NO. 1

28TH SEP 2020

PANDA

Panda's Announcements, News and Disfunctional Advice

Welcome back

New Physics and Astronomy Magazine

Photo Credits: Will Bowles

Dear Reader,

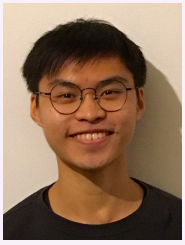
We are happy to share with you the very first issue of The PANDA Magazine! The concept started over the summer with the hope of sharing ideas and experiences of physics students within the school. We hope it will help to bring Undergraduates and Postgraduates from the school together (but we hope that some staff might read it too!). We also hope to share with you lots of interesting articles: from everyday physics to our physicist of the month, from interviews with graduates, to your internship experiences, and even a few puzzles!

It was Rose Waugh and Viktor Nordgren who helped take this magazine from concept to reality and pulled the weight of finding the first contributors. The beautiful design is mostly due to the hard work of Ishbel Wright. The content was created by Anson Ho, Rachel Black, Georgina Hirst, Ian Shand, Annie Layhe, Carolyn Mill and Veronika Sedlakova.

We really want to hear from you and share your articles too! We are looking forward to your suggestions, ads, and flat(mate) hunting posts – please don't hesitate to get in touch via email at pandamagazine@st-andrews.ac.uk, or find us on social media: **Facebook**, **Instagram** and **Twitter**

See you soon!

Rose Waugh



Anson Ho

Veronika Sedlakova

Annie Layhe

Ian Shand

Viktor Nordgren

Rachel Black

Carolyn Mill

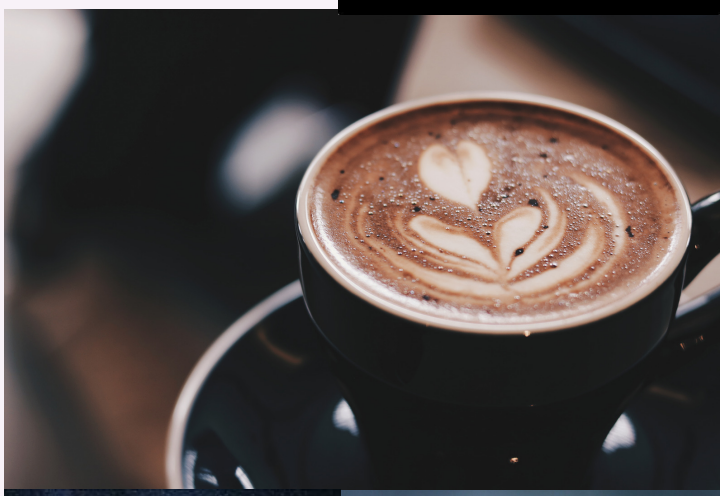
Ishbel Wright

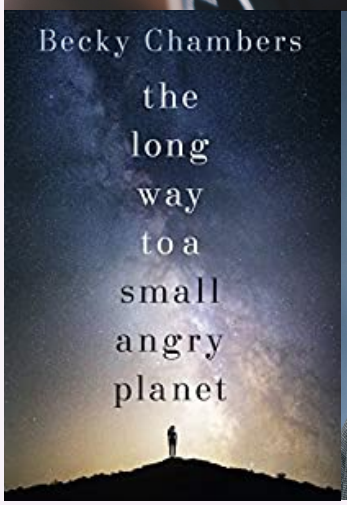
George Hirst

CONTENTS

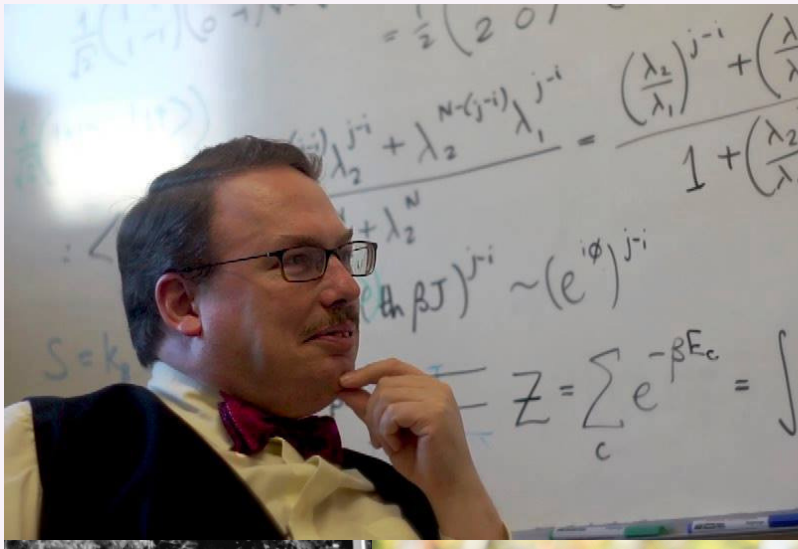
SOCIETIES

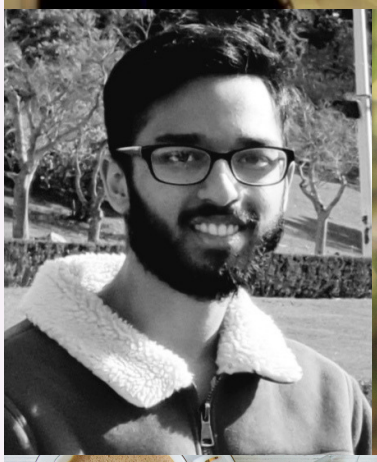
ARTICLES





INTERVIEWS





PHYSICS LIFE

physoc

the university of st andrews physics society

We are the society that brings together everyone who is interested in physics!

We organise fun lectures...

...host socials between all year groups...

...stream large physics events...

...help students buy and sell textbooks...

insight

...produce a podcast series where we interview staff to learn about their life and research...

COPENHAGEN
by Michael Frayn

CERN

...we also have bi-annual trips to CERN and last year we joined in with the local theatre producion of Copenhagen!

Find out more by visiting our pages

facebook.com/PhySocStA

@StAPhySoc

www.st-andrews.ac.uk/~physoc1

physoc@st-andrews.ac.uk

ASTROSOC

UNIVERSITY OF ST ANDREWS
ASTRONOMICAL SOCIETY

The Hitchhiker's Guide to The Society

BY RACHEL BARRON

It's a cool night. The curtains billow into the room as you stare out into the dark sky. Above you, glittering like grains of sand, is the cosmos. Full of stars and supernovae; planets and nebulae; moons and mystery and majesty.

That feeling strikes you. The awe. The profound notion of being a little fish in a big celestial pond, which has inspired countless composers and artists and poets. You're not alone.

Join the club.

The University of St Andrews Astronomical Society (affectionately dubbed AstroSoc) is a celebration of this curiosity. It is a place to share knowledge and enthusiasm within the shuttered domes of the observatory (and sometimes the physics building... or the pub). You don't have to study astrophysics either: we welcome everyone into our curious, cosmic community. We also drink quite a lot of hot chocolate.

So how do you join us?

This year, membership is available on the YourUnion website for £3 (super cheap). For semester 1 of 2020/21, in-person events will be suspended, but we intend to resume them as soon as we are allowed.

Fear not, however, as we still have some exciting events coming your way this year, and some tips on how to stargaze from home!

WHAT DO WE DO?

- Weekly Stargazing
- Guest Talks with Academics
- Pub Quizzes
- Collaboration Events & Trips
- Twitch Live Streams
- Starball
- Telescope Training
- Photography Workshops
- Public Outreach

Where do we meet?

The St Andrews observatory comprises a few buildings scattered across the field beside the Sports Centre. We meet in the Napier Building, easily recognisable by the two domes perched next to each other on the roof. Specific event details including times and dates are regularly posted to our social media.

What kind of telescopes do we use?

The Napier building contains Schmidt-Cassegrain telescopes with 25 (10″) and 40 cm (16″) aperture (which we use during our weekly stargazing). The other flagship telescope on campus is the 37″ James Gregory Telescope (JGT), the largest operational telescope in Scotland. This is used primarily by postgraduates and postdocs for monitoring stars, space debris, and for discovering exoplanets.

So come along, if you like.

The society has been running for nearly 50 years now, with committee members tending to stay on once they join. This may be due to the uniquely strong and caring community we've grown, or perhaps simply the allure of free hot chocolate. But, with all that being said, if you ever need some space to think, perhaps come along and think about space.

AstroSoc Galaxy Masks

Need a mask for class?

We've got you covered.

Order yours here: https://forms.gle/JT3EZ9gh3dLzvicQ6

Stargazing at Home

1. Sky Safari
2. Star Walk 2
3. Star Chart
4. Sky Map
5. Stellarium Mobile
6. Solar Walk 2
7. Mobile Observatory 2
8. Sky View Free
9. Star Tracker
10. SkyWiki

Run for committee in our EGM in week 2

Positions

Treasurer
Secretary
Sr. Observing Director
Jr. Observing Director
Web Overlord
Publicity Officer
Freshers Rep
Baking Rep
Postgrad Rep
Ordinary Member
Trip Organiser
Starball Rep
Events Rep

Contact us for more info!

HOW TO JOIN

YourUnion Page
www.yourunion.net/activities/society/6089/

Facebook
AstroSoc St Andrews

Twitter & Instagram
astrosoc_sta

Email
astrosocmail@st-andrews.ac.uk

Twitch
AstroSocsta

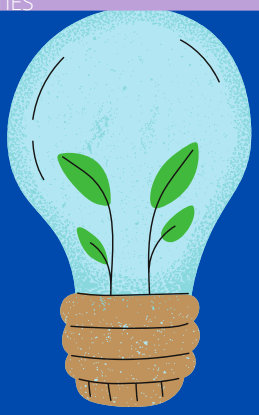
Website
http://www.astrosoc.club

SPIE. STUDENT CHAPTER UNIVERSITY OF ST. ANDREWS

We provide space and resources to facilitate research, outreach and career development.

Involved in organising international conferences

teaching in schools



seminars, cheese and wine events and opportunities to exchange ideas

Open to all staff and students!

Interested - come talk to us!

Ian Shand
President

Natalie Mica
Vice President

EASy
Engineering and Aerospace Society

WHO WE ARE

EASy, short for Engineering and Aerospace Society, is a society made up of students across many disciplines who are passionate about engineering and aerospace.

WHAT WE DO

We participate in engineering competitions against other unis and host workshops, talks, careers events, socials, and more!

FOLLOW US

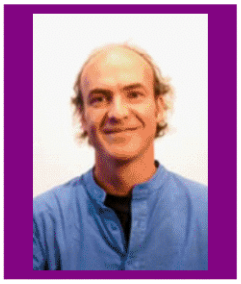
@EASy_UStA

@EASyStAndrews

@EASyStAndrews

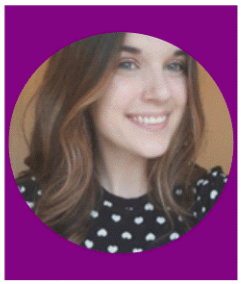
Who's who

Head of School



Ian Bonnell
hospanda@

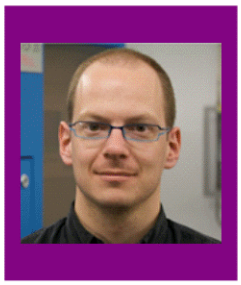
School President



Sarah Johnston
physicspresident@

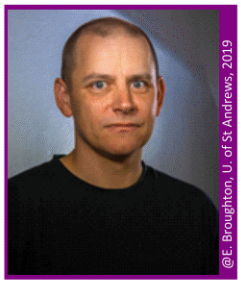
Directors of Teaching

Bruce Sinclair
physdot@



Paul Cruickshank
pasc@

Director of the Observatory



Alex Scholz
as110@

Examinations Officer

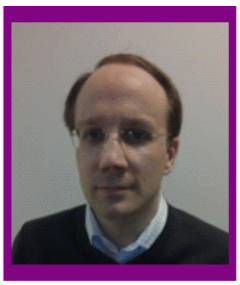
Brendon Lovett1
bwl4@

Directors of Postgraduate studies

Taught

Anne-Marie Weijmans
physdotpgt@

Research



Johnathan Keeling
physdotpgr@

School Secretary

Lesley Aitken
lma1@

Teaching Secretary

Linda Cousins
ljc21@

Research Secretary

Dimali Vithanage
da16@

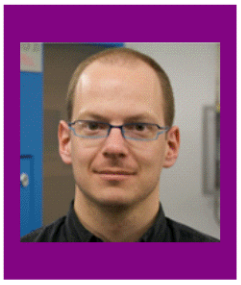
Finance Assistant

Poppy Nicholson
pkwm@

Director of Equality and Diversity

Lucy Hadfield
physeqdiv@

Wellbeing Officer



Paul Cruickshank
pasc@

Outreach Officer

Simon Reynolds
simon.reynolds@

Careers Centre Link Officer

Charles Baily
crb6@

PGR EDI Representatives*

Viktor Nordgren
vmn3@

Rose Waugh
rw47@

Up to some additions, this information was taken from the school's "Key contacts" page, where you can find a more comprehensive list.

* UG and PGT representation is via the school president

Physicist of the Month

Prof. Mercedes Richards

Birth: 14 May 1955
Death: 03 Feb 2016

Links to a few of their papers:
arXiv:1408.0224
arXiv:1210.0081
arXiv:1312.1105

Mercedes was born in Jamaica and obtained a BSc in Physics from the University of the West Indies. She later moved to Toronto to pursue an MSc in Space Science and then a PhD where she focussed on imaging binary star systems. [1]

She went on to become a Professor of Astronomy at the University of Virginia and Penn State. In her research into binary star systems, she modelled the accretion of mass between the two bodies. She was the first in astronomy to apply the technique of tomography (using X-rays to image a cross section through a solid object). Her work also focused on simulating the gas transfer between the stars within a binary system and using this to predict the consequential magnetic activity. [2]

She credits her pursuing a physics degree to her friends and teachers, who were all women as her primary and secondary education were segregated by gender. She has been quoted discussing the importance of those role models to her “Having those female teachers gave me a boost,” “As a young woman I could say, ‘Hey, I can be like them.’” She also committed a lot of time to mentoring and encouraging young people in physics, especially those from underrepresented groups. [3] [4] [5] [6]

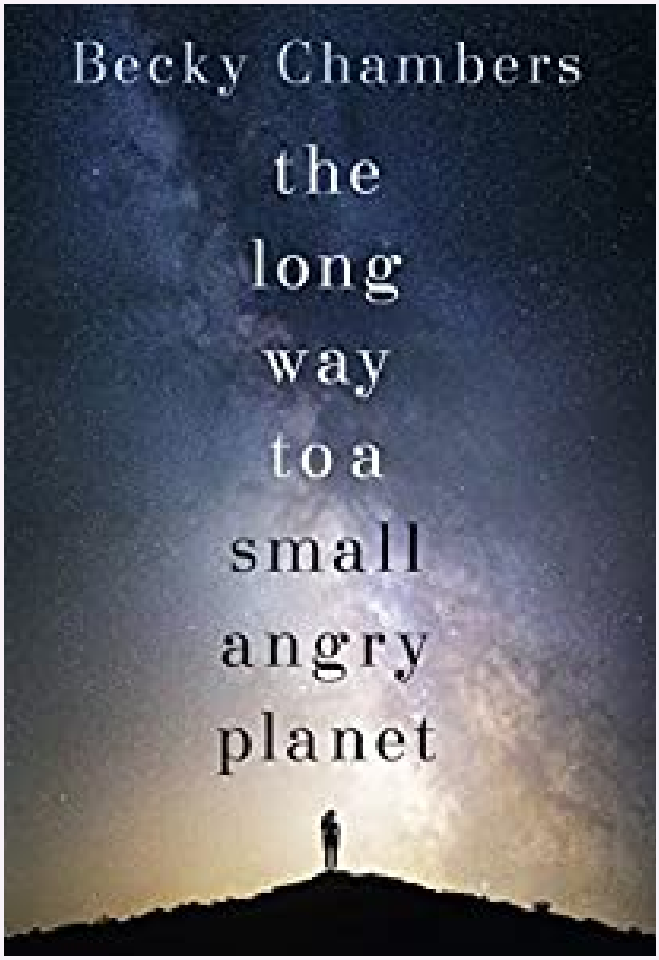
by Rose Waugh

A Fun Approach to Sci-Fi: the long way to a small angry planet by Becky Chambers

As a physicist, it can be hard for me to enjoy science fiction. This isn't because I have a deep running hatred of Spock, or the teddy-bear aesthetic of the Ewoks gives me the heebie-jeebies. It is because I know that whilst the universe is wild, it has limitations. Just adding the word "quantum" in front of something isn't going to magically fix all the basic laws of physics your "quantum mini quasi-death ray teleportation engine of doom" will break. Adding more smart-sounding adjectives does not make your piece of work smarter, it just makes you sound kind of pretentious. Quantum is not a catch-all net, and I wish authors would stop treating it like one.

My favourite authors will take an already known theory of the universe and push it in a fun new direction. This is exactly what Chambers has done throughout 'the long way to a small angry planet'. There is something romantic about quantum mechanics, and I can appreciate the desire to make all these grand metaphors about twisting time or the uncertainty of the future. It's just such an overly common way of drawing in the reader with grand promises. Those that practice using and calculating these quantum characteristics in their day-to-day lives have a different experience with it. More substance is needed. If you're going to introduce a new law in the universe that lets your character do something impossible like shrink down to the size of an ant, tell me about the practicalities. What are its limitations? What conditions does it need to function? Those are the things I find most interesting, the details that ground the law in some sort of reality.

My favourite example in the book is how spaceships can travel at such high speeds. Space-time is treated as a sheet, like in those videos you get explaining gravity as a curve in space-time where they put a ball in the middle of a blanket. What if we were then able to pierce this sheet like a needle going through fabric? The spaceship, acting as the needle, can then sew its way across the fabric of space-time, making lots of little jumps to get where they need to go. This is so much more fun than the regular wormhole leap-of-faith, and the book goes into more details of the equipment needed to facilitate such fast movements (the anchors, the biology of the alien pilot, the politics of such wide movement range, all of it). That creativity is exactly what I crave in science fiction, and if you are



of a similar mindset then there are many more instances of a fully fleshed out world that lie waiting for you in this book.

I haven't even started gushing about the characters and theming yet. We follow a likeable young woman named Rosemary who is the new clerk of a wormhole construction ship named the Wayfarer. The plot is simple; they need to journey a long way to construct a new wormhole. The true strength of this book lies in the crazy array of characters that are aboard the ship and how relationships develop between them. If you like 'found family', this will be perfect for you.

As a woman, the portrayal of such diverse and elaborate female characters is like eating chocolate on the sofa at the end of a long and frustrating day of

work. It's so refreshing to see women living their lives on a cool spaceship, actually interacting with other women on board because there's more than one of them! For some readers, this wouldn't be a novelty, but I finally felt seen and appreciated as a woman in STEM. There's also some great romance and sexuality representation in the novel, though it isn't a large part of the story in the first book. The sequel, 'A Closed and Common Orbit', spends a lot more time expanding upon an LGBT+ romance, if that's something you look for in your reads.

Overall, this book is a great meeting point of science, creativity, and friendship. So much time is spent developing the themes of finding daily positivity and having respect for one another that the novel leaves you with a warm and serotonin-filled aftertaste. I fully recommend this book to those who want to have a relaxed and happy time – with some added aliens thrown into the mix.

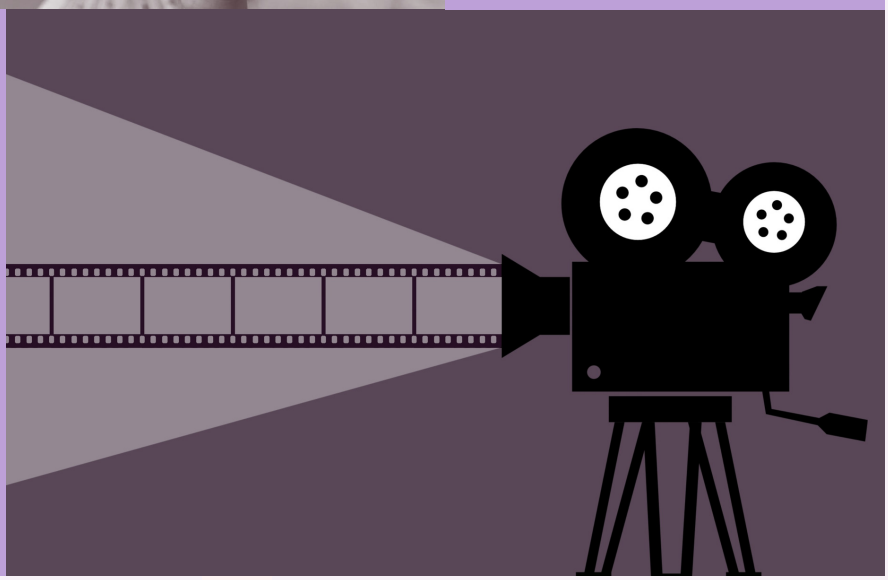
By Annie Layhe

Do you have an opinion about a book, film, video-game, or TV show featuring physics?

Maybe an indie artist has produced an interesting concept album...

...or a poet has captured the essence of what it mean to be a charm quark in only three sentences.

Whatever it may be, get in touch to have your own article included in next months issue!



Do Physicists make the best Baristas?

Want to make an espresso that is as good as Taste itself? Perhaps your physics degree has given you the ideal skill set to make a pretty amazing brew.

WARNING: The following topic may be addictive.

And I do not mean just the caffeine. Once you have fallen down the artisan coffee rabbit hole, there is no going back. As the world's most popular drink, with the UK alone consuming roughly 95 million cups a day, it is no wonder there are so many styles and varieties out there to discover. As a brief aside, instant coffee will not, I repeat NOT, be discussed in this article. You, dear physicist, are better than that. As much as I, and my all-Italian flatmates, love a frothy cappuccino in the morning, today I bring you the latest scientific lowdown on the king of coffee, the unadulterated perfection that is Espresso. No fancy glasses, frothy milk or watering down to suit the American(o)s. Before I get to the interesting physicsy stuff, it is important to understand how an espresso is made, and how it is different to other coffee. [1]

From Bean to Cup

Let us start with a bit of myth debunking. It is a common misconception that espresso contains more caffeine than your regular brew. The average cup of coffee contains up to 140 mg, whilst the espresso contains less than half of that. The intense taste difference associated with the espresso actually comes from the way in which it is prepared, coupled with the lower overall volume. I'll break it down. [2]

The popular filter coffee method relies upon gravity to extract the delicious flavours from the coffee grinds, as hot water is poured over them in a filter. This water emersion takes roughly 5-10 minutes, and although I have already blacklisted instant coffee, the first espresso was invented with the exact same motivation as its instant descendant - to make coffee much faster! That's where the comparison ends, however. Hailing from the wonderful Italia, the 'Caffe Espresso', literally meaning fast coffee, is made by forcing high pressure water through a bed of ground coffee beans for 25 seconds, producing what is known as a shot. Sitting at roughly 9 bars, this unique high pressure is what creates the signature foam, or 'crema', that sits on top of the coffee. The most important part of the process, however, relies upon the coffee itself. An espresso must be made using the finest grind of coffee beans, their pure essence. Now bear with me – the world of quality espresso is complicated and not for the fainthearted. There are a huge number of variables you need to keep in mind whilst preparing your perfect cup. These include grain size and distribution, water temperature and pressure, brew duration and roast type, and let us not forget, personal preference! Coffee connoisseurs have argued over the best possible combination of these variables for decades, but the greatest dilemma facing amateur coffee makers and professional baristas alike is reproducibility. [3]

Physics to the Rescue!

Picture this. You are at the World Barista Championships (yes, these do exist). You have just created something resembling liquid perfection. You win, becoming no less than coffee royalty. How can you be certain you could create EXACTLY that same espresso again? Did you think about the atmospheric conditions? Did you consider the water chemistry? [4]

It was these questions that intrigued PhD student, Christopher Hendon, whilst studying materials chemistry at the University of Bath. Joining up with a local independent coffee shop, he investigated the numerous factors influencing the variation in espresso. Now at the University of Oregon with doctoral title in hand, Hendon's research has certainly assisted him in his quest for a consistent cup. In fact, the results of his many studies may also have had significant economic benefits for the entire coffee shop scene!

Outlined in a report entitled 'Systematically Improving Espresso', Hendon's argument challenges one of the fundamental laws of espresso - the finer coffee grind rule. Shock! The rule itself originates from the assumption that the high pressure water flows homogeneously through the coffee bed during extraction. It follows that the amount of yummy goodness we can steal from the beans, known as the extraction yield, should decrease as the grind size gets larger, simply due to the decrease in surface area. [5]

Here comes the surprise twist. They had not consulted the physicists. The extent of extraction can be measured based upon the refractive index of the resulting espresso. By using this technique, Hendon's experimental results showed that the relationship between grind setting and extraction yield was not linear. In fact, there was a peak somewhere in-between course and fine grinds – suggesting an inhomogeneous flow at both extremes. Fundamentally, too fine a grind results in no space for the water to flow, thus actually reducing the exposed surface area.

Not only does this prove that reproducing the perfect espresso using a fine grind is impossible, it implies that we are wasting some of the coffee in the process! Moreover, Hendon estimates that implementing their mathematical model to identify the optimal gauge of grind could reduce the mass of coffee required per cup by up to 25%! Wow

Give us the Recipe!

Ok, ok. I know that as much as you are interested in going through the many, many lines of differential equations with me, what you really want to know is the end product. What are the perfect conditions for the perfect espresso?

Hendon says that for a highly reproducible espresso, the barista must reduce the mass of coffee for a double shot to 15 g and use a coarser grind. This means that you will also get a much faster shot, cutting down the extraction time to 15 seconds. I implore you to give it a go if you have an espresso machine at home, and please do share the results with me if you catch me in the physics café!

Flawless Formula or Massive Miscalculation?

With sustainability at the forefront of everyone's minds, the idea that we are cutting down on coffee waste whilst simultaneously making consistently good espresso is awesome! Hendon's 'waste reduction protocol' has even been implemented in a speciality coffee café in Oregon, where they have been able to save roughly $0.13 per drink. The reduced shot time has also allowed café goers to get their caffeine fix far quicker. Overall, the cafe could see an increase in profits amounting to $3,620 per year – huge!

It might be time to wake up and smell the coffee, because the whole procedure may kinda overlook the key variable – taste. Uh-oh. As it turns out, the inhomogeneous flow in the original espresso method may actually be WHY the drink tastes so good. Blockages in the coffee bed create a goldilocks style mixture of over and under extracted coffee which is just right. In the game of imaginative names by scientists, Hendon refers to this perfect mixture as the 'tasty point'.

All is not lost! With the aid of a beautifully crafted graph, he argues that both this 'tasty point' and the economic success of his model may be reached through a method of blending shots. Admittedly, this procedure may only be for the most pedantic baristas among us, as it is nit-pickingly technical. It could, however, easily be executed in large firms, such as the mighty Starbucks (although in my opinion they have a few basic issues to get right first ...).

So, do physicists really make the best Baristas? Since its creation in the early 1900s, the modern espresso has been so globally loved, yet also so hugely disputed and diversified. Whilst Hendon's vision to economically improve the coffee making industry shows amazing innovation, the concept of the best ever espresso cannot simply be a scientific argument. The vast number of variables that go into that tiny cup of coffee provide so much scope for interpretation that quantifying a 'tasty point' seems more than impossible to me. Perhaps physicists simply make the best physicists. Sigh, I think I need another coffee.

There's so much science in coffee – from the design of the machines, to the "9barista" concept, and even the science of freeze drying for instant (yuk) coffee. Please let us know if you'd be interested in a regular series of coffee inspired science articles!

By Rachel Black
Photos by Jodie Wight

Look out for the N-rays!

The inevitability of confirmation bias and how it affects physics

The Discovery of N-rays

France, 1904.

Professor René Blondlot is about to make physics history.

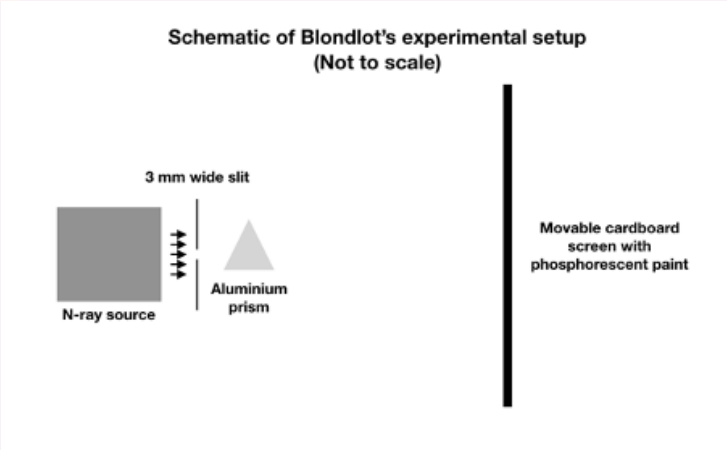
Just last year, he announced his discovery of a previously unknown part of the electromagnetic spectrum: N-rays [1-4]. Allegedly, these rays are emitted by almost all objects and have a host of bizarre properties, like the ability to change the brightness of sparks and improve the resolution of distant objects [4-7].

News of his discovery spread rapidly throughout the physics community, but many were unable to reproduce his experiments [5,7]. Amidst the resulting scepticism, *Nature* sent Professor Robert W. Wood to Blondlot's lab to investigate things further [6-8].

This is where we are now – a dimly lit physics laboratory at the University of Nancy. Robert Wood watches with scrutiny as Blondlot and his lab assistant run through their demonstration. The alleged N-rays are split using an aluminium prism and observed using phosphorescent paint on a screen, which should glow ever so slightly when the rays impinge upon it [2,5,7]. In order to see the effects, the room has to be very dark, and the eyes of the observer sensitive to even the most minute changes [7,9]. If Blondlot is right and N-rays do indeed exist, a distinct spectrum will be observed [5,7]. With everything meticulously set up, all that is left to do is to let physics do its thing.

Wood watches with anticipation and sees something truly remarkable: absolutely nothing. Blondlot on the other hand, is absolutely convinced that the spectrum is distinctly visible, and he attributes Wood's inability to see the pattern to a "lack of sensitiveness in the eye" [5]. In light of these assertions, Wood proposes a follow-up test: he would adjust the aluminium prism, and Blondlot would have to tell when the changes were being made and how the prism was aligned [5].

Secretly though, Wood removes the prism altogether, ruining any chance of the spectrum being observed [3,5]. But neither Blondlot nor his assistant detect any change – they remain convinced that they see the same pattern, utterly oblivious to what has happened [1,3,5-8].



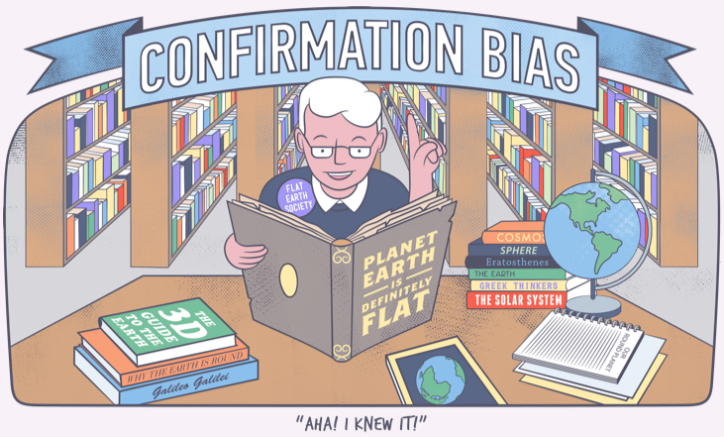
Wood's conclusions are quite self-explanatory:

> "I am not only unable to report a single observation which appeared to indicate the existence of the rays, but left with a very firm conviction that the few experimenters who have obtained positive results have been in some way deluded [5]."

Confirmation Bias

Coming back to the present, we now know that the purported N-rays were just a figment of the imagination [1,3,7-9]. This is true not just of Blondlot and his assistant, but also of the other physicists who claimed to have replicated his experimental findings. How could all of these scientists have believed so firmly in the existence of non-existent rays? The answer is *confirmation bias*, and is also the delusion that Wood alluded to. This involves favouring information that conforms to our beliefs while ignoring evidence to the contrary [10-14].

The reason for this bias is not entirely clear, but it likely stems from our natural impulses [11], such as our tendency to prefer coherent narratives in thinking. This has been shown in MRI studies, where observed brain activity suggests active yet unintentional attempts to minimise cognitive dissonance [11,12,17]. This leads to both avoidance of contradicting information because we do not like to be wrong, and seeking supporting evidence because we like to be correct [11].



Credit: Towergate Insurance[13]

In physics, there are two main ways in which this happens. The first of these is the biased search for information [9,11]. In Blondlot's experiment, he was explicitly looking for a miniscule change in the luminosity of phosphorescent paint. It appears that he tried so hard that he managed to force it into (his) existence!

The second way is through the biased interpretation of information [9,11,15]. This could be through assigning more weight to certain results, or by simply ignoring evidence that supports alternative explanations. As previously mentioned, one of the apparent features of the N-rays was that it could change the brightness of sparks [4-7]. It turns out that these changes were in fact due to normal, random fluctuations that sparks usually undergo regardless of any intervention [5,7]. However, when Blondlot observed such fluctuations, he quickly attributed them to the effect of the N-rays [4,5,7]. This just goes to show that our expectations can really distort how we see things

What should I do?

The damage can be great if confirmation bias is ignored. Incidentally, Blondlot's reputation was brought to its knees, and he never recovered from the resulting public humiliation [1,3,7]. Allowing biases to remain unchecked during the research process can also diminish both the quality of collected data and the accompanying analysis. Imagine having to repeat an experiment from scratch all because of this... ugh! It can even sustain false theories despite contradicting evidence [16].

Eradicating the bias, however, is not always a simple process. Consider the following question:

> **Q: Your physics experiment stubbornly refuses to obey the laws of physics. What should you say? (You may choose one or more answers.)**
>
> (A) "It's probably just random error"
> (B) "I'll fake the data... Who could possibly know?"
> (C) "What have I done wrong this time?"
> (D) "Physics is broken!"

Options A to C all describe situations of confirmation bias – in some sense, a denial of the existing evidence. Option D would therefore be the "correct" option, right? As you can probably tell, things are not so simple. For instance, if the physical law that is violated is very well established experimentally, there is probably more reason to believe that something has gone wrong than to declare "the end of physics as we know it". Of course, there is also some chance that the law is indeed wrong, but this would be very unlikely and the chances would have to be weighed accordingly [18]. You could therefore imagine how difficult it might be to suggest that a widely accepted law is flawed in some way.

Although it is practically impossible to eliminate confirmation bias completely [11,12,16], there are fortunately still some things that we can do to mitigate it.

- **List ideas as to why the hypothesis might be incorrect [10-12].** It can also be helpful to list alternative hypotheses and to see whether these are consistent with findings. Knowing about these other possibilities can help limit how much we search for evidence that only supports a particular view.
- **Constantly ask yourself whether you are processing information in biased fashion [10-12,18].** What is your first reaction to a book titled "The Moon Landing Hoax"? Why do you have that particular impression? Would it be a good idea to look at what the book says? Doing this does not mean that you have to agree with whatever you see; rather, it means being aware of our reasoning and identifying weaknesses in how we see information.

Beyond the individual level, there are also other ways of combatting confirmation bias. One of these is scientific peer review, although it is important to note that this process is itself prone to the bias [20]! It is also useful to have attempts to replicate the original experiment. As a matter of fact, this was what eventually spelled doom for Blondlot's N-ray theory – the failure to replicate the experiment consistently and independently [3,7]. These methods are far from being a cure-all, however [16].

With the benefit of hindsight, it can be very easy to dismiss the N-ray debacle as a singular case of delusion, and to think that this is not relevant to ourselves. But it is important to realise is that no one is infallible. Everybody is susceptible to confirmation bias, and if we're not careful, there's no telling whether or not we might see N-rays of our own.

By Anson Ho

An Interview with Dr. Chris Hooley

Transcript of highlights: Insight Ep. 1

For our inaugural interview we sit down for a delightful conversation with Dr Chris Hooley, a man recognised for his style and presence around the physics building. We talk about some of his thoughts on physics, what physicists are like at parties, and how to ruin an almost perfect moment in St Andrews.

Sam: Could you tell us something about your original interest in physics?

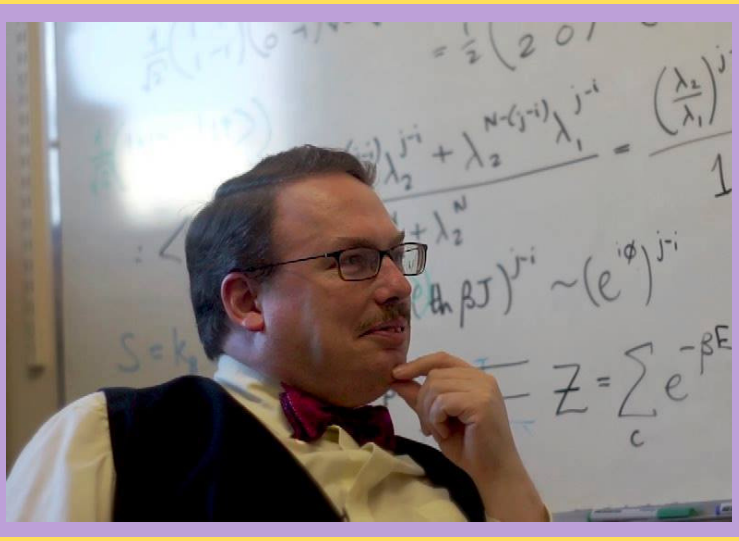
Chris: Sure! It was very... odd. I was at school in England. I did quite a scientific set of A-levels, essentially because I was good at maths. I was always good at maths as far as I remember, even at primary school where you have to partition fish between groups of people, I was very happy with all this stuff. My father was an engineer and I think he was very happy I was good with mathematics, and that he could talk about it and teach it. He taught me calculus at a young age. As soon as he thought that I was ready for it, he would teach it, so I was often ahead of what was done at school. So anyway, I ended up doing Maths, Physics, Chemistry, Further Maths, and French (which is maybe not such a scientific subject). I was tooling up for science.

Then in Sixth Form, I became interested in Philosophy, which started as an interest in logic, but then became broader. Some friends and I formed a little reading group where we would read some philosophical works that seemed to be important. Looking back, we made some odd choices because we didn't know what we were doing. Anyway, I realised I would actually like to do Philosophy, but with my A levels, they wouldn't take me on a degree with Philosophy because they were all scientific. I thought ok, maybe if I do one of these joint degrees like Physics and Philosophy, I can get in on the physics and then exit as a philosopher. That was the plan when I went to university, I was not planning to be a physicist. And then halfway through the degree, I was less interested in the Philosophy that I'd expected, I felt I was hearing the same argument several times, thinly disguised as different arguments. Of course, we also started studying quantum mechanics, which I found completely fascinating.

went to my tutor at the end of my second year and said: "I know this is a crazy thing, and I know that my degree doesn't contain any statistical physics or condensed matter, but nonetheless, any chance of going into a PhD in physics after that?" And he could easily have said "No, no chance of doing that, you've made your bed, you'll have to lie in it", but he did quite the opposite. He gave me a huge amount of his time, his books and resources. He organised with his colleagues to give me one-to-one tutorials on the bits that I was missing, so I had a wonderful year in 1995 basically learning privately all the bits that I have missed by doing Philosophy. And then I was ready. In practice, I had to stay in Oxford, because on paper I wasn't qualified. If I was going to go on into a DPhil, I was probably going into it in oxford because they knew me, but probably nowhere else. I applied to several other places and, sure enough, no dice. And then it was just a question of applying to Oxford and indicating interest in a supervisor. Here, I did what they say you should never do, and I chose the person. I was pretty agnostic between working in high energy or condensed matter. I'm not sure I really understood what the distinction was between them. I met my future supervisor at a party, we got really drunk, and so I asked him "Can I put you down". He worked in condensed matter theory – and now so do I.

Sam: My next question is what are the concepts that you maybe struggled with as a student?

Chris: Classical Mechanics! That's something I have no intuition for. If you show me a mechanical device with masses and pulleys and things and say, "I'm going to release this, which way is it going to move?" I'd have no clue. I have no good intuition for rotational motion. I have no good intuition for rotational inertia. Classical Mechanics has always been the subject where the only way I can do it is to set up the equations and just rigorously solve them. I just can't see it, somehow. Which is odd, as people usually say that they have the intuition for classical mechanics, and they can't see quantum mechanics. I can see quantum mechanics, obviously not from the beginning, it took some work, but I developed some sense for it. Classical Mechanics, I mean I know how it works, but I don't feel it, somehow.



Sam: There are always these stereotypes about physicists being those guys you don't want to invite to the party. You've worked with many of them, so now maybe it's time for you to defend them, or maybe concede a few points...

Chris: I concede nothing. In some sense, obviously, once there is a stereotype, people play to it a bit. I suppose it is true that when you look at the people who got into the sciences at school, they were the ones that when you asked to choose between people and rocks, they chose rocks. That must say something. But it's also true that if you go to the March meeting of the American physical society and you wander around the halls at 4pm and you say to people that you only faintly know "do you fancy going for a beer?" I've almost never heard anyone say no to that question.

Sam: Have you asked this question a lot?

Chris: That's my entire approach to the March meeting of the American physical society! Of course, you start as a student thinking "Oh, I must go to all these talks". But with thirty-three parallel sessions, by the time it's over, you've missed 97% of it, so why feel too guilty about the remaining 3%. Go find someone to have a chat with them, you're bound to find out more interesting things that way.

Feela: A single piece of advice that you'd give to the students in the physics department to enjoy their university experience to the fullest.

Chris: Piece of advice...I don't know how universally applicable this is, but I would say make good plans. The reason for that is because making good plans is a really good way to enjoy what you're doing. Often people don't enjoy what they're doing, because they know they should be doing something else, or that they are behind with something else. There's always something else praying on their mind. If you can plan well enough to stop these things, it's amazing how much you can enjoy what you're doing.

Want to hear the FULL, original interview?

Visit the Insight web page to access all of our episodes!

Follow us on Facebook for updates on when new episodes are released, and visit our YouTube page to listen in a different format.

Want to get involved? Email physoc@st-andrews.ac.uk and give us your thoughts!

insight

Internship Interview

Vinayak Shastri, MIT Covid 19 Challenge 2020

Tell us about your hackathon - who ran the event / how long did it last?

The MIT Covid 19 Challenge was an online hackathon event on May 29-31, 2020. This was a global event with 1800 selected participants with bright & diverse backgrounds, 200+ mentors, 70+ partners from 89 countries all coming together to provide creative solutions to shape the Post Covid-19 world. I am proud to be part of a team which won the MIT Covid 19 Challenge.

What did you do?

Our team consisting of myself and the North American based Sandeep Gummadi, Heer Joisher, Saket Tulsan, Hiba Turqui, Luca Pizenberg met during the hackathon itself and worked together across multiple time zones and conceptualised our idea during the event on incentivising restaurant safety. We decided to design an app called CoSAFE, which will rebuild restaurant confidence in order revive the restaurant sector in the Post Covid-19 world. I particularly focused on designing the initial algorithm which will rank restaurant safety using certain parameters.

What was it like?

This was a unique experience where I had the opportunity to communicate my ideas with successful entrepreneurs and receive advice from MIT mentors regarding on how to build business which can take precautions from Covid-19. The sleepless nights were all worth it when our project was considered as a winner of the hackathon. It felt really empowering to receive validation for an idea by MIT and other associated businesses including major pharmaceutical companies.

What are the next steps after the hackathon?

After winning the MIT Covid 19 challenge the project will receive $500 dollars to boost the development of the idea. Currently, I am working on my own to pursue this idea. In order to push this venture, I am more than happy to have people in my team with a background in app development, website designer, experience in database

building and security programmer in order to build this app. This venture will be a perfect opportunity for students to work on a good cause whilst boosting their CV as they will be working on an idea which has the concept approval of Massachusetts Institute of Technology. In these tough times I understand the difficulty in finding placements hence I am more than happy to offer this opportunity to anyone struggling to find placements.

Do you have any tips regarding the recruitment process?

I am just looking for people who are passionate about helping the world heal from this virus and with the technical ability to build a solution on this project.

What will you personally take into the future from this experience?

This experience has bolded me to push myself and think outside of the box. The exposure of working with world leaders in their fields has taught me how to cope with the pressure and expectations of delivering ambitious projects. I have seen the effects of this belief this summer when I was assisting research projects on terraforming and planetary science in the University, something I am deeply passionate about. I will use this to motivate myself to make University of St Andrews and my hometown Croydon proud in future ventures.

Have you had an internship experience this summer? Why not share it with us!
Email us at pandamagazine@st-andrews.ac.uk

Graduate Interview

Richard Tatham, Senior Patent Attorney, HGF

Tell us a little about your time as a physicist in St Andrews?

I came to St Andrews in 2008 having studied for my undergraduate degree elsewhere. While in St Andrews I studied for a PhD in theoretical physics under Natalia Korolkova, which I received in 2012. My research was somewhat varied – I began by looking at how to increase the amount of quantum entanglement (non-local correlations that have no classical analogue) between two samples of caesium gas, which led me to look into various measures for quantifying quantum correlations. Believe it or not, the maths can be beautiful!

What have you been up to since then, and what is your current job title?

After completing my PhD, I moved to London with my then-girlfriend, now-wife (another St Andrews alumnus). I started work as a trainee patent attorney and after several years of on-the-job learning and passing several difficult professional exams, qualified as both a chartered patent attorney and a European patent attorney. I am now a Senior Patent Attorney with HGF.

What does your job involve?

Patent attorneys act at the interface between the technical and legal worlds. I spend a lot of time talking with inventors at large multinational firms, in cutting edge start-ups, and in universities/research institutes in order to understand their new inventions and then translate their ideas into suitable patent applications. A lot of time is also spent arguing with patent offices as to why an invention is worthy of a patent – a patent gives the owner an effective monopoly over a patented invention for 20 years – and this can culminate in oral hearings in which one has to provide complex highly-technical and legal arguments. These days I work with several start-ups who primarily operate in the fields of quantum computing, machine learning, and blockchain technologies, and advise them on how to best protect their ideas, and how to deal with competitors. Although they are relatively rare, one can be pulled into large court cases, which are particularly interesting.

Why did you choose your career path? (or maybe you didn't, in which case "how did you end up here?")

Several factors were involved in my decision to become a patent attorney. A friend of mine had gone into patent law and she was very positive about patent law as a career choice. I have always enjoyed learning about new technologies and, after the deep focus of my PhD, wanted to be able to learn about a wider range of topics – this has certainly proved to be the case. Also, the job of a patent attorney can be fairly lucrative.

What do you see as the most crucial skills a person needs for your role? What makes a physicist a good candidate?

All patent attorneys need a strong background in science or engineering in order to understand the inventions that crop up – in that respect, physics has proved invaluable. While a PhD isn't necessary, I have found that my time at St Andrews has helped with some of the more challenging technologies, such as quantum computers. A good written ability is also essential.

If you hadn't done a physics degree, what would you have studied instead?

I considered becoming an electrician as a teenager. Then, at around 16, I read a book on the history of codes and codebreaking, and the final chapter discussed how quantum mechanics could in theory be used to crack bank codes. At that age cracking bank codes sounded like a good skill to have, so I studied physics to learn more about quantum mechanics.

What is your fondest memory of your time in St Andrews?

Jazz in the Byre Theatre.

What do you wish you'd have spent more time on during your time in St Andrews?

I wish I had taken the opportunity to pick up another language

What do you miss about your time here?

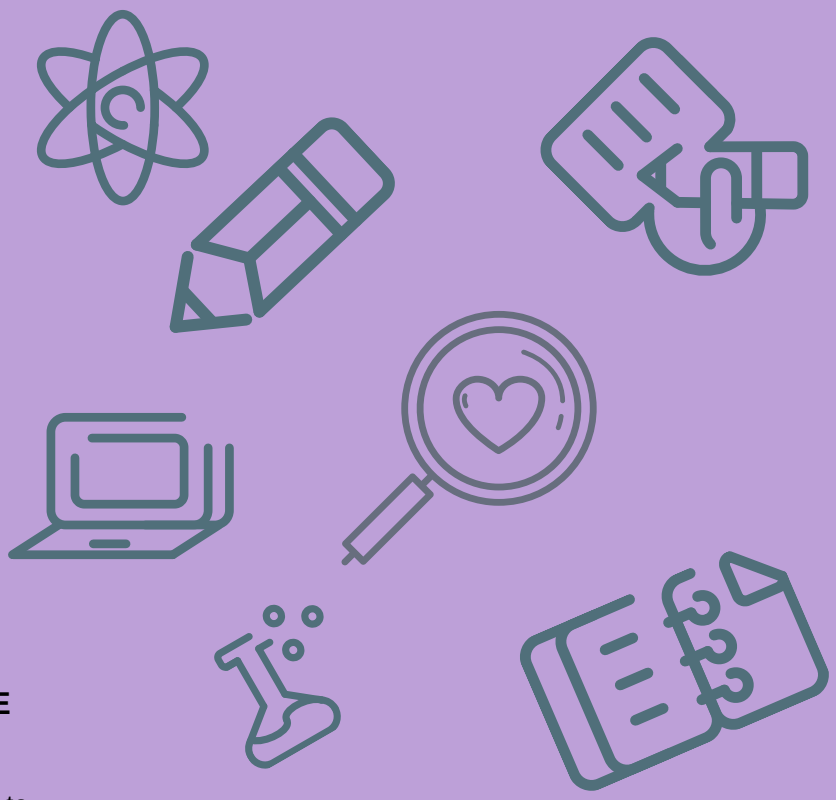
Easy access to the beach!

Do you know someone that went on to do something exciting and would like to tell others about it? Why not it with us!
Email us at pandamagazine@st-andrews.ac.uk with the subject "Graduates".

TIPS FOR WORKING FROM HOME

Right now it can be hard to stay motivated, so here are some tips on how to be productive without sacrificing your mental health to do so!

by Carolyn Mill



1 KEEP YOUR WORKSPACE ORGANISED

Know where your stuff is and tidy it away when your done. Find a designated place to work like your desk or your kitchen table, and try to avoid eating or relaxing there, if possible.

2 MAKE LISTS

List everything: weekly tasks, daily tasks, the smaller tasks that make up bigger tasks. Tasks are more manageable once you know the smaller steps you need to take to finish them. Personally, I like to put something I'm going to do anyway, like "make coffee", on the list to get me started on the box-ticking dopamine high.

3 PACE YOURSELF

Don't leave stuff till the last minute, but don't overwork yourself either! If today's list seems unconquerable, what little tasks can be left till tomorrow? If today is looking idle, what can you start on to make tomorrow easier? Be kind to tomorrow's you, but also to today's you. I may be labouring this point too much, but it's very important!

4 GIVE YOURSELF INCENTIVES

Give yourself small things to look forward to between or after tasks, especially ones you're not exactly enjoying. Once you finish this two-page integral, you'll go on that walk!

5 TAKE BREAKS

This ties into giving yourself incentives. If you feel yourself getting tired or stressed, take a break! Make yourself some tea, go for a walk, do some stretches, have a snack, or text a friend. It's unhealthy to push yourself without taking a rest, be kind to yourself!

6 AND FINALLY, DO WHAT WORKS FOR YOU

There's no point in doing all of this if it doesn't help you focus and motivate yourself. Do things your way, at your pace,

Green bean salad

Ingredients

Base

Green beans (Haricot verts) *frozen*	A bunch *How hungry are you?*
Tomato	1
Onion	1/2
Favourite oil *Olive, canola*	A drizzle *Think "Gordon Ramsay"*
Favourite acid *Lime, Apple cider vinegar*	1-2 dashes

Optionals

Chickpeas	1 tin
Butter beans	1 tin
Hard-boiled eggs	1 or 2
Chilli flakes	A pinch
Sesame oil	1-2 dashes

Preparation

Estimated time
15 minutes

1. Put the green beans, along with a pinch of salt, in a heat-proof bowl and fill it with boiling water (if the water cools down too much, drain and refill). Cover and drain when cooked but still a vibrant green colour (about 4 minutes. Taste one: it should be tender, not mushy nor taste raw.)
2. Meanwhile, chop the tomatoes and onions into some geometric shape of your desired dimension.
3. Mix everything in a bowl, adding the oil and acid (I usually go for olive oil and the juice of ½ a lime).
4. Top-up with any additional ingredients.
5. Enjoy with some carbohydrate: flatbreads or pasta.

Alterations

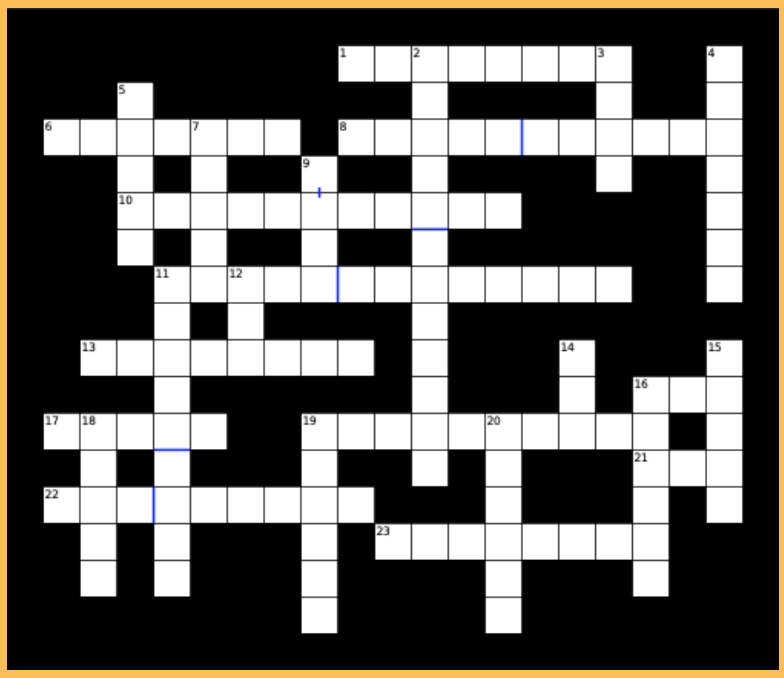
For some warmth you can fry the haricot verts in a pan with some oil, removing them from the hot water earlier or skipping that altogether. Watch out for oil splashing when adding the haricot verts as they may be wet.

Let them char lightly for extra flavour.



PUZZLES

Coffee Conundrums



An interactive version of this crossword can be found here. (Links to OneDrive file for download, requires university login).

Across

1. A physicist's necessity (8)
6. Makes coffee filters possible (7)
8. Sings in his lectures (5,6)
10. One reason why bubbles pop (11)
11. Author of "the long way to a small angry planet" (5,8)
13. Kelvin's equivalent? (8)
16. Important message to the public (abbr.) (3)
17. Interesting part of the NMR spectrum (5)
19. Imaging method for solids (10)
21. Black or chai, for instance (3)
22. Et Al. (3,6)
23. unite ron (anag) (8)

Down

2. Where are the aliens? (5,7)
3. First name of Tesla founder (4)
4. "Fiosaig" in English (7)
5. Light amplified by stimulated emission of radiation (5)
7. It could be real or virtual (5)
9. False electromagnetic wave (1-3)
11. A real sucker (5,4)
12. Type of geometric isomer (3)
14. PhySoc affiliate (abbr.) (3)
15. SI unit of capacitance (5)
16. Language or snake? (6)
18. Physics and astronomy (5)
19. A force's moment (6)
20. Connects you to the internet (6)

Riddles

Boomerang Ball?
How can you throw a ball as hard as you can and have it come back to you even if it doesn't hit anything? Assume that there is nothing attached to it and no one else catches or throws it.

Starry Starry Night
Relative to the Andromeda galaxy, how many times does the Earth rotate in a non-leap year? (Hint: It's not 365!)

Anagrams

Piece of cake
fresco (1 word)
destiny (1 word)

Rather challenging
a lift or bicep *(2 words)*
antique munch scam *(2 words)*
rafter gnome *(1 words)*

Rocket Science
scenic tent cooker *(3 words)*

Solutions on page 34

Poster Board

Bookshop

Have some unwanted textbooks?
Email us some information or a small ad to post here

Flat(mate) hunters

Looking for a flat or someone to share one with?
Email us some information or a small ad to post here

Dear Niblings,

Is there anything keeping you awake at night or even nagging you just a bit?
If the answer is yes then I'd like to hear from you and I'll listen to your worries (I might even answer with something useful!). If you want, I can also pass on your worries to your representatives in the the school's equality and diversity comittee - let me know in your message.

Much love,
Your local agony aunt.

What does "PANDA" stand for?

Fitting words to pre-chosen Acronyms is a key part of astronomy! Email us your ideas "PANDA" for the next magazine acronym with the subject "Acronym" and we will pick the best one for next issue.

Eg: People Are Nice Dinosaurs Aren't

Poster Board

Introducing your President!

My name is Sarah and I am the Physics & Astronomy School President for this academic year. I'm a 4th year Astrophysicist, and when I'm not doing physics stuff you can find me at dance classes, rehearsing for a musical, organizing charity fundraisers, or debating which Marvel superhero is best. My role as SP is to represent the views of students to the staff and the wider university. I chair the school's Student Staff Council where class reps and members of staff meet and discuss issues and ideas within the school.

II am here for any issues, comments, concerns, or questions you may have about the school, your modules, or education in general. I'm also in charge of organizing careers events, department socials, and some wellbeing activities. My email (physicspresident@) is always open to feedback or you can keep track of what I'm up to on my Facebook page!

Anything to advertise?

Do you want to highlight an event your society is holding? Or maybe even just to let others know of your society.
Send us an email with an image or some text.

Do you want to contribute?

This magazine is produced entirely by students (U&PG).
Let us know if you want to write something or if you have an interesting idea for an article!

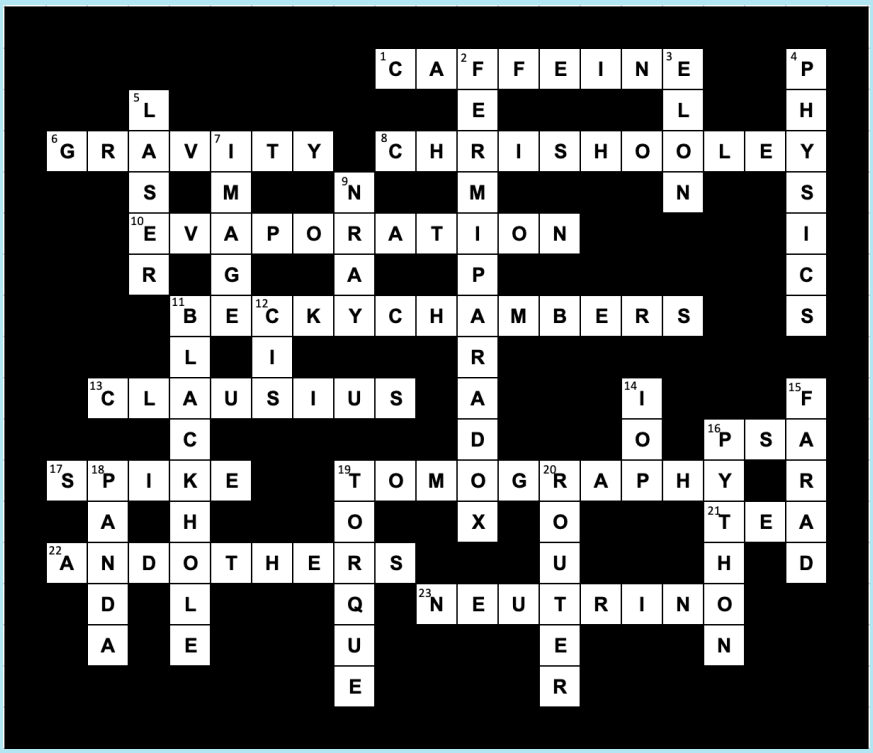
How to contact us

For queries and contributions
Email: pandamagazine@

Social media
Facebook: PANDA magazine
Instagram: @sta_panda_mag
Twitter: @sta_panda_mag

Puzzle Solutions

Coffee Conundrums



Anagrams

Piece of cake
FORCES
DENSITY

Rather Challenging
OPTICAL FIBRE
QUANTUM MECHANICS
FERROMAGNET

Rocket Science
NOT ROCKET SCIENCE

Riddles

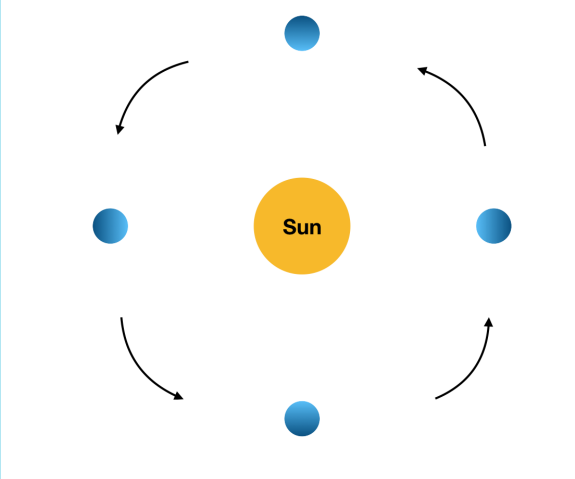
Boomerang Ball?

Throw the ball straight up in the air!

Starry Starry Night

366 times! The Earth rotates 365 times relative to the Sun in a non-leap year, but because we are considering the point of view of a faraway galaxy, there is one additional rotation that we need to take into account due to the Earth's orbit.

You can think about it like this. Imagine that the Earth were somehow tidally locked to the Sun such that St Andrews always directly faced the Sun. There would be no "solar days" because the Sun would never seem to rise or set. After a year, when the Earth returns to the same point in its orbit, it would still be facing the same direction. But wait - this must mean that over the year, the Earth would complete one full rotation even though the Sun never rises or sets. Relative to a "stationary" (practically speaking) faraway observer, like an alien in the Andromeda galaxy, this would be seen as one rotation per year.



If you then include the 365 rotations due tot he Earth spinning on its axis, then you get 365 + 1 = 366 rotations. Although there are 365 days in a non-leap year, the Earth makes 366 full rotations relative to the stars, This must mean that the Earth spins slightly more than 360 degrees on its axis every day!

References & Resources

A Fun Approach to Sci-Fi: the long way to a small angry planet by Becky Chambers

Goodreads link: https://www.goodreads.com/book/show/22733729-the-long-way-to-a-small-angry-planet

Do physicists make the best baristas?

Link to Christopher Hendon's paper on espresso

Systematically Improving Espresso: Insights from Mathematical Modeling and Experiment
https://doi.org/10.1016/j.matt.2019.12.019

References

[1] https://www.britishcoffeeassociation.org/coffee-in-the-uk/coffee-facts
[2] https://www.coffeescience.org/caffeine-coffee/
[3] https://www.gaggia-na.com/pages/skills
[4] https://worldbaristachampionship.org/
[5] https://doi.org/10.1016/j.matt.2019.12.019

Physicist of the Month: Professor Mercedes Richards

Links to their papers

Images of Gravitational and Magnetic Phenomena Derived from 2D Back-Projection Doppler Tomography of Interacting Binary Stars https://arxiv.org/pdf/1408.0224.pdf
New Evidence of Magnetic Interactions Between Stars from 3D Doppler Tomography of Algol Binaries: β Per and RS Vul https://arxiv.org/pdf/1210.0081.pdf
Long-term Variability in the Length of the Solar Cycle https://arxiv.org/abs/1312.1105

References

[1] https://www.nsbp.org/nsbp-news/bhm-physics-profiles/2017-honorees/32-mercedes-richards
[2] https://aas.org/candidate-statement-mercedes-t-richards
[3] https://www.eurekalert.org/multimedia/pub/59092.php
[4] https://kochfuneralhome.com/tribute/details/1159/Mercedes-Richards/obituary.html
[5] https://sites.psu.edu/astrowright/2016/02/04/mercedes-richards-1955-2016/
[6] https://news.psu.edu/story/141653/2009/08/05/research/stellar-detective-profile-professor-mercedes-richards

References & Resources

Look out for the N-rays! *The inevitability of how confirmation bias and how it affects physics*

[1] *Fantastically Wrong: The Imaginary Radiation That Shocked Science and Ruined Its 'Discoverer'* by Matt Simon (Web article) https://www.wired.com/2014/09/fantastically-wrong-n-rays/
[2] *A little more light on N rays* by Spencer Weart (Journal article) https://aapt.scitation.org/doi/10.1119/1.11342
[3] *New light on old rays: N rays* by Robert T. Lagemann (Journal article)
[4] *"N" rays: a collection of papers communicated to the Academy of sciences* by René Blondlot and Julien Garcin (Book) https://archive.org/details/nrayscollectiono00blonrich/page/n29/mode/2up
[5] *The n-Rays* by Robert W. Wood (Journal article) https://zenodo.org/record/1429443
[6] *N-rays exposed* by Mark Pilkington (Web article) https://www.theguardian.com/education/2004/sep/02/research.highereducation4
[7] *N-rays: An episode in the history and psychology of science* by Mary Jo Nye (Academic article)
[8] *What Ever Happened to n-Rays?* By Terence Hines (Web article) https://www.skeptic.com/eskeptic/10-10-13/
[9] *A selected history of expectation bias in physics* by Monwhea Jeng (Academic article)
[10] *Confirmation Bias: 3 Effective (and 3 Ineffective) Cures* by Louise Rasmussen (Web article) https://www.globalcognition.org/confirmation-bias-3-cures/
[11] *The Confirmation Bias: Why People See What They Want to See* by Effectiviology (Web article) https://effectiviology.com/confirmation-bias/#How_the_confirmation_bias_affects_people
[12] *Confirmation Bias* by Iqra Noor (Web article) https://www.simplypsychology.org/confirmation-bias.html#imp
[13] *How Cognitive Biases Affect Our Everyday Decisions* by Towergate Insurance (Web article) https://www.towergateinsurance.co.uk/liability-insurance/cognitive-biases
[14] *Confirmation Bias: A Ubiquitous Phenomenon in Many Guises* by Raymond Nickerson (Journal article) https://journals.sagepub.com/doi/full/10.1037/1089-2680.2.2.175
[15] *The Influence of Prior Beliefs on Scientific Judgments of Evidence Quality* by Jonathan Koehler (Journal article) https://www.sciencedirect.com/science/article/abs/pii/S0749597883710447?via%3Dihub
[16] *The Trouble With Scientists: How one psychologist is tackling human biases in science* by Philip Ball (Web article) https://nautil.us/issue/24/error/the-trouble-with-scientists
[17] *Neural Bases of Motivated Reasoning: An fMRI Study of Emotional Constraints on Partisan Political Judgment in the 2004 U.S. Presidential Election* by Drew Westen et al (Journal article) https://www.mitpressjournals.org/doi/abs/10.1162/jocn.2006.18.11.1947
[18] *Consequences of Prejudice Against the Null Hypothesis* by Anthony Greenwald (Journal article)
[19] Centre for Open Science https://www.cos.io/our-products/osf
[20] *Publication prejudices: An experimental study of confirmatory bias in the peer review system* by Michael Mahoney (Journal article) https://link.springer.com/article/10.1007%2FBF01173636

Puzzles

Boomerang Ball?
https://gpuzzles.com/mind-teasers/physics-riddle/

Starry Starry Night
Solar and sidereal time
http://adsabs.harvard.edu/full/1904PA.....12..649B#:~:text=Consequently%2C%20in%20365%20days%2C%20the,sidereal%20days%20in%20a%20year.&text=While%20during%20a%20year%20the,a%20star%20rises%20366%20times
Space Facts: Earth Rotates 366 Times Per Year https://www.youtube.com/watch?v=VYKnWYu6fiU
Positional Astronomy: http://www-star.st-and.ac.uk/~fv/webnotes/chapter6.htm