on the rate at which the Universe is expanding. Different, seemingly valid, methods for its calculation give conflicting results.

Dr. Banik believes that modifying gravity on scales of the order of 10 megaparsecs (Mpc) may be the key to resolving this conflict:

"I think there is a very good chance of deviations from GR on those scales. Obviously, this is a huge extrapolation of GR from the Solar System scales for which it was designed. And this extrapolation does cause very real problems like the Hubble tension. Modified gravity on those scales is quite reasonable. I got into it in one particular way, but one does not have to believe that galaxies are purely baryonic to think that gravity might be modified."

Further Reading and Resources

For a further breakdown on these potentially decisive tests of MOND, Dr. Banik recommends this YouTube video, made independently by Dr. Rebecca Smethurst, as an excellent resource:
"HUGE blow for alternate theory of gravity MOND" by Dr Becky
https://www.youtube.com/watch?v=HlNSvrYygRc .

Dr. Banik's recent article for the Institute of Arts and Ideas is also a great read on this topic:
"The MOND alternative to dark matter is wrong" by Indranil Banik
https://iai.tv/articles/the-challenge-to-dark-matter-mond-is-wrong-auid-2676

See here as well for a recent article in The Conversation by Dr. Banik on the Hubble Tension:
"Do we live in a giant void? It could solve the puzzle of the universe's expansion" by Indranil Banik
https://theconversation.com/do-we-live-in-a-giant-void-it-could-solve-the-puzzle-of-the-universes-expansion-216687

A department talk by Dr. Banik about the Hubble Tension can be found here:
"Solving the Hubble tension with a local void" by Indranil Banik
https://www.youtube.com/watch?v=fsBykeVXHG0

Galaxies of Po

Empowering Women

BY ROSIE GITTINGS

In the world of physics, where equations dance across whiteboards and curiosity knows no bounds, a formidable force often remains – gender bias. As a physics student, I have felt the weight of condescension and an undermining of confidence, a story not too uncommon for women navigating the world of physics. It wasn't until reading through the pages of 'The Only Woman in the Room,' a riveting book by Eileen Pollack, where I felt an echo of this feeling that mirrored my own experiences, when I realised this is what it is like for most women entering into a degree in physics. Fueled by my own personal experience and a desire for change, I set out to discover the untold stories within our own School of Physics at the University of St Andrews.

How exactly do my fellow peers perceive gender bias, and what can we uncover about the challenges faced by women in this academic setting?

FIGURE 1: EILEEN POLLACK, AUTHOR OF THE BOOK "THE ONLY WOMAN IN THE ROOM" TAKEN FROM THE DAILY EVERGREEN

In early September I decided to conduct a survey (see Appendix) with the endeavour of delving into the perspectives of physics students at St Andrews on the pressing issue of gender bias and discrimination within their academic sphere. Despite efforts from the School of Physics to harbour an inclusive and diverse environment, highlighted by the prestigious Athena SWAN Silver award received in 2017 [1], the survey results suggest a widespread gender bias in the outer world of physics. Significantly, nearly 93% of participants identifying as female or non-binary (31 of 43 participants) voiced their perception of a pronounced gender inequality within the realm of physics, while a substantial 75% of male survey participants (12 of 43 participants) shared this conviction. This figure shouldn't come as a surprise considering a recent study at the University of Melbourne, which analysed data spanning the last 20 years, discovered that physics has one of the largest gender gaps when compared to other STEM subjects. [2]

tential

in the Physics Cosmos

But are these statistics relics of the past, with the notion that it is no longer unheard of for women to study physics? Think again. Nearly half of the participants in the survey acknowledged witnessing instances of unfair treatment towards women, stemming from both unconscious and conscious gender bias at the University of St Andrews. When delving into personal experience, only 42% of participants identifying as female or non-binary believed they had never encountered gender-based discrimination, compared to 75% of participants identifying as male.

One respondent shared a disheartening experience, stating, when she encountered a problem with her equipment, her concerns were initially met with queries about whether she had accidentally turned it off. A stark contrast to the immediate assistance offered to her male colleagues facing similar issues. This disparity not only necessitated her to repeat her request but also led to a significant loss of lab time—two hours, to be exact—forcing her to come in the next day to redo her work. This experience highlighted the challenges women face in a professional environment, struggling to achieve parity with male peers amid an undercurrent of unconscious, or perhaps even conscious, bias. It's reassuring, however, to note that the experimental department has been made aware of these concerns, and steps are being taken to ensure that all students receive equitable support.

While I did anticipate results indicating women being condescended to by peers, I was genuinely surprised to see multiple respondents comment on instances of unfair treatment by lecturers. One participant shared how they believed “Women here tend to get patronised or overlooked in conversations and tutorials,” while another revealed witnessing a male lecturer talking down to female students. It was within the experimental department that gender equality appeared notably absent. With a few survey respondents shedding light on their perception that concerns voiced about equipment issues were not treated with the same gravity when raised by female students.

However, the main concern appears to be rooted in the interactions between male and female students. A notable challenge was seen during collaborative endeavours such as group projects and study sessions, with several participants highlighting the pervasive issue of ‘mansplaining’. Cambridge Dictionary states that mansplaining refers to “the act of explaining something to someone in a way that suggests that they are stupid; used especially when a man explains something to a woman she already understands” [3].

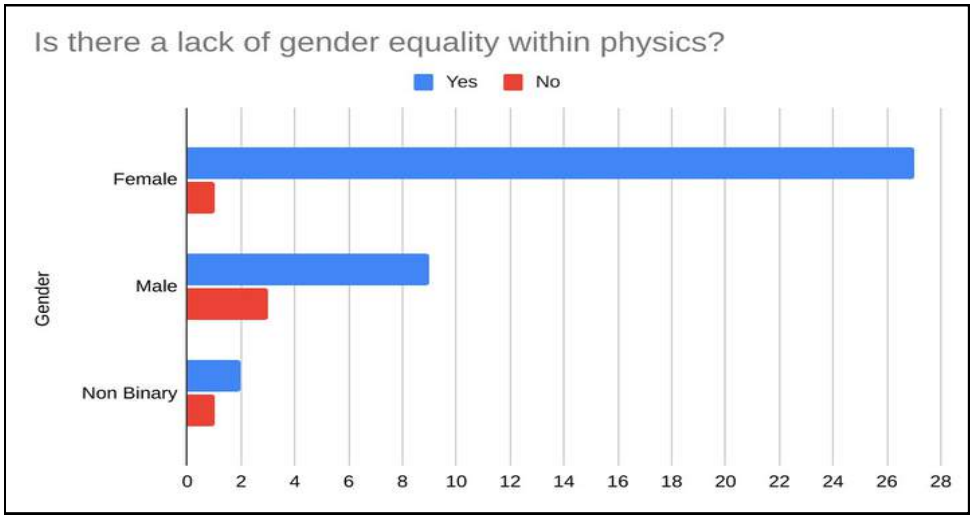


Fig 1: Graph depicting the survey responses across genders to the question 'Is there a lack of gender equality within the field of physics?'

A recurring theme throughout the survey discloses instances where women are excluded from discussions, talked over, and have their ideas dismissed until validated by a male peer. Shockingly, the accounts go beyond mere exclusion, revealing more insidious remarks, in one instance including inappropriate comments about something a woman was wearing.

As I began my journey in physics, I struggled with the notion that embracing my feminine interests might undermine my professional credibility. This feeling was mirrored by another respondent who experienced a sense of shame for having interests deemed 'girly', as these were seen as incompatible with the field of physics.

Before delving further, it's essential to address the issue of selection bias. In any group, there will be individuals both satisfied and dissatisfied with various matters. When it comes to surveys, those with negative experiences are more likely to voice their opinions. Although it is disheartening to witness the persistence of gender bias struggles in our community, and action should be taken to prevent future occurrences, the limited positive responses may be influenced by selection bias in the data.

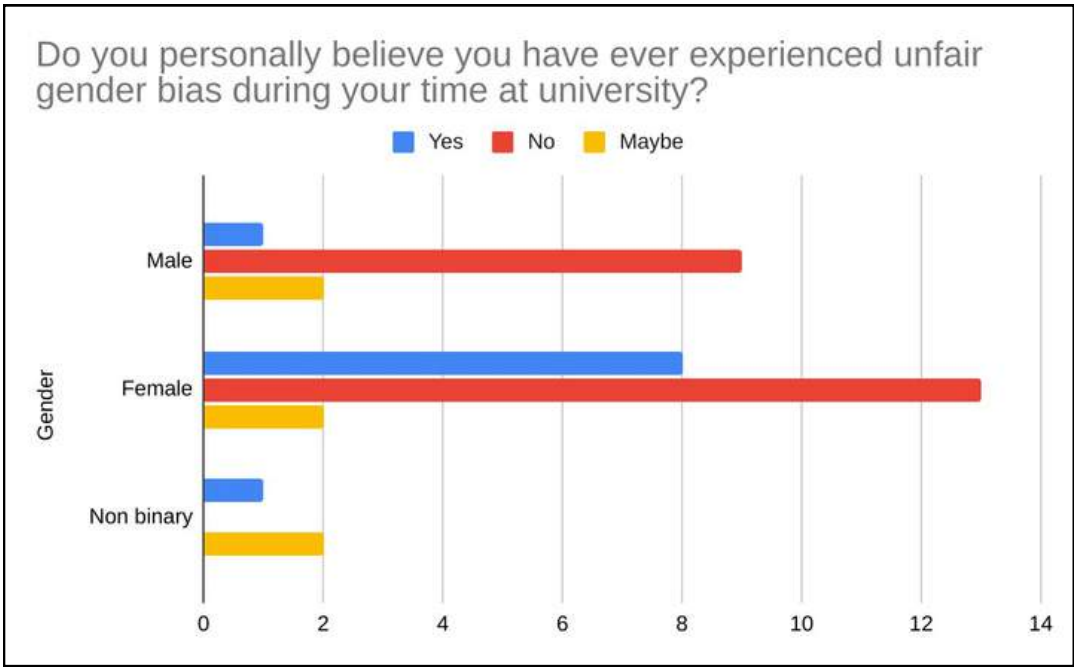


Fig 2: Graph depicting the survey responses across genders to the question 'Do you believe you have ever experienced unfair gender bias during your time at university?'

While these comments may seem innocuous, research indicates that the cumulative impact of microaggressions can be corrosive, leading to diminished self-worth, reduced participation, and an inhibited ability to thrive in such an environment. [4]

Only 42% of participants identifying as female or non-binary believed they had never encountered gender-based discrimination.

With that taken into account, the survey does suggest a silver lining - female and non-binary students at the University of St Andrews who participated expressed a higher inclination in pursuing physics-based careers after graduation compared to the national average. However, this optimism is lessened by the reality that gender-based discrimination persists, even in job application processes. A study conducted by Moss-Racusin and her team revealed disturbing biases in hiring practices. Identical CVs for a lab manager job, under the names 'Jennifer' and 'John' were shown to a group of professors, 'Jennifer' consistently received lower ratings for competence and hireability. Additionally, the professors taking part in the study were far less willing to provide mentorship to 'Jennifer', despite identical qualifications with 'John' [5].

On a more positive note, St Andrews University stands out in advancing gender inclusion in various aspects. Approximately 40% of physics students identify as female, surpassing the average of 24% observed at other universities [6]. This noteworthy achievement is further enhanced by the university's dedication to fostering important discussions about unconscious bias in the Transferable Skills module.

Additionally, the impactful research undertaken within the physics department has culminated in the development of an invaluable Impostor Syndrome workshop, now an integral part of the first-year curriculum. This initiative reflects the university's proactive approach in addressing psychological barriers and promoting a more inclusive and supportive academic environment. These initiatives highlight our university's dedication to leading the way in eradicating gender bias within the field of physics.

But why does all of this matter? The significance lies in paving the way for equal opportunities in which women can thrive. The shortage of women in the STEM workforce hinders intellectual progress, which depends on attracting the very brightest minds – regardless of gender.

Approximately 40% of physics students identify as female

One key solution—increasing the representation of female role models within physics.

There's no quick fix to addressing systemic issues ingrained in institutional foundations; solutions tend to be gradual and incremental. Most respondents focused on one key solution—increasing the representation of female role models within physics. One participant succinctly captured this, stating, "There is a culture behind certain subjects like physics, maths, computer science, which are portrayed as 'unfeminine.' We need to take action in removing these cultural stigmas by not characterising certain subjects as more masculine or feminine. If it's cool and fun to learn, it's cool and fun to learn!". Showcasing more female physicists as role models proves that physics isn't inherently masculine. Another recurring solution emphasises hosting more female-centric groups in physics with the aim of encouraging a supportive community, acknowledging the importance of solidarity in overcoming gender biases.

The journey to gender equality in physics is an ongoing process, marked by significant progress. Reflecting on experiences detailed in "The Only Woman in the Room", which recounts challenges faced by women studying physics in the 1970s, we recognise the substantial distance we've covered since then. While acknowledging these strides taken, it is crucial to shed light on the remaining challenges. In doing so, we contribute to paving the way for a cosmos where every aspiring physicist can thrive, regardless of gender.

*If any of the topics discussed have resonated with you or if you have suggestions for improvements within the school, we encourage you to reach out to **panda_wellbeing@st-andrews.ac.uk**. For issues of harassment or violence, you can contact the **Report+Support team (https://reportandsupport.st-andrews.ac.uk/)** which allows incidents of abuse to be **reported anonymously**. Your input is valuable in shaping a more inclusive and progressive educational environment.*

Breakthrough for Wind

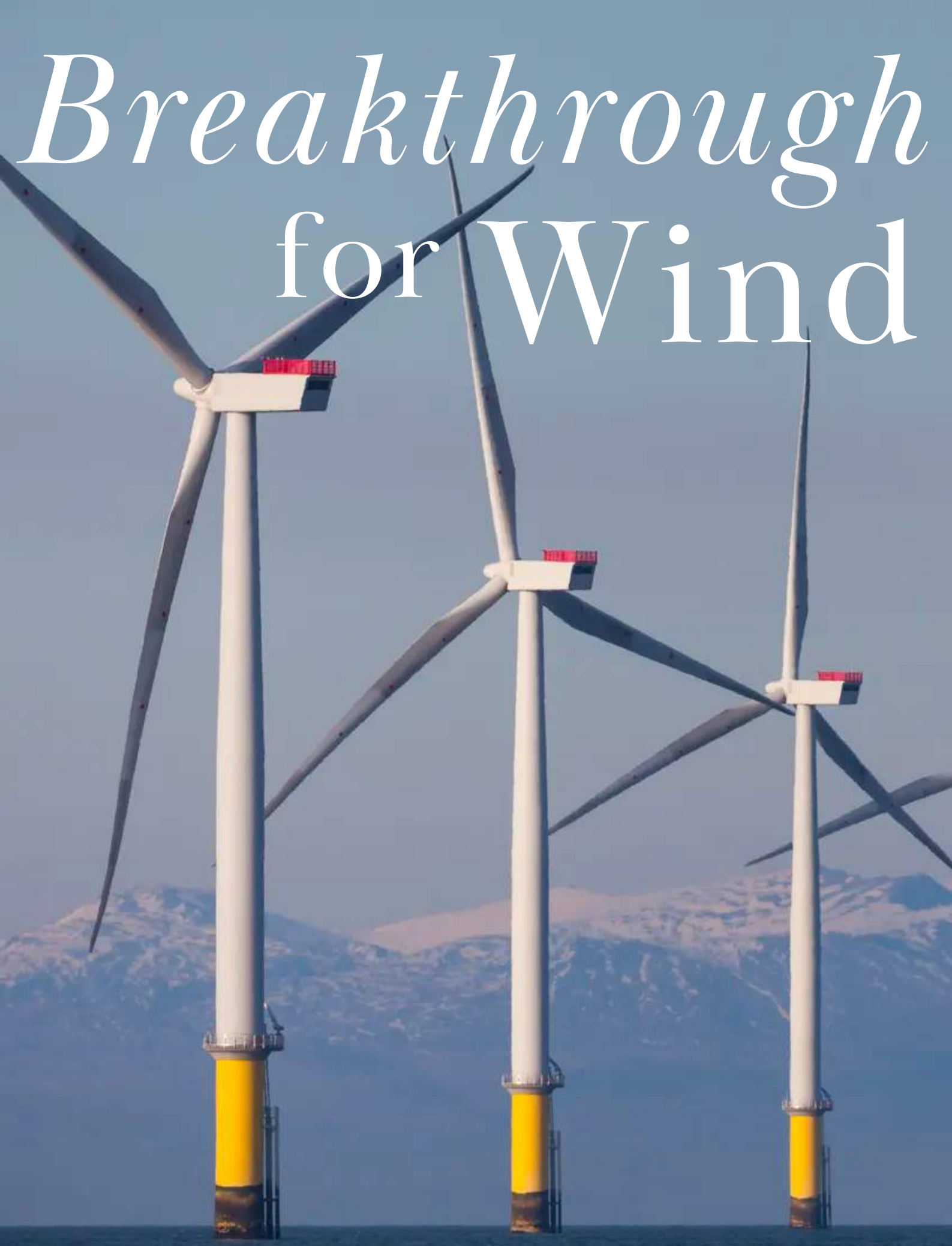


FIGURE 1: THE WALNEY WIND FARM IN THE IRISH SEA - ONE OF THE LARGEST IN THE WORLD.

TAKEN BY ROB ARNOLD/ALAMY

Power

BY SAMUEL ALLEN

A collaboration between chemists and physicists at *Hebei University* and the *Chinese Academy of Sciences* has produced a **new method to generate electricity** from low-speed wind by exploiting the internal rotation of ionic liquid droplets – a technological breakthrough with the potential to drastically improve the versatility of wind power technologies and bring clean energy generation to more places than ever before. [1]

What's wrong with current wind power technologies?

Wind power has grown in popularity enormously in the last twenty years, and now generates around **27% of the UK's electricity** [2] and accounts for over 6% of the world's supply. [1] Wind power is favoured as it is low-maintenance, completely carbon neutral to operate, comparatively cheap, and scalable. Also, contrary to popular belief, it doesn't kill masses of birds, [3] give you ADHD, or cause tinnitus. [4] Furthermore, it isn't considered a serious eyesore like large-scale solar farms or hydroelectric dams, which tends to keep nimbyists[1] a little happier than they are with other green alternatives.

However, wind power suffers from one catastrophic (and thus far unavoidable) Achilles' heel: ***what do you do if it's not windy?*** The answer, until now, was *nothing*. The reliance of wind power on wind speed is hardly shocking, but you may be surprised to learn that the power generated by a wind turbine varies with the *cube* of the wind speed. This means that below wind speeds of around 5 ms−1 traditional wind turbines are effectively useless. Areas with average windspeed below this level cover well over 75 % of Earth's land surface, [5] including almost all forested and urban areas. Of course, this wind speed required is the average wind speed perpendicular to the plane of the turbine blades, so in reality this dependence necessitates a consistent wind direction too.

In cases where the wind speed is too low, or the wind direction is highly changeable, the economic and environmental costs of the construction and maintenance of the turbines outweighs any power they might generate. This **seriously limits the sites** at which it is viable to install them to mostly flat plains, offshore sites, and coastal areas – the consensus in the literature and industry is that terrain and wind current distribution favours Europe and North America when it comes to suitable wind farm sites.[5]

The weaknesses of current wind power technologies don't end with their need for fast and consistent wind. They are also reliant on the area swept out by the turbine blades and the air density – no use if you need energy in a confined space or at high altitude. The wind also can't be too fast – the keen observer will note that in high winds turbines are often stationary – when they are shut down to avoid damage to their internal mechanisms. These same internal mechanisms that break in high winds also require frequent maintenance due to their moving parts. All in all, then, wind power is a fantastic renewable energy source which is tragically restrained by its requirement for very specific and often unrealistic conditions.

1 People who oppose development in their areas because of the inconvenience to them. The origin of the term is the acronym Not In My Back Yard (NIMBY)

The new approach: ionic liquid arrays for Drop Wind Generators (DWGs)

The approach developed by the teams at *Hebei University* and the *Chinese Academy of Sciences* has the potential to solve all the highlighted problems of conventional wind power by simply throwing away the turbine blades. Instead, their approach uses the **internal rotation of ionic liquids** to harvest the wind's power in a "drop wind generator" (DWG). DWGs use suspended droplets of an ionic liquid (in this case, 3-methyl-1-octylimidazolium chloride) on a nanowire array which is exposed to the wind.

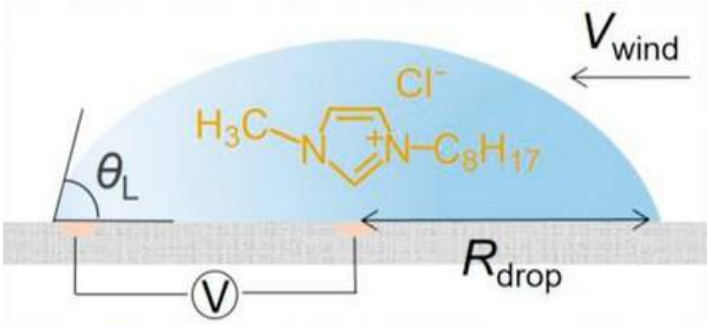


Figure 2: The ***ionic liquid droplet***, showing the region the potential difference is generated between. The diagram includes the schematic structure of the ions in the ionic liquid 3-methyl-1-octylimidazolium chloride. Reproduced from [1].

The properties of the liquid droplets mean that the friction at the liquid/air surface as the wind passes over them causes rotation within the liquid, which is usually dissipated as heat due to internal friction. By restricting the liquid's movement on its nanowire array by "pinning" it in place, the internal motion causes separation of the positive and negative ions within the liquid, instead of heating. This leads to a surface charge redistribution, creating a potential difference which can then be used to "persistently generate electricity." [1] The properties of the liquid also help to stabilise a bulbous droplet shape, which can generate even more friction at the liquid-air boundary than alternative liquids.

The recent study demonstrated the feasibility of this basic mechanism for generating usable currents from winds as low as 0.2 ms−1, with individual cells generating potential differences around 0.84 V. [1] By combining these cells into **ionic drop "wind farms"**, the team has managed to scale up the process to generate around 60 V. The hope is that by expanding these "farms" of ionic liquid droplets and nanowire arrays, the potential difference can be increased even further. Even in its current state, the voltages generated are sufficient to have practical applications in powering small-scale electronics.

Implications of the new technology

How does this new approach resolve wind power's fatal flaw? It is quite simple. By eliminating the turbine mechanism this new technology has eliminated in one stroke the need for high and consistent wind speeds. In doing so, it has also reduced the need for large spaces, frequent maintenance, and high air density. Development of this approach further will make wind power undoubtedly one of the most **versatile, low-maintenance, and least intrusive renewable energy** options on the market.

The team foresees their technology having applications in traditional large-scale power generation in low or changeable windspeed areas, but also in powering consumer or industry electronics on smaller scales. It is easy to see the potential for applications such as individually powering LCD screens in outdoor spaces, lighting and signalling, and even consumer gadgets like children's toys. Low-grade wind power generation has the huge advantage of being **more reliable** than solar or traditional wind power, making it more suitable for powering isolated systems, and applications where energy storage is more difficult. Imagine this technology powering a lamppost on a remote road or a ticket machine at an isolated train station – completely off grid.

The limitation of areas suitable for traditional wind power to sites overwhelmingly concentrated in Europe and North America also means this technology has the potential to make renewable energy more accessible for those in the global south, provided costs can be minimised when translated to a commercial scale. The high degree of sensitivity of the potential difference generated to the wind speed could also give rise to commercial sensing applications based on similar technology, although this has not been investigated.

The ability to tap the earth's widespread low-grade wind as a reliable source of energy will be **a revolution for renewable energy generation**. Bringing wind power to all regions of the globe in a new system that is more easily scalable, more adaptable, and lower-maintenance than existing options is one of the most exciting developments in renewable energy in the last decade.

TAKEN BY CELINE PARRO RICCI

An Interview with Dr. Rose Waugh

On a particularly windy day in St Andrews during Independent Learning Week, we get the opportunity to talk to Dr. Rose Waugh, a relatively new lecturer at St Andrews but definitely not a newcomer to the University. Dr. Waugh is one of the co-founders of the PANDA Magazine. They completed both undergraduate and PhD studies at St Andrews and are now an Associate Lecturer here. Our interviewer, Joel, learns about their experiences at different stages within the University, thoughts on diversity and inclusion in Physics, the origins of the PANDA Magazine and some other fun tidbits. The talk took place online over Teams where Dr. Waugh was occasionally joined by their dog Luna.

20/10/2023

How did you find the experience of becoming a lecturer at St Andrews now that you have gone through the process of both your MPhys and PhD here?

It's been interesting, especially since I've been at the same university, so some bits of it have been easier because I've kind of known the system. But it's also been kind of interesting because I've seen things from all the perspectives now, whereas I guess you don't have quite the same experience of that when you when you move around. I found undergrad hard. It was a demanding degree and I enjoyed it, but it was hard going.

I actually found the step to a PhD in some ways better. There are different pressures on you, I suppose. I felt that I could handle those pressures a little bit better. So yeah, I enjoyed my PhD. I enjoyed all the research. I enjoyed the department and the kind of culture that exists here, as well as going to conferences and writing papers. But like with a lot of us, it had hiccups along the way. The pandemic made things difficult at times.

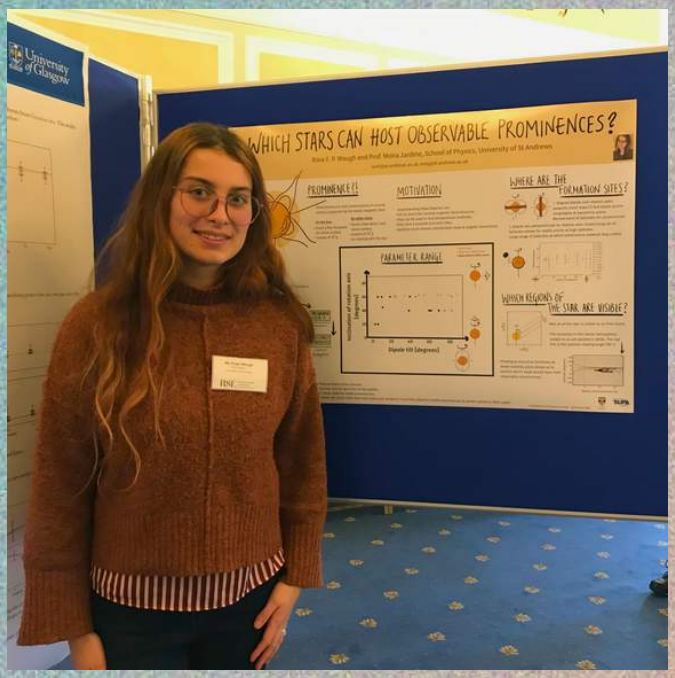
I did some of my PhD part-time in the end. The department was very supportive of it and I probably wouldn't have been able to finish otherwise. So that was definitely the right path for me.

[Luna enters, expressing agreement]

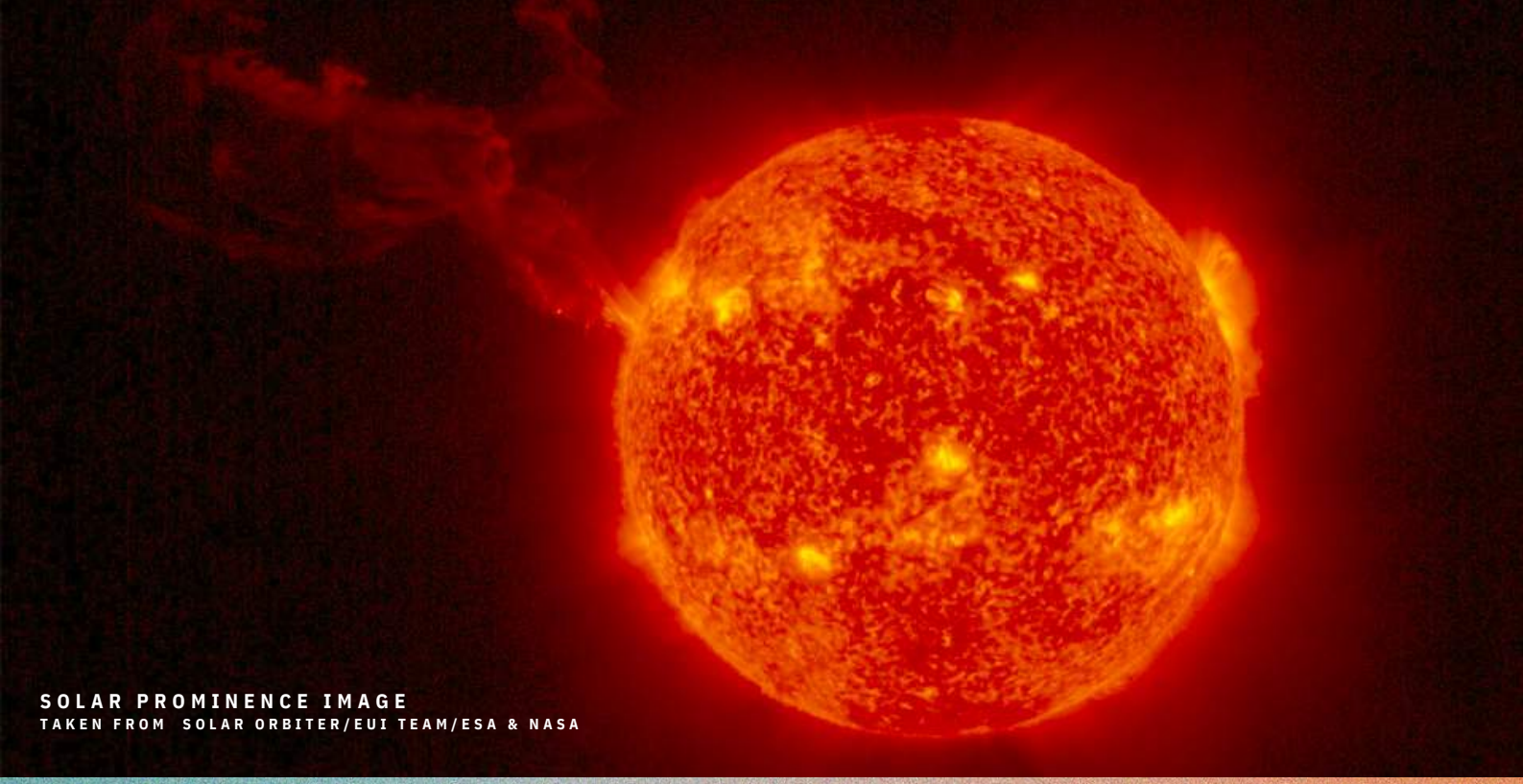
I was very lucky that the department could find me a teaching job as well. It's been very interesting revisiting courses that I haven't seen since I was an undergrad.

Yes, I saw on Instagram, you recently mentioned working on special relativity lectures?

Yeah. I haven't really touched special relativity since I was an undergrad, and I suppose that's just what happens when you go into research. You end up in a particular niche and you use all of the physics from that area and you don't really use the rest of it. It's been nice to revisit it; I did theory for my undergrad, so I did see special relativity throughout my degree. I guess it wasn't that long ago, but it was still a while since I last saw it.



PHOTOS PROVIDED BY DR. ROSE WAUGH



SOLAR PROMINENCE IMAGE
TAKEN FROM SOLAR ORBITER/EUI TEAM/ESA & NASA

What did you work on for your PhD. I understand that it was a continuation of work you did for your Masters?

Yeah, I think like a lot of people who did their Masters and then went onto a PhD, the work kind of followed on from what I did in my Masters. It can have its negatives, but by doing a masters project, you get to kind of trial something and see if that's what you are interested in. If you decide you do want to go down that route, then you don't get so broad an experience as if you picked something else but I enjoyed it!

I've spent a lot of time modelling the locations around stars that are similar to the Sun, but a lot younger. I've looked at where around them you can support these things called prominences. We see them on the Sun; they're basically just big clouds of hydrogen. But on stars that are a lot younger than the Sun, these clouds are significantly bigger and can have substantial consequences for how the star evolves.

So is most of your work on solar prominences observational work, or is it more theoretical modelling?

There are observations of these prominences and in fact Andrew Cameron has done a lot of work on this. So you definitely can observe them.

The difficulty is that we basically have one method in which we can detect them and that is kind of crude in a sense that it's a bit like the transit method for finding exoplanets. You have the star and the cloud has to go in front of the star and block out some light in a certain wavelength, and then you know it's there. That's great in theory but as you can imagine, there are lots of scenarios (like with exoplanets) where your cloud never passes in front of your star. So they have been observed many times, but the extent of how common they are or how many there are is not very easy to tell from observations.

I've tried reading some of the papers you've published and realised that they deal with a fair amount of electromagnetism. I remember you saying in another interview that you struggled with that subject in your undergraduate, but you've clearly overcome it. How was that experience?

Haha. Yes, I found the electromagnetism module in undergrad very difficult. I got the impression as an undergrad that I wasn't alone in that feeling. And then I got the impression as a PhD student that this extends across universities and across generations. It wasn't a specific problem to my class. I think that it can be a very difficult subject but as with all areas of research, whilst I do obviously work with magnetic fields now, I don't use all of the stuff that I saw in that class.

In research you become very, very good at a very small amount of science really.

A lot of stuff just comes with practice. The first time you see it, it is really difficult; taking the EM module was really hard. But now looking back at it, I'm not saying it's easy, but because my physics abilities have hopefully improved since then and my maths abilities have hopefully improved since then, when you come back to look at it, it's almost not as bad the second time round. And then presumably it's not going to be as bad the third time round etcetera, etcetera. Hopefully, you make incremental steps in the right direction.

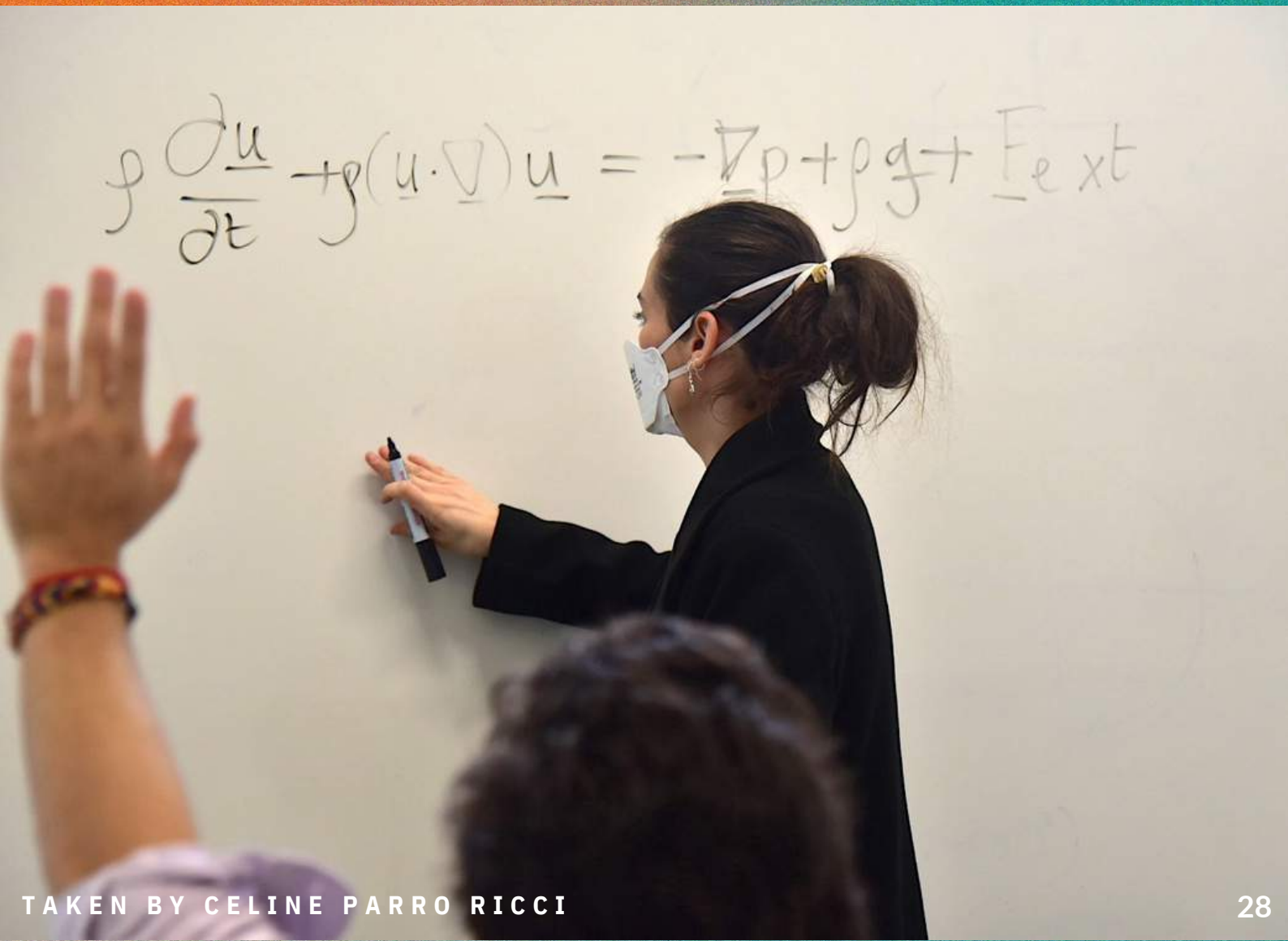
What would you say is the biggest change from being a PhD student to being a lecturer?

I think that when you are a PhD student in the School, you're highly valued. A lot of PhD students help with teaching: many of the tutorials are run by the PhD students and postdocs.

So in some ways, it doesn't feel that different. But I suppose the PhD progress can feel slow: you're taking steps forward over a few years. There's a lot of work that goes on by the teaching staff. Even when you know it's a lot of work, I think you kind of can't appreciate it until you're in it. I guess the extent to which you are expected to be adaptable is maybe a bit different. I feel like I'm teaching more of a variety of courses this year than I did as a PhD student.

So do you continue any research as well, or are you mostly focused on lecturing now?

How the lecturers get any research done during term time, I have no idea. If they could tell me, that would be great. There's a workload model that kind of says you should be doing X percent teaching and X percent research but obviously all of the staff that are teaching want to do the best job that they can do. Because they wouldn't be teaching otherwise. I do have some time for research, but I don't get anywhere near as much research done as I should.



TAKEN BY CELINE PARRO RICCI

How are you able to manage your time with all the things you have to do: lecturing at St Andrews, parenting and science communication on social media?

As you probably notice, the outreach has taken a bit of a back seat recently. It kind of had to whilst I was finishing up my PhD. I haven't managed to yet work out exactly how to balance my time to get back into it again. I will, I'm just not quite sure yet how to how to effectively manage that. Most of the research I do honestly right now gets done at like 11:00 PM onwards when the world (and my kid) is asleep. I don't feel like I have any work at that point and that's when I can do my research. But the teaching always comes first: you want to do the best you can for the students. The teaching is kind of fixed, and everything else you just kind of try to slot in where you can. The department is very understanding and friendly though. I think it probably is quite hard in some departments where the culture is possibly quite different.

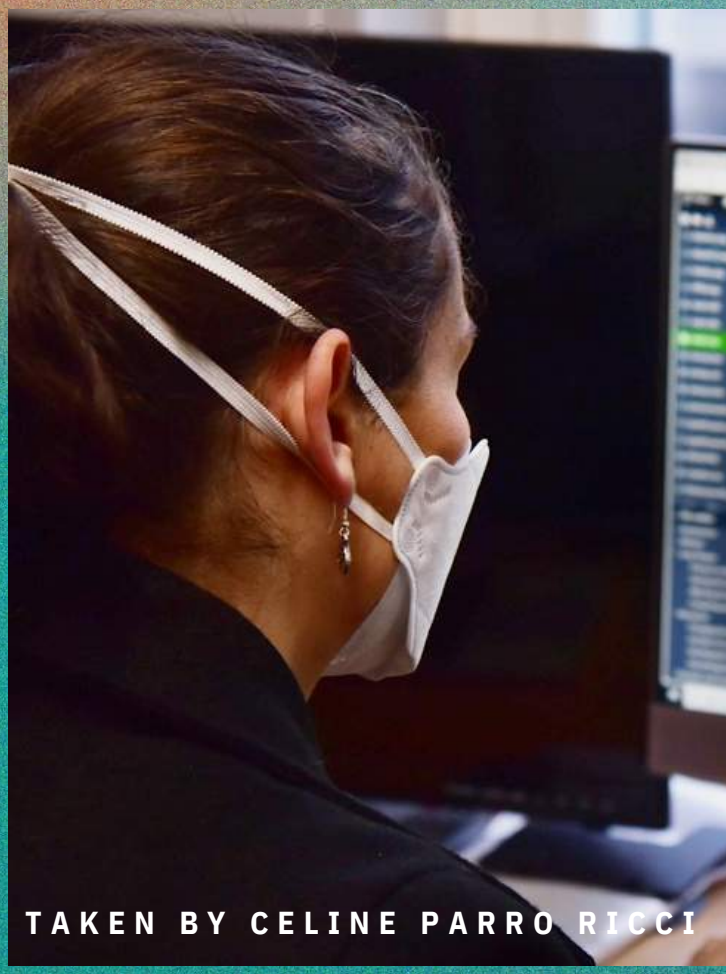
Do you think that this is an environment unique to St Andrews?

I mean, I've not been to that many universities out there to know a lot about their cultures and environments, but St Andrews does generally care a lot about students' happiness and success and I think it's part of the culture. Whereas, perhaps if you had a bigger department, it's a little bit different. It's very normal, for instance, in St Andrews that lecturers and other staff members will know the names of lots of people in their classes whereas this may be more difficult for some other universities. It makes everyone, students and lecturers, more human and influences the energy of the department.

I know you've done a fair amount of work as well on equality, diversity and inclusion in St Andrews and in general. In the broader world of physics, what's your sense of how inclusivity is progressing, or not progressing?

I have to try and keep myself positive about these things because I think it is quite easy to fall into a kind of pit of despair sometimes. And at that point, you almost aren't motivated to help to make the changes. However, I think that academia in Physics in the UK has a long way to go. It can be shockingly bad when it comes to equality in Physics. For example, gender equality often only focuses on whether there are women in the workplace: it's all a binary thing most of the time. There is a long way to go. I can't pretend that there isn't. Some departments are more aware and open to change than others: I always like to highlight that when I'm asked these kind of questions because you don't want to find yourself in a university that is less aware of the changes that need to be made.

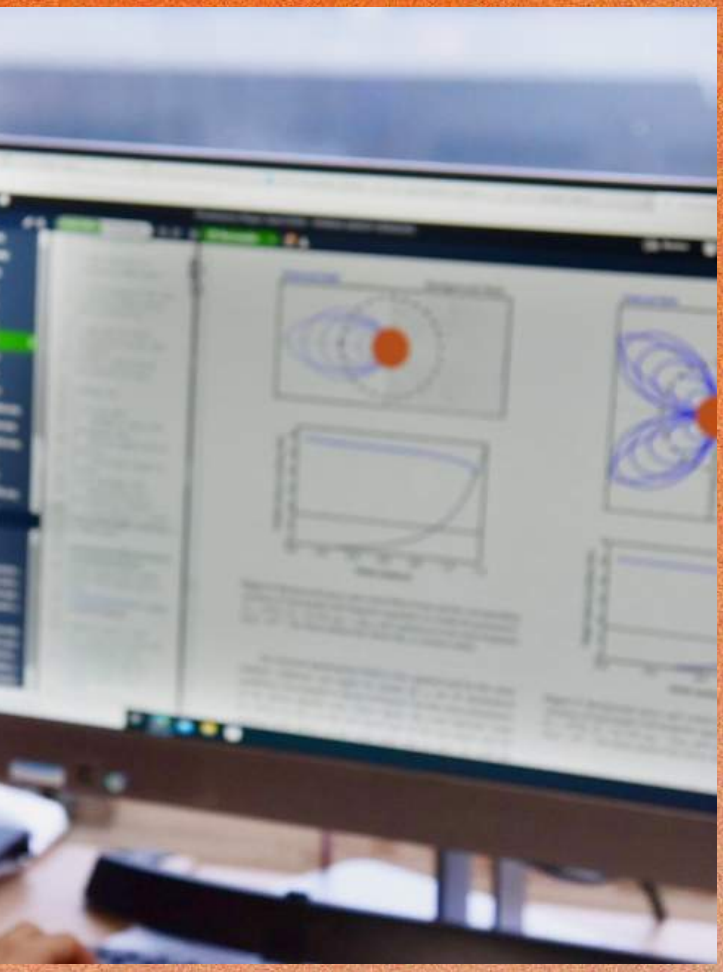
→



TAKEN BY CELINE PARRO RICCI

I don’t have the answers as just one person. I have opinions about things and I like to try to form my opinions from facts where possible, but I am also human. I think that there are policies that can be put in place to help. There are systemic things that need to change but we can all do our bit as well.

Even in St Andrews, which is a supportive environment, a lot of female students decide to leave at the BSc level. And it can't be explained really why that's happening. There are issues with retainment for all minority groups when it comes to continuing studies and this goes all the way up to permanent positions.



What do you think are some simple things the average student can do to promote a better environment?

Honestly, I think the students are probably the best at it. I can’t speak on behalf of everyone, but I think the students generally do a good job of supporting their peers.

However, I think that there are more things that departments can offer. For example, mentorship schemes: having someone (even just one person) who you can relate to can be helpful. Being able to say “I relate to that lecturer; I can see someone like me doing that job” is already a really important thing. It’s obviously not fixing everything but feeling like the odd one out, or one of the odd ones out, can be uncomfortable.

As researchers, we can also do our bit. When I write a paper, it’s up to me to reference researchers. Lots of citations can signify that someone’s work is really important: it can make someone more likely to get a job, a permanent position or funding. It’s very easy to just give citations to the same old people. It involves a bit of effort, but it’s useful to think about using references from diverse sources – these little things can make a difference although they’re not solving the [diversity] problems by themselves.

Moving onto a bit of a lighter topic now, how did you all go about starting the PANDA Magazine? What inspired its beginning?

Wow. It feels like a long time ago. There were a few of us at various levels in our studies that felt like it would be beneficial for lots of reasons. We felt like it would be an avenue for people to do something kind of creative, which is often kind of lacking from the Physics degree. There are lots of physicists who are interested in writing and the more traditionally creative kind of thing. We felt like it was also an avenue for students of different years to meet each other as well. A lot of times in undergrad, it can be easy to only have friends in your year group. It was a nice way for undergraduate students to network with one another and also to chat with me about what it's like being a PhD student. It just seemed like a good idea I suppose, especially with everything being online at the time. We felt like it would be a way for there to be a connect within the student body.

What advice would you give to someone who wants to become an astrophysicist (other than to buy your book)?

Haha. Hmm, at what point are they in their life?

Let's say at the undergraduate level.

I would say not to worry too much about individual grades or exams. Yes, you want to do well in your degree – of course you do. But we all have bad exams; we all have bad grades hidden away and they get forgotten about with time. A few bad exams are not going to define your career by any stretch of the imagination. The fact that you maybe are not an exam person will not ruin your life. Once you get to PhD level, researching takes a different set of skills.

I would say that it's useful to do an internship if you can before your Maters/BSc project. This is so that you:

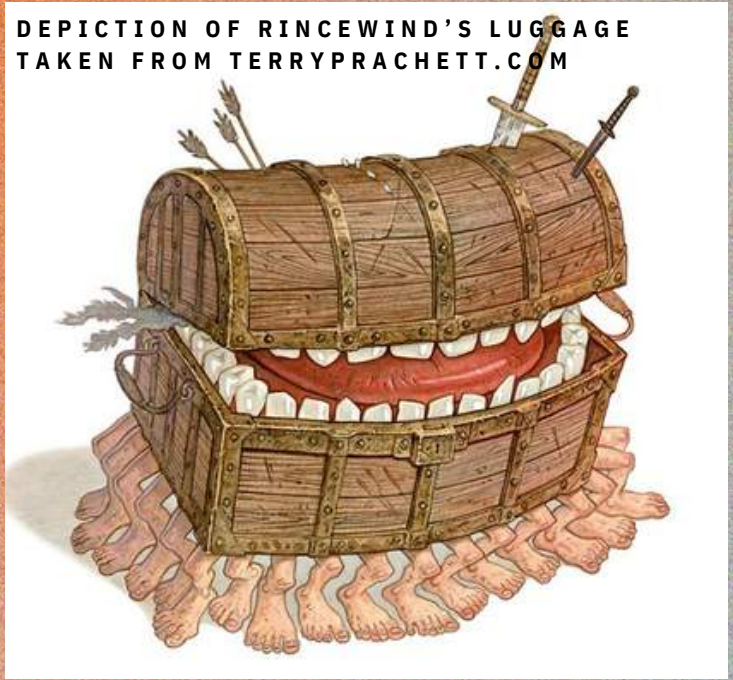
A. Have some experience with some research (Even realising you don't like something can be useful.)
B. Have something to talk about for PhD applications.

If you don't have an internship, that's not the end of the world: you will still have your dissertation, though you might not have as much as you can say about it [compared to an internship] at the time of your PhD applications. So it is valuable if you can do an internship but I appreciate that it's not practical for everyone for various reasons.
Otherwise, I'd recommend talking to people. Talk to people who are doing PhDs, talk to people who are your lecturers or tutors, especially if they are doing astronomy and that's what you're interested in. Even if they're not astronomers, they're still researchers so they have a lot of insight that they can share.

Any significant plans for the future?

So, I have a job here until May and then I guess I might be unemployed but I'm hoping I won't be! I will apply for some more jobs or fellowships. Having to make those applications will be a steep learning curve for me but I would like to continue my research and I also really do like teaching so I would like to keep doing that if I can.

DEPICTION OF RINCEWIND'S LUGGAGE TAKEN FROM TERRYPRACHETT.COM



→

Rapid Fire:

Favourite Place in St Andrews:
Ooh. There is a bench on East Sands that is outside the gates to where Albany used to be. It's one of my favourite places.

Terry Pratchett question supplied by one of our editors, Niya: If you had Rincewind's luggage, what would you put in it?

Ooh. That is a good question. My entire supply of Terry Pratchett books I guess? Haha. I'd carry it around with me.

If you could magically gain the answer to one of astrophysics' big questions, which would it be?

I would like to know what causes the coronal heating problem. I think that's probably a very vanilla answer but it's one of those things that a lot of us hear about from relatively young. It's kind of hailed as this big unsolved problem in physics and it's kind of an annoying itch that I wish would go away. I would like to know why!

Surprisingly, I haven't asked this yet but where are you from?

I've spent my formative years in both England and Scotland.

In science communication, what would you say is a flawed/annoying explanation that you find is commonly presented?

I think the one that annoys me the most is when things talk about the Sun being a burning hot ball of gas. There's something about the idea that you're trying to tell people it's on fire that I really cannot get behind. It's not burning; I know what they're trying to say but, as with anything, you have to be aware of how people might interpret what you're saying. I'm far from immune to it, but what you think you're saying may not always be interpreted how you think it will be.

TAKEN BY CELINE PARRO RICCI

An Interview with Veronika Vašíčková

A transcript of the highlights of Insight Episode 71.
(Recorded on 6/11/2023)

Insight Producer Luke has a conversation with PhD student, St Andrews graduate, former Insight producer and former PANDA Magazine contributor Veronika, talking about her time in St Andrews, what she's currently up to in Germany and what her favourite physics joke is.

You can find the FULL interview over on Spotify, YouTube or Apple Podcasts by searching Insight by Physoc.

insight

Want to get involved? Email insight@standrews.ac.uk and give us your thoughts!

Luke: Hello, I am joined here with Veronika. Veronika was a member of Physoc and Insight back in the day but now she has left us after graduating. But thank you for coming on and I hope you enjoy the interview.

Veronika: Thank you

Luke: So we'll start off with asking what you have been up to since graduating St Andrews. So am I right in saying you graduated- you graduated last year. Was that with a master's degree?"

Veronika: That's right, so I mean, this- the end of this summer, so last academic year with a master's degree in theoretical physics.

Luke: Nice. Well, that's what I'm hoping to be able to do over the next 5-ish years. Hopefully that works out okay. Since graduating from St Andrews what have you been up to over the last few months?

Veronika: Well, I took a long summer to relax a little bit.

Luke: Well deserved.

Veronika: Yeah basically shake it all off. And then actually in august I started my PhD in Astroparticle physics in Germany. So, it's with the Pierre Auger Observatory and the topic: since I've started, I have basically been defining my topic up until now-ish where I've already started working on it, now it's November right. And yeah, it's fun, it's in Wuppertal in Germany. It's an amazing group so another thing I have been doing is just hanging out with my colleagues.

Luke: Fair fair. So, you've moved from St Andrews to I'm not even going to try pronounce where in Germany for your PhD. Has it been a big change, is there a big difference between studying in Germany to studying in St Andrews?

Veronika: Absolutely actually. For undergrads there is a big difference between the British school system I guess and the Germany school system. One of them being I don't know for instance that it's quite usual to fail exams in Germany, like that's an experience basically everyone has. But you get more tries I guess and grades are less important so I guess it weighs itself off. You basically either pass or don't. Whereas we're like 'I need to get a 1st, I need to get a 2.1

Luke: This German system sounds great to be fair, to have less of a stress on getting that whatever number grade you need to progress. But while it has been different, have you found that St Andrews, and your time studying there has prepared you sufficiently well for moving away to Germany?

Veronika: Absolutely yeah. Well to be honest, so I originally come from the Czech Republic right then I moved to Scotland and then I moved back to Germany. So having all this international experience moving countries was helpful. Then kind of, Germany is culturally I guess much closer to the Czech Republic than I expected personally and slightly more different from than the UK than I expected. So, I guess in that it feels just normal it feels okay. But academically, definitely. It was more than well prepared. And also all the skills that just- these transferable skills, I'll say it, the attitude of just like solving a problem even though its hard and really we are used to working hard and that's going to be very useful whetherr you're dealing with the horrible German bureaucracy, which is just horrible, or an actual physics problem.

Luke: What's worse?

Veronika: I don't know. At least the physics problems tend to be in English whereas bureaucracy is typically in German.

Luke: Yeah that's fair enough.

.

.

.

Luke: We have a lot of freshers that just joined us this year at St Andrews so as an international student yourself could you give any advice to these new international students?

Veronika: It's going to be okay, just keep repeating that to yourself until you start believing it. It's genuinely going to be fine. I guess, you're going to figure it out, all the initially weird things that many people who are from the UK do not realise are so so different from other countries, you're going to figure it out. If there are some differences between what you can do and what people from the UK can do like from school, that's fine, you can learn that, you are a smart person. And just get to know lots of other people and start integrating in. The more you do that the better you'll find it and the quicker the transition will be and generally it will be fine.

Luke: Well said, I'm sure that going to help lot of people who just moved here for the first time. I feel as well St Andrews as place is just its own little bubble you know. It's got its own culture outwith the Scottish culture as well. But yeah, I'm sure that going to help put a lot of people's stresses at ease.

.

.

.

Luke: For people that are coming to the end of their undergraduate degree, what is the process from going from that to applying and then hopefully landing a PhD course?

Veronika: I mean it starts with googling. I literally came across my PhD when I google neutrino PhDs. And half of them were like expired and just not really relevant any more but they were still online so I just sorted through that. For me, I saw my PhD the last day. It was Sunday and the deadline was next Monday noon. I didn't have my references I didn't have anything. But the thing is don't worry about it if something like that happens, just email the professor. I did that, I was thinking that they'll tell me to just apply next year but they actually said it was going to be fine and to send the references later and it was alright. So yeah, google it, I'd say be open minded because I'm definitely not doing neutrinos in the end. And yeah, especially if you want to go abroad it is a good idea to start early to start in the first semester even though the deadline is going to be much, much later because then you might or might not have to sort your own funding but once you find the PhD adverts online then you will get stuff from there. If you are on mailing lists from some groups, for example from summer internships, you will receive emails from them. But if just you want to stay in St Andrews or want to stay in some particular research area you can go to a lecture and ask. Either them or maybe a colleague of theirs knows of a PhD for you.

Luke: I think it was where you were saying about the fact you sent you application the day before it was due, I think every listener to this podcast can relate to that, to sending in anything the day before it was due. There have been many a time where I've, I hate to say, sent something in the day it was due.

.

.

.

Luke: So, with doing the whole undergraduate thing and being in St Andrews as long as you have, you've enjoyed multiple Physoc event, multiple class tests and exams, but you've also had a lot of the traditions: May dip or raisin or the peri walk. Do you have a favourite one of those, a favourite tradition that St Andrews has?

Veronika: Favourite one… oh my. So, I mean I do like raisin although like sometimes I have seen it getting a bit too extreme, like really scared people that had no idea so maybe I won't say that. But I will say May dip. May dip is so freezing cold, so freezing cold, I love it.

Luke: As being a student of Physics, what is your favourite place in the universe outwith earth?

Veronika: Ahh, that's a good one. My favourite place in the universe outwith Earth, I guess the insides of neutron stars because I just really want to know what's in there. Like genuinely I just want to know how it works.

Luke: I've been doing something, where at the end of interviews I ask, can you give me a physics joke?

Veronika: It's a long one though, can I say a long one?

Luke: We've got time.

Veronika: So basically, there's a farmer who has cows and he needs them to give more milk. So he hires an agrotechnician.

Veronika: He hires someone and they're like: 'For £200,000 and in 10 years you can have a 5% increase in the amount of milk your cows give you'. The farmer says 'Okay, okay' and hires a molecular biologist. And they say: 'If you give me £2 million and 3 years, I will be able to increase your cows' milk production by 50%'. And the farmer is like 'Okay good enough, but let's try a third person'. So, for the third time he hires a physicist and the physicist comes back in 2 days and he's like: 'So if you give me about £100 and 3 days, we can increase the milk production by 300%. And the farmer is like 'Wow! How?'. And the physicist is like 'Okay, let's assume the cow is a perfect sphere in vacuum.'

.

.

.

Luke: Before you leave us, I know you gave some words of advice for international students but can you give us a small thing you would have liked to hear that would have helped you out when you were a sub honours student to just getting through that first couple of years of university?

Veronika: I guess I would say not to listen to the stuff about how honours is hard and horrible and 5th year will kill you and this year is like bad, this teacher is like bad, and this lecturer is like bad. I would not listen to that because honestly, it's semester by semester, person by person, subject by subject, lecturer by lecturer. I say just don't listen to that. Obviously, you need to work hard, but you also ned to enjoy, do your best to pull it together as good as you can but also don't put yourself under too much pressure to do everything. And engage, that's another thing. Like don't shut off only studying because then you'll burnout so do engage in Physoc for example, wink wink. And yeah enjoy, it's going to all pay off in the end.

SISCO 2024

St Andrews Interdisciplinary Science Conference

27-28 January

With over 340 sign ups, 8 speakers, 3 workshops and nearly 20 posters from undergraduate and postgraduate students, SISCO had its most successful year yet. We thank everybody who attended the conference, and we hope that you are inspired by the other fields of research you could go into. We will be back again next year, and if you would like to be part of our team, feel free to get in touch with AstroSoc or PhySoc to find out more!

SISCO 2024 Organisers

SISCO 2024 Ceilidh

Setting up for talk by Dr. Andrea Di Falco

Talk by Durham PhD Student Thomas Williamson

 PHOTOS BY SUPAKORN NIKKO JUENGSOPHONVITAVAS

Photography Competition

FIRST PLACE

Daniel:

For weeks, the smog of the city would keep the sky covered, but as I arrived to Himachal Pradesh, one of India's mountainous states, this quickly changed. Surrounded by the Himalayas, I trekked around the town of Manali and was amazed with the clearest skies I had ever seen. Sadly, I did not have my tripod, so this photo was not taken with my camera, but, surprisingly, with a friend's IPhone 13 in Night Mode. At the camp, we set up the lighting from the tent and spent the night trying to get a neat composition of sky, mountains and foreground. It was an amazing experience, and I only wish I could have had my photography equipment to make this shot even better!

SECOND PLACE

THIRD PLACE

Nikko:

I got two images, one of the Northern Lights, and another of Napier 3 with star trail around the Northern Star. Both images were taken using the following equipment:

Canon M50 with Sigma 18-35mm F1.8 lens on a K&F tripod.

The star trail image was a stacked 30s x 120 long exposure at ISO 100.

The aurora image was a 12s exposure at ISO1600.

Both images were minimally post-processed to bring out the colours.

Riddles

HERE ARE SOME FUN QUESTIONS TO TEST HOW CLOSELY YOU HAVE BEEN PAYING ATTENTION.

Raised by a flower
Chimes in in tune
What is the name of the pet of the moon?

How could a person have possibly thought of this?
Name the one who made the large number
hypothesis.

Women in Physics have untapped potential.
Galactic in size, some may say
Name the author Rosie found influential
In analysing inequalities of today

Probability can be understood in different wayses.
What is the approach different to Bayes'?

When energy bills are high and winds are low
What ionic fluid might keep electricity aflow?

Easter is coming, when rabbits abound
On what page in here can an egg be found?

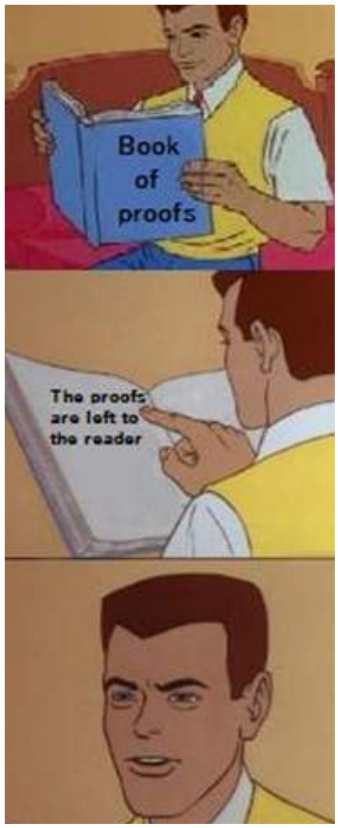
Aurorae come.
Aurourae go.
How many of our poets might you never know?

Physicists seek to understand "how".
What is the cost of a spherical cow?

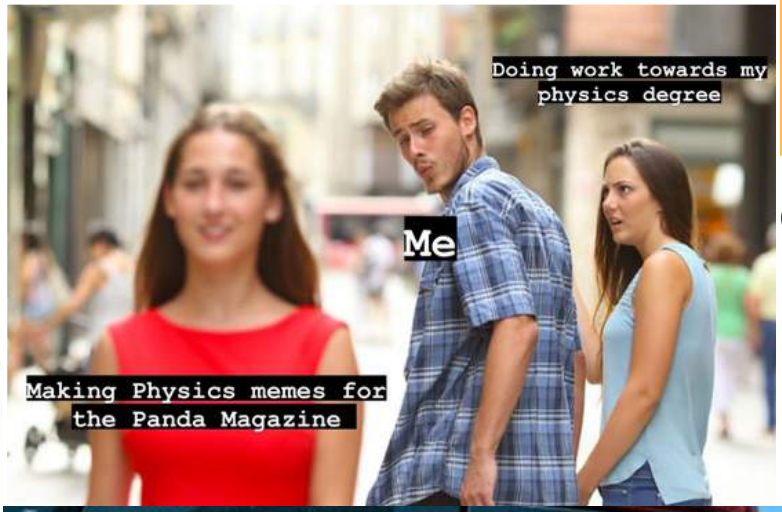
At SISCO, everyone had a ball.
Who is the person who started it all?
I hope you don't find this too unfair,
but you can find their photo two times here.

Memes

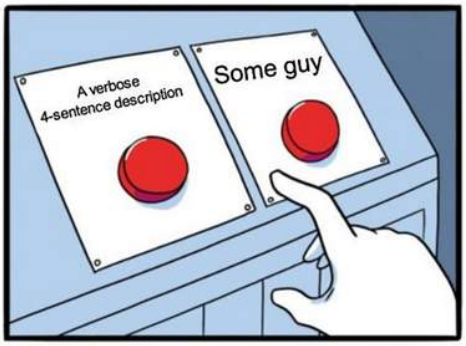
Supakorn Nikko Juengsophonvitavas



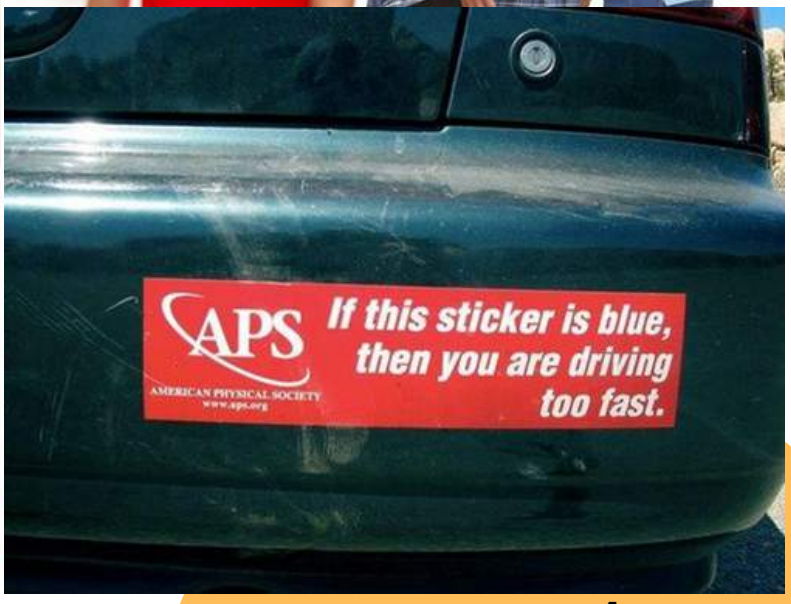
Anonymous



Rosie Gittings



Stuart Van Breda



Anonymous

References

References "On Large Numbers and High Frequencies"

[1] Schmittberger BL, Scherer DR. A Review of Commercial and Emerging Atomic Frequency Standards. IEEE Trans. Ultrason. Ferroelectr. Freq. Control. 2021 June;68(6):2007-2020.

[2] Filzinger M, Dörscher S, et al. Improved Limits on the Coupling of Ultralight Bosonic Dark Matter to Photons from Optical Atomic Clock Comparisons. Phys. Rev. Lett. 2023 June 22;130(25): 253001-253007. https://link.aps.org/doi/10.1103/PhysRevLett.130.253001

[3] Prestage JD, Tjoelker RL and Maleki L. Atomic Clocks and Variations of the Fine Structure Constant. Phys. Rev. Lett. 1995 May 1;74(18):3511-3514. https://link.aps.org/doi/10.1103/PhysRevLett.74.3511

References "The Death of MOND?"

[1] Banik I, Pittordis C, Sutherland W, Famaey B, Ibata R, Mieske S, et al. Strong constraints on the gravitational law from gaia DR3 wide binaries. Monthly Notices of the Royal Astronomical Society. 2023;527(3):4573–4615. doi:10.1093/mnras/stad3393

[2] Celebrating 40 years of Milgromian Dynamics and charting the road ahead: [Internet]. [cited 2023 Dec 31]. Available from: http://star-www.st-and.ac.uk/~hz4/MOND40Conf2023/index.html

[3] Banik I, Zhao H. From galactic bars to the Hubble tension: Weighing up the astrophysical evidence for Milgromian Gravity. Symmetry. 2022;14(7):1331. doi:10.3390/sym14071331

[4] Banik I, Pittordis C, Sutherland W. Detailed numerical implementation of the wide binary test [Internet]. 2021 [cited 2023 Dec 31]. Available from: https://doi.org/10.48550/arXiv.2109.03827

[5] Desmond H, Hees A, Famaey B. On the incompatibility of the radial acceleration relation and solar system quadrupole in modified Gravity Mond [Internet]. 2024 [cited 2024 Jan 13]. Available from: https://arxiv.org/abs/2401.04796

[6] Mazurenko S, Banik I, Kroupa P, Haslbauer M. A simultaneous solution to the Hubble tension and observed bulk flow within 250 *h*^-1 Mpc. Monthly Notices of the Royal Astronomical Society. 2023;527(3):4388–96. doi:10.1093/mnras/stad3357

References "Galaxies of Potential"

[1] www.st-andrews.ac.uk. (n.d.). Equality, diversity and inclusion - School of Physics and Astronomy - University of St Andrews. [online] Available at: https://www.st-andrews.ac.uk/physics-astronomy/about/equality-diversity-inclusion/ [Accessed 28 Oct. 2023].

[2] Physics World. (2018). Gender gap in physics among highest in science. [online] Available at: https://physicsworld.com/a/gender-gap-in-physics-amongst-highest-in-science/#:~:text=Physics%20has%20one%20of%20the [Accessed 28 Oct. 2023].

[3] dictionary.cambridge.org. (n.d.). mansplaining. [online] Available at: https://dictionary.cambridge.org/dictionary/english/mansplaining.

[4] The University of Edinburgh. (n.d.). Effects of Microaggressions. [online] Available at: https://www.ed.ac.uk/equality-diversity/students/microaggressions/effects-of-microaggressions [Accessed 28 Oct. 2023].

[5] Harvard.edu. (2022). Science Faculty's Subtle Gender Biases Favor Male Students | Gender Action Portal. [online] Available at: https://gap.hks.harvard.edu/science-faculty%E2%80%99s-subtle-gender-biases-favor-male-students. [Accessed 28 Oct. 2023]

[6] Students in UK physics departments. (n.d.). Available at: https://www.iop.org/sites/default/files/2020-07/Student-characteristics-2017-18.pdf. [Accessed 28 Oct. 2023]

References "Wind Power Breakthrough"

[1] Shan Peng, Binglin Xie, Yanlei Wang, Mi Wang, Xiaxin Chen, Xiaoyu Ji, Chenyang Zhao, Gang Lu, Dianyu Wang, Ruiran Hao, Mingzhan Wang, Nan Hu, Hongyan He, Yulong Ding, Shuang Zheng. Low-grade wind-driven directional flow in anchored droplets. Proc. Natl. Acad. Sci. U.S.A. 2023, September 11; 120(38). Available from: https://doi.org/10.1073/pnas.2303466120.

[2] Britain's electricity explained: 2022 review [Internet]. National Grid; 2023 [cited 2023 Oct 23]. Available from: https://www.nationalgrideso.com/news/britains-electricity-explained-2022-review

[3] Scott R. Loss, Tom Will, Peter P. Marra. Estimates of bird collision mortality at wind facilities in the contiguous United States. Biol. Conserv. 2013, October 14; 168. Available from: https://doi.org/10.1016/j.biocon.2013.10.007.

[4] Geoff Levanthall, Peter Palmear, Stephen Benton. A Review of Published Research on Low Frequency Noise and its Effects. London: Department of Environment, Food and Rural Affairs (DEFRA); 2003.

[5] M. R. Patel, O. Beik. Wind and Solar Power Systems: Design, Analysis, and Operation. Boca Raton: CRC Press; 2021.

Appendix

Appendix for "Galaxies of Potential"

Overview of Survey

Question Asked	Available Answers	Number of Responses
What year group are you in?	1st	4
	2nd	2
	3rd	6
	4th	27
	Masters	3
	Post-Grad	1
How would you best describe your gender identity?	Male	12
	Female	28
	Non-binary	3
	Prefer not to say	0
Is there a lack of gender equality in physics, in your experience?	Yes	38
	No	5
In your university experience, have you observed any instances of women being the subject of unfair treatment by reason of their gender?	Yes	21
	No	22
If you answered yes to the previous question, please elaborate if possible	Long-answer text box	15
Do you personally believe you have ever experienced unfair gender bias during your time at university? This could be conscious or unconscious bias.	Yes	11
If you answered yes to the previous question, please elaborate if possible	Long-answer text box	9
Please indicate the degree to which you agree with the following statement: It is important to take action to increase the involvement of women and girls in physics fields	Strongly agree	25
	Agree	10
	Neutral	6
	Disagree	0
	Strongly Disagree	2
In your opinion, what can we do to increase female participation in physics?	Long-answer text box	21
How likely do you believe you are to remain in a physics related field after leaving university? (1= Highly Likely, 5 = Highly Unlikely)	1	10
	2	15
	3	8
	4	6
	5	4
Do you believe there is adequate academic support / mentorship opportunities for women pursuing physics at our university?	Yes	13
	No	5
	Maybe	25
Are you aware of any gender inclusion initiatives or organisations related to physics at our university?	Yes	14
	No	24
	Maybe	5

BACK COVER PHOTO TAKEN BY SUPAKORN NIKKO JUENGSOPHONVITAVAS