NO. 2

4TH FEB 2021

PANDA

Panda's Announcements, News and Disfunctional Advice

WILL BOWLES

This stunning front cover won the Astrophotography competition - find out how he did it | p. 26

WIBBLY WOBBLY TIMEY WIMEY

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CAN PHYSICS STOP COVID?

The latest developments in far-UV-C light research | p.16

PANDA's Announcements, News and Disfunctional Advice

Dear Reader,

Welcome to Issue 2! As we start this new semester let us look forward with faith in ourselves - we can do this, it's all going to be okay.

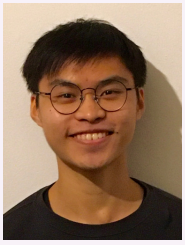
I hope you are accessing this issue through our new fancy website, with many thanks to our wonderful Anson Ho.

Our fabulous team have worked hard to collate all these fantastic interviews, fun puzzles and written some stellar articles all for you lovely readers.

We may be new but we are hoping to last- so if you or anyone you know would like to join or contribute an article please do not hesitate to get in contact! It's a very chill and great opportunity for all. Contact any one of us individually or through our social media (Instagram, Twitter and Facebook). You can also email us at pandamagazine@st-andrews.ac.uk.

Please enjoy!


Rose Waugh


Anson Ho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Viktor Nordgren


Rachel Black


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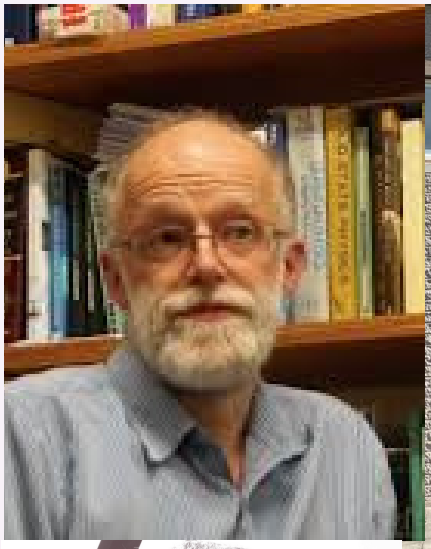

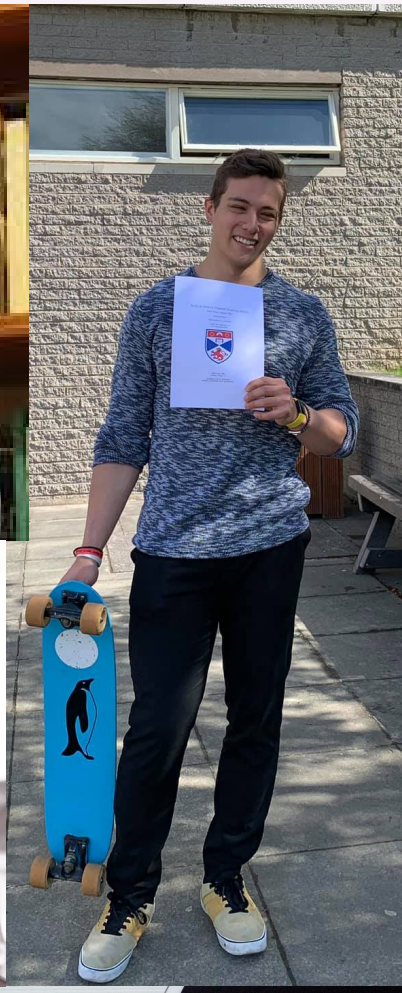

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physoc
the university of st andrews physics society

Experiments you can do at home.

1. PEPPER WATER

Things you will need:
- Plate
- Water
- Dish soap
- Black pepper

1. Fill the plate with water (be careful not to overflow!)
2. Sprinkle the pepper on the water surface
3. Place soap on the tip of your finger, then place your finger in the centre of the plate

When you add dish soap to the water it lowers the surface tension of the water. The water molecules try to stick together and move away from the soap while carrying the pepper with them!

2. LEAK-PROOF BAG

Things you will need:
- Plastic sandwich/freezer bag
- Water
- Sharpened pencils

1. Fill the bag half-full of water
2. Poke a pencil straight through the bag – in one side and out the other.

The bag is made of a polymer – which is long, flexible chains of molecules.

When you poke the pencil through the bag, the molecules spread apart and then seal themselves around the pencil.

3. HOMEMADE LAVA LAMP

Things you will need:
- Empty plastic bottle
- Water
- Vegetable oil
- Food colouring (water-based works best)
- Alka-seltzer

1. Fill the bottle 3/4 with oil and 1/4 water
2. Put in food colouring of your choice
3. Break Alka-seltzer into small pieces and add one piece at a time

Because water is more dense than oil, it will sink to the bottom when the two are put in the same container.

Water molecules are "polar" because they have a lopsided electrical charge that attracts other atoms. The end of the molecule with the two hydrogen atoms is positively charged. The other end, with the oxygen, is negatively charged.

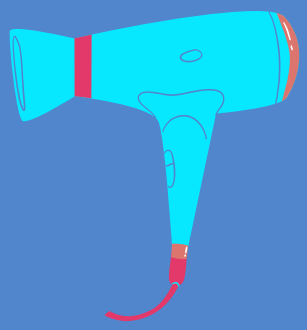
Oil molecules, however, are non-polar— they don't have a positive or negative charge, so they are not attracted to the water molecules at all. This is why oil and water don't mix!

The Alka-seltzer reacts with the water to produce carbon dioxide gas bubbles. These stick to the water droplets. The water/gas combo is less dense than the oil, so they rise to the top of the flask.

YOU ONLY NEED COMMON HOUSEHOLD ITEMS

4. BIN BAG BALLOON

Things you will need:
- Bin bag
- String
- 8 paper clips
- Hair dryer



1. Bunch up the bottom of the bag and tie with string
2. Attach paper clips at equal intervals around the opening of the bag
3. Hold the bag upside down, and blow into the opening with a hair-dryer

You've made a mini hot-air balloon!

Hot air is less dense, which means it rises. The bag is light enough that it gets dragged upwards with it.

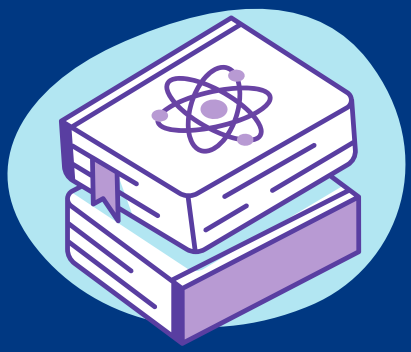
5. INVISIBLE INK

Things you will need:
- Paper
- Lemon
- Cotton Bud
- An Iron
- Bowl

1. Cut the lemon in half and squeeze the juice into a bowl.
2. Dip one end of the cotton but into the juice and use it to write out a secret message
3. Let it dry for 15 minutes.
4. Iron over the message and it will become visible again!

Lemon juice contains the chemical element carbon. When heated, the carbon bonds break, and the carbon is released.

Carbon turns a different colour when it reacts with the air. Hence, you message is revealed!



You.

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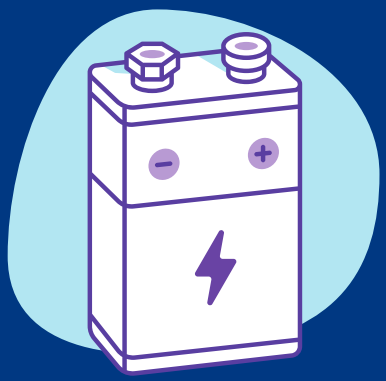

Find out more by visiting our pages

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ASTROSOC

UNIVERSITY OF ST ANDREWS ASTRONOMICAL SOCIETY

What we're up to:

This semester we'll be working hard to bring our members engaging events, whether online or in person. We will be holding an event every second Thursday. In **Week 2** we will be having a virtual pub quiz themed around astronomy to let you meet fellow space lovers and show off your astro trivia skills! In **Week 4** we will have a talk by Zooniverse project manager and St Andrews alumnus Alex Hygate. Check out our Facebook to see our latest events and what else we'll be up to!

Astronomy from home:

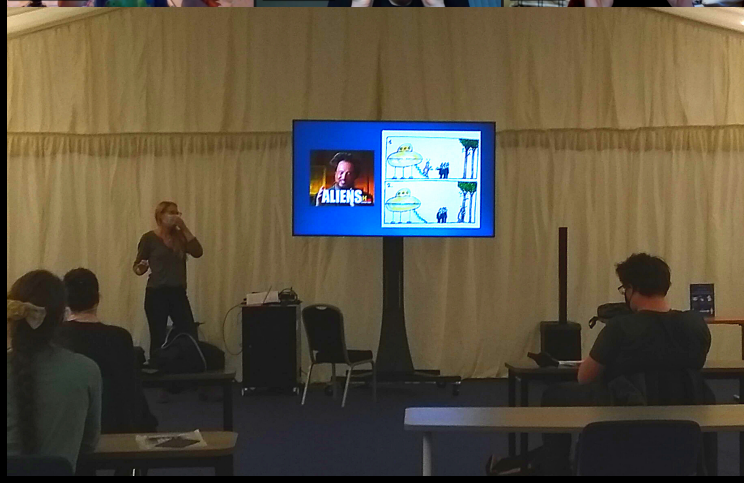
Even if we're unable to use the observatory just now, there's many ways to observe from home! Both images on this page were taken by AstroSoc's Web Overlord, Paul Graham, who writes about his photographing of the M51: the Whirlpool Galaxy (image on left) from his own backyard:

M51 is an interacting pair of galaxies in Canes Venatici, around 23 million light years from us on Earth.

Final image takes data from around 3 hours of total exposure with my 1000mm f/5 telescope over 2 nights. This was also my first time attempting a HDR image by combining exposures taken at different ISOs, but I don't think this is the best solution. Image edited in PixInsight & Photoshop.

What we've been up to:

Last semester we hosted a variety of events for our members. Through "Can Do" we were able to hold two in-person events - an arts and crafts event combining talks on topics from Hubble's tuning fork to exoplanets and a relaxing afternoon of crafting, and Navigating with the Stars, a workshop on the history and method of using our night sky to navigate. We also hosted a series of virtual talks given by St Andrews alumni talking on their research, career, and insterests within the field of Astronomy. Additionally, throughout the semester we've been hosting socials such as film nights and game nights, and connecting with our members through our Discord-come join!



Where to find us:

facebook.com/Astrosocstandrews

astrosoc.club

astrosocmail@st-andrew.ac.uk

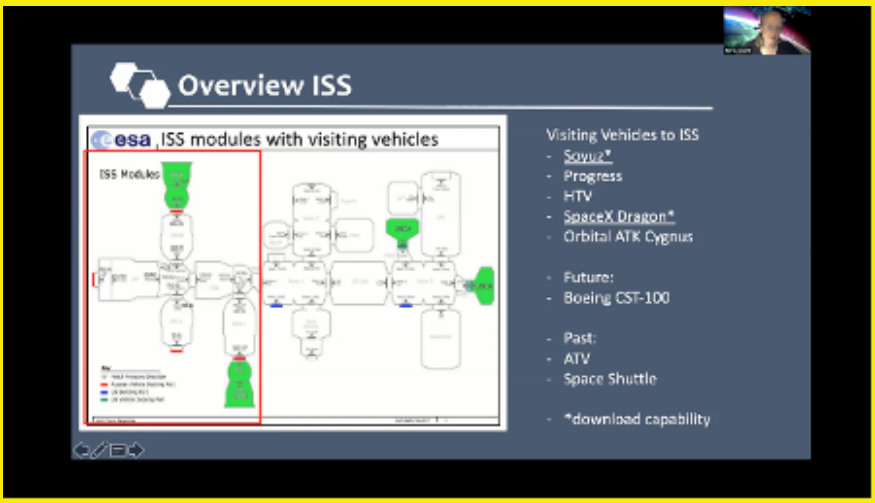
@astrosoc_sta

Although we've been missing the observatory and are looking forward to when we can return, we'll be hosting a range of events and socials throughout this semester for fellow space-lovers. We hope to see you there!

SpeakEASy Conference 2020

On November 7th and 8th, the University of St Andrews Engineering and Aerospace Society (EASy) welcomed speakers from around the world to their inaugural online conference, SpeakEASy. The two-day event was open to all students at the University; it aimed to give an insight into the variety of opportunities available in the engineering and aerospace sectors and demonstrate the accessibility of the industry to students of all disciplines and backgrounds.

Those with a passion for aerospace engineering attending the conference had plenty to sink their teeth into. Guillermo J. Dominiguez Calabuig, a PhD candidate working with ASCenSion, spoke about how the project is advancing space accessibility with reusable launch vehicles and multiple-satellite injection. NASA had two representatives at the conference. Kate Gunderson gave attendees an insight into how she came to work as an engineer for the organisation and Jeremy Myers, the lead of the Onboard Imagery Project for NASA's Space Launch System (SLS), the rocket that is scheduled to take humans back to the Moon in 2024. He talked about the history of NASA's launch vehicle imagery systems, and why they are so important. Justin Martin, an aerospace engineer working with the US' Federal Aviation Authority, covered the safety processes for commercial launches including his work with companies such as SpaceX.



Speaking on a topic a little further into the future, the president of the International Space Elevator Consortium (ISEC), Dr Pete Swan, talked about space elevators and utilising them for a dual space access architecture to get humans to Mars. The European space industry was also well-represented. Niels van der Pas from Airbus Netherlands gave attendees an introduction to satellite thermal engineering and its basic principles, and Maria Grulich from the German Aerospace Centre (DLR) delivered a presentation on the day-to-day operations of the International Space Station. Maria talked about research currently being conducted on the station, as well as what it's like to work in mission control. For students more inclined towards coding, Oscar Miles from the UK Civil Service spoke about how machine learning can be utilised to identify clouds from satellite imagery.

Biochemical engineering was also a hot topic at the conference. Bradley McCallion, a recent University of St Andrews graduate, shared his experiences as a member of the University's iGEM team. Bradley focused on how statistical physics and mathematical modelling can be utilised in biotechnology. Laurence Webster, a biochemist who has previously worked for LabSkin, spoke about the company's artificial human skin and its uses in research. Ben Greaves, an analogue astronaut with the HI-SEAS project, discussed how to grow plants in space.

Geologists could look forward to talks from Dr Shovan L Chattoraj of the Indian Space Research Organisation (ISRO), who spoke about how space-based remote sensing can be applied to geology, and EuroMoonMars' Marc Heemskerk who discussed lava tubes and their potential to provide habitats on the Moon and Mars.

Although traditionally the aerospace and engineering industries may not be as accessible to those from a non-technical background, the conference also offered plenty for students in the arts, including a panel on the importance of humanities and the arts to STEM. Arts subjects often face unwarranted criticism from those in STEM fields, but few realise the important contributions they make. Shedding light on this by answering audience questions were Karlijn Korpershoek, who studies the anthropology of outer space; the University of St Andrews' Chris Hooley, a senior Physics lecturer; Jaclyn Wiley, a space technology data analyst at Bryce Space and Technology; and Elisabet Fonalleras, an aerospace law graduate who also spoke on the first day of the conference. She covered on space law and the contribution of space lawyers to the space industry.

The conference was a huge success, bringing professionals from all corners of the global engineering and aerospace industries to St Andrews. However, this was only the beginning for the society! In the future, EASy will continue its goal of increasing accessibility of these sectors for students at St Andrews. More speaker events, competition participation, workshops, and careers events are just some of the exciting things planned!

EASy would like to take this opportunity to extend our gratitude to all those who generously gave their time to speak at the event, and all the students who attended.

By Josh Bernard-Cooper

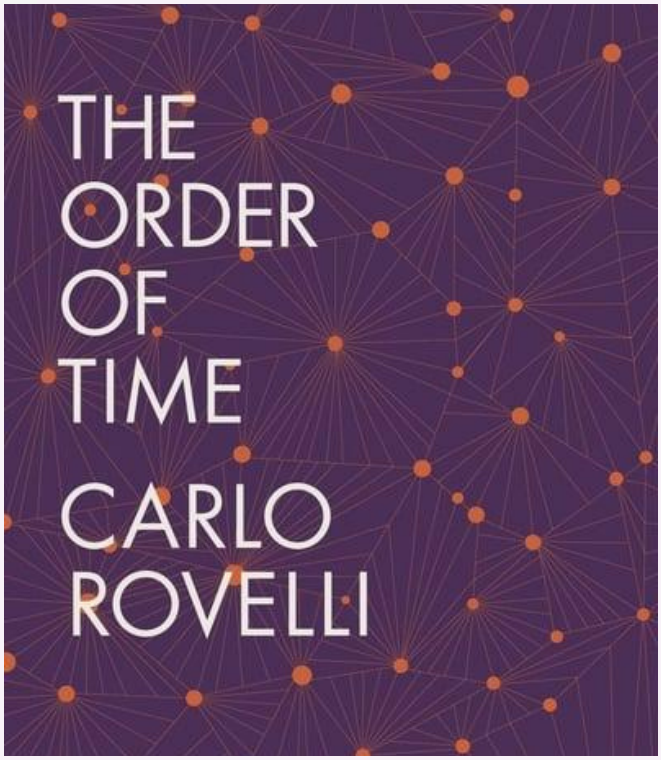
Does Time Exist? A review of 'The Order of Time' by Carlo Rovelli

Does time exist? It is an awfully big question. And perhaps one you have never thought to ask yourself. Carlo Rovelli's 'The Order of Time' presents a poetic and enlightening account of the nature of time, and its implications for modern physics and beyond. I offer a warning to those of you prone to existential crises; this one may be your greatest yet.

We all experience the passage of time - we have memories of the past, we have hopes and dreams for the future, and we live, to the best of our abilities, within the present. Timetables and zoom meeting alerts govern our modern lives – and the rising and setting of the sun has guided us since our very beginnings. Despite this, the mystery of time has been one that humankind has always pondered – from Aristotle, who defined time as the measurement of change, concluding that if nothing changes then no time has passed, to Einstein, who (disputedly) called time an 'illusion' after the development of his theory of General Relativity.

Good, old 2020 was certainly a year of change, and one in which my interpretation of time was severely challenged – time passed painfully slowly during lockdown, whilst moving alarmingly fast when I finally made it back to university. In fact, I was not alone in this adventure though time. A study conducted by psychologist Dr Ruth Ogden found that over 80% of us felt our perception of time dramatically change during lockdown – with a half and half split between those who felt it fly by more quickly, and those who felt it drag on endlessly [1]. But our perception of time relative to what? What is the 'normal' passage of time? Time is not a sense – nor have we any organ that particularly measures it. Scientifically speaking, we also know that the perfect clock has not and will not ever be made [2]. As well as this, we know from our relativity classes that if I sent my twin sister, Rebecca, off on a spaceship (very willing to try this, by the way) that she would come back having aged less than me.

So, I ask you again, with slightly more educated wording, does objective time exist?



Hold on to your timepieces, folks; things are about to get a whole lot more bewildering than this...

Just as we once thought that the Earth was flat, or that there might actually be treasure at the end of a rainbow, in his book, 'The Order of Time', Rovelli gracefully destroys everything we thought we knew about reality. By inviting the reader to review their own naïve perspective of the world, the founder of quantum loop theory will quickly convince you that there is no such thing as a universal present; that the difference between past and future does not exist (in the eyes of the equations) and that the world is made up of 'kisses', not 'stones'.

Corelli narrates his tale of time in three parts. The first breaks down our common understanding of time, using topics that are well known to us as physicists, such as time dilation and the second law of thermodynamics, as his tools. The second helps us to visualize what a world without this 'time' may look like. The third works to rebuild our picture of time in this timeless existence.

Now, if you think that all this sounds a little too paradoxical for a Sunday morning read, do not give up on me yet. There is a reason that this book has sold over a million copies and has been translated into 41 languages. Far from the academic (might I say boring, dull, and uninspiring?) style of writing I am used to from my physics textbooks, Corelli's writing convinced me that I was reading an autobiography, a philosophy book, and a collection of poetry at the same time; all whilst giving me an incredible lesson on the history of modern physics.

Not only because I had nothing much else to do this lockdown 3.0, I managed to devour the book in less than a week, as well as forcing it upon the rest of my family. The book pushed me to think more profoundly about the nature of the world, but I also could not have discovered it at a more perfect time (no pun intended). Nearing the end of my undergraduate degree, it felt as though the book was hugely valuable to me and my fellow 4th years, succinctly linking together every one of our modules in a delightfully colourful summary. However, it should not be exclusively considered as pitched towards this group – a wide range of readers will get a lot out of it (unless you get a headache thinking about space – this might turn it into a migraine).

Whilst the book is, as I have said, extremely readable and beautifully written, I must confess that with so much packaged into each chapter, I found it easy to become distracted (a.k.a. lost and confused) in parts. Rather than making me want to put down the book, however, it made me want to pick the book up again and get to the bottom of it. In saying that, I have almost four years of an undergraduate physics degree under my belt. The book is written for the genre of 'popular-science', and should hypothetically be appropriate for any reader, regardless of their scientific background. Corelli does provide a disclaimer on difficulty around particular concepts, such as thermal time (yup, still do not really know what that was all about) and quantum loop theory (absolutely NO chance), however I do think that this was a bit of a 'get out of jail free' card.

I was also not mentally prepared for the closing chapter, in which the physicist offers a lengthy philosophical discussion on why we should not be afraid of death, but this is perhaps more of a reflection on my own psychology than anything else...

Should you bother reading it? Well, I suppose, in the words of J.R.R. Tolkien, 'all we have to decide is what to do with the time that is given to us'. And I think this would be an exceptionally good use of that time indeed, but if you do not want to commit to buying the book, Anson's article 'How to Travel Upwards in Time' on page 16 may be a good place to start...

By Rachel Black

Book Availability

The Order of Time by Carlo Rovelli , translated from Italian by Erica Segre and Simon Carnell, may be bought from lackwell's on offer for £7.31.

It can also be found from all other popular book sellers

Physicist of the Month

Prof. Sally Ride

Birth: 26 May 1951
Death: 23 July 2012

Links to a few of their papers:
The EarthKAM project Urey
The Urey Instrument

Sally became famous as the First American woman (and third ever woman) in space in 1983. At 32, she was the youngest American astronaut to travel to space, a record that still stands today. [1]

Alongside an interest in science Sally was also a keen tennis player from a young age, a hobby through which she met her later partner Tam O'Shaughnessy.

She attended Swarthmore College and the University of California, before entering Stanford University where she graduated with a bachelor's in Physics and English and later an MSc and PhD. Her PhD research focused on the interaction of X-rays with the interstellar medium.

Before her first space flight, she received a lot of attention from the media on account of her gender. During one press conference she was asked "Will the flight affect your reproductive organs?" and "Do you weep when things go wrong on the job?" [2]

After her career as an astronaut, she went on to become a professor of physics at the University of California. She also led two outreach projects for NASA, cofounded her company Sally Ride Science (which creates science programmes and publications for school aged children, particularly girls) [3] and wrote multiple children's books about space [4]. It was not until after her death that she became known as the first lesbian astronaut, when her sister mentioned in her obituary that she had been in a relationship with Tam [5].

by Rose Waugh

How to Travel Upwards in Time

The physics hiding in everyday language

Long Time No See

Time is strange. We can't see or hear it directly, and philosophers seem to be having a hard time pinning down what it actually is [1]. Regardless of how abstract it is, it at least *feels* really real – the years pass by faster and faster, and deadlines are always just around the corner.

For such an abstract concept, it helps to have some way of thinking about it that makes it more tractable. Clocks and calendars are really good at this, because they allow us to visualise time spatially. But what about words? How do we talk about time?

Here's where things start to get interesting. If you do a bit of searching, it's not hard to find examples where we talk about time as if it had spatial attributes. For instance, we might arrange to meet a friend *in* an hour, as if an "hour" were something that we could be "inside". We can also be *on* time, work *from* nine *to* six, and reach home *at* seven. In English, there's no term specifically devoted to measuring temporal quantities, like "duratiousness" [2]. Instead, we say that things take a "short" or "long" time.

So it seems that we often speak of time using spatial metaphors. This in itself is a curious idea, but just for the fun of it, let's do perhaps a bit more thinking than the situation deserves!

A Relatively Good Time

All this talk about space and time seems to suggest that we can try and map things out – what does our language suggest about our mental models of time? To be more precise, let's draw a 1-dimensional time axis* [3].

Fig. 1: A simple 1D time axis

From our experience, we might expect it to look something like this, with past, present and future. But wait – words like "present" are defined relative to an observer, so we'll need to draw in a person as well.

One way to do this would be to make the person moving along the time axis, with the past constantly behind and the future constantly ahead [4]. This assumes a stationary time axis, but what if we've gotten it the wrong way round? Perhaps we're standing at this point called the "present", and time is flowing towards us!

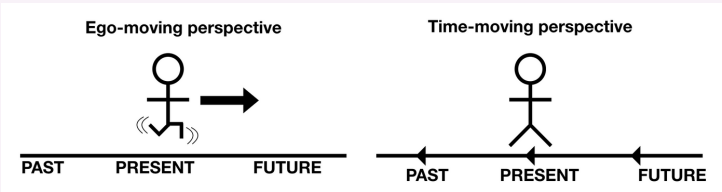


Fig. 2: Two perspectives of time

* Perhaps you're wondering why time ought to be a constrained to a 1-dimensional axis. Why not 2? Or 3? Or maybe 2.5? Frankly, I'm not sure, but for the sake of argument let's just assume a single past-present-future axis.

How do we know which of these two views is correct? To test this, try and answer the following question:

> *Next Wednesday's meeting is moved forward two days. Which day is the meeting now?*

If you think that the answer is obvious, I encourage you to ask your friends for their opinions. Trust me, you'll be surprised!

Most answers are either "Monday" or "Friday", and the original psychology experiment that asked this question found a 50-50 split in the responses [5]. This certainly came as a surprise to me, because I was adamant that the correct answer would be "Friday". So what's behind this result?

In the study, the authors suggest that different people have different mental representations of time. If you thought that the answer was "Monday", then you see yourself as stationary and time as flowing towards you, i.e. *the time-moving perspective*. Moving the meeting "forward" would mean moving the meeting in the direction that it was already heading; relative to the meeting.

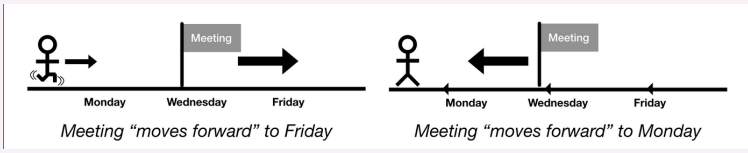


Fig. 3: Is the meeting now on Monday or Friday?

If you're like me thought that the meeting would be shifted to Friday, then you instead see time as a stationary axis that you move along, i.e. the ego-moving perspective. In this case, "forward" is the direction that the observer "moves" along; relative to the observer.

The researchers further found that they could change the proportion of answers from participants using spatial cues. For instance, subjects that rode an office chair across a room were more likely to answer "Friday", because this primes the brain to think of us as moving through a fixed absolute space. Conversely, those who pulled an office chair toward them with a rope were more likely to answer Monday, with the environment "moving" past us and priming the time-moving perspective.

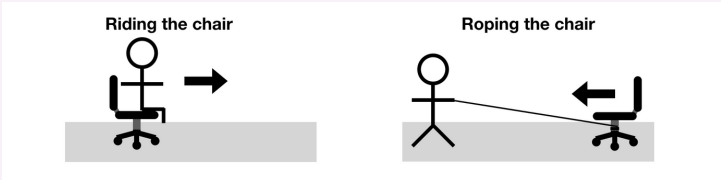


Fig. 4: Changing our mental representations of time using spatial cues

So depending on how you want to look at it, both "Monday" and "Friday" could be correct. What this implies is that the way we think about time is very closely tied to how we think about space, and also changes with context.

If our brains have been primed appropriately, we may be more likely to adopt an ego-moving perspective and vice versa. Good luck making it to the meeting on time!

How to Travel Upwards in Time

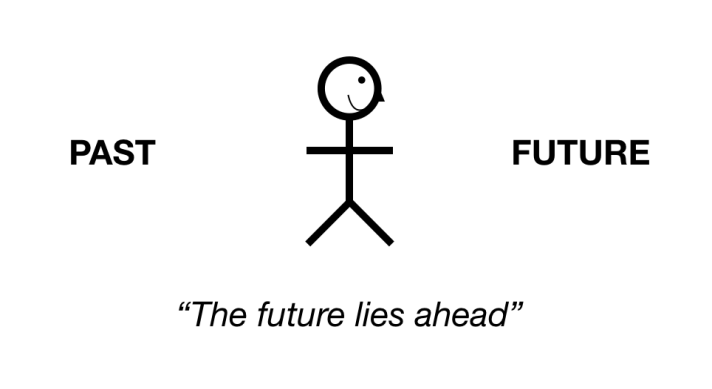


Fig. 5: Representing the future as ahead and the past behind

Another thing that we could consider is the direction of the observer relative to the time axis. We've assumed that "the future lies ahead", but what if it isn't? Why don't we say that the "future lies behind", for example?

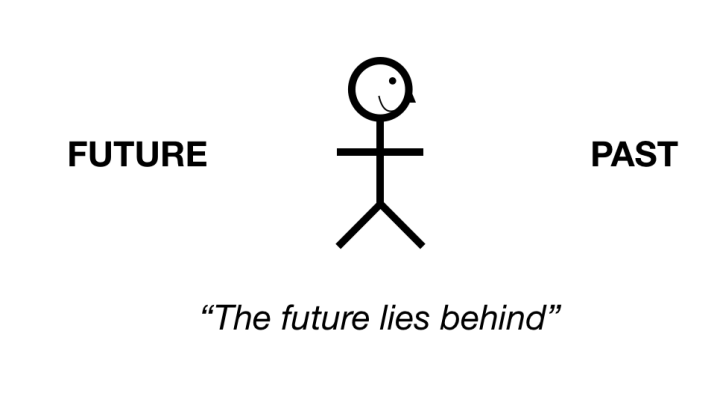


Fig. 6: Seeing the past as in front of us

Believe it or not, this is exactly how the Aymara people seem to visualise time, where the word *q"ipa*, roughly meaning "behind" or "the back", is used to talk about the future [6]. We also see similar features in other languages. The Māori proverb, *Kia whakatōmuri te haere whakamua* translates to "I walk backwards into the future with my eyes fixed on my past" [7]. In Malagasy, past events are referred to with words that connote forwardness. An interesting explanation is offered for this: the past and present are known and so exists "before one's eyes", but the future is as yet unseen and so lies behind [8].

But why stop here? What if the time axis isn't horizontal? In Chinese languages [9], "last year" is literally said as 上年 "up year", and next year is 下年 "down year". There's one more example that I find especially intriguing. Thus far we've seen examples where the axes are oriented relative to the observer, but what if the time axis were absolute and fixed?

For the aboriginal Pormpuraaw people, the time axis is fixed according to the cardinal directions. Unlike in English, where we talk about space in relative terms like "left" and "right", Pormpuraawan languages are inextricably linked to absolute space†[10]. To be able to communicate, you would need to be constantly aware of where East and West are! In a study by Lera Boroditsky and Alice Gaby [11], the authors write:

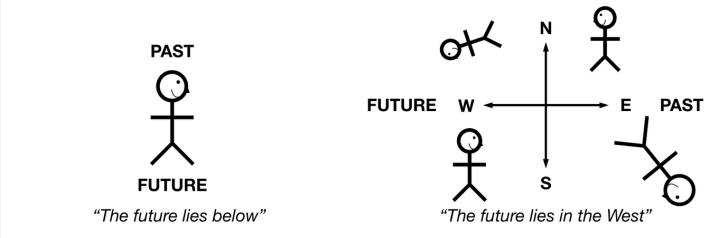


Fig. 7: A vertical time axis (L) and an absolute time axis (R)

> *In Kuuk Thaayorre (one of the languages included in this study), to say hello, one says, "Where are you going?" and an appropriate response would be, "a long way to the south-southwest." Thus, if you do not know which way is which, you literally cannot get past hello.*

Their mental representations of time seemed also to resemble the way that they thought about space, with the past in the East and the future in the West, perhaps relating to the apparent rising and setting of the Sun.

So when we say things like "the future lies ahead", or "I've put the past behind me", we're really using a very particular way of visualising things that may not be common across different cultures. Different people can look at the same world in myriad ways, and it can be all too easy to treat our views as gospel.

Much Time No See?

For most of this article, I've talked about how our temporal understanding of time is often achieved using a metaphor with space. While there are many examples to support this view, it's worth noting that this is by no means a hard-and-fast rule, and that many exceptions exist.

For instance, if you're a Spanish speaker, you're more likely to say *mucho tiempo* or "much time" instead of "long time", and similar patterns can be found in Greek and Italian. Rather than picturing time with spatial axes and lengths, it is interpreted as something with volume [12].

Many of the patterns we've seen are also heavily context dependent. Chinese speakers don't only use vertical space-time metaphors – while "up year" might refer to "last year" with a vertical time axis, 前天 "front day" means "the day before yesterday" with a horizontal time axis. Linguists seem to have different interpretations of how to reconcile these differing metaphors, and in general it can be quite hard to give consistent explanations across multiple contexts.

There are countless other interesting questions that we could examine if we dive deeper, like the effect of writing direction and the mental representations of time in bilinguals and polyglots. But these are probably best left for another day. What I hope I've shown through this article is that even for something as universal as time, there is a diverse set of ways that we can think about it. In English, we have a habit of speaking of time in terms of front-back spatial metaphors, but maybe there's more to that than meets the eye.

† Of course, physicists now know that thinking in terms of absolute space and time aren't quite right, but let's ignore that for the time being!

by Anson Ho

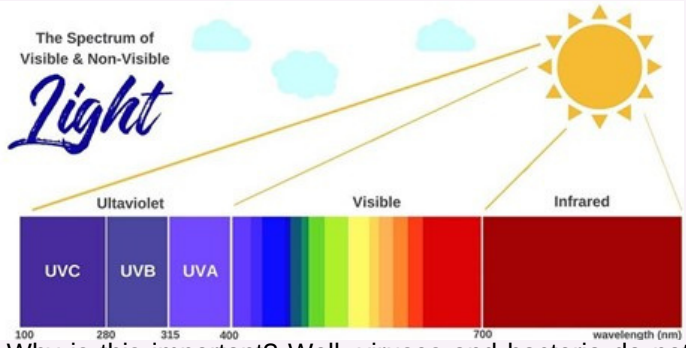
Is UVC lighting the way to a COVID-19 free future?

What if I told you that a part of the UV light spectrum could be used to kill COVID-19? What if I also told you that these particular wavelengths are so far thought to be completely safe to humans? What should we do with it?

"Use it!". That's what I exclaimed when Dr Kenny Wood asked our 4th year *Stars and Nebula* class those exact questions during a tutorial last semester. The UK's vaccination program is now well under way, but virologists have not been the only scientists fighting the pandemic fight. More and more research is emerging from the world of medical physics on the use of far-UVC light to destroy the SARS-CoV-2 virus responsible for COVID-19. This includes work from Kenny and a team here in St Andrews, along with a group at Ninewells Hospital in Dundee, that has caught the attention of both the UK and Scottish government.

What is UV-C?

On earth, as all of you sun cream wearers will hopefully know, we receive UV-A and UV-B light from the sun that may damage our skin and eyes, potentially leading to more serious issues such as skin cancer and cataracts. However, the sun also emits a third type of UV radiation: UV-C. These wavelengths, lying on the shorter end of the spectrum between 100-280 nm, are absorbed by ozone in the atmosphere before they can reach us here on the ground [1].



Why is this important? Well, viruses and bacteria do not cope very well under the UV-C spotlight. In fact, UV-C has been known for a long time to inactivate not only the SARS-CoV-2 virus responsible for Covid-19 [2], but thousands of different viruses, and even the bacteria behind drug resistant 'Superbugs' [3]. Now, given our well established fear of its longer wavelength family, you might have already guessed at a potential problem here; surely at this higher energy, UV-C must be the lethal Godfather of all ultraviolet light?

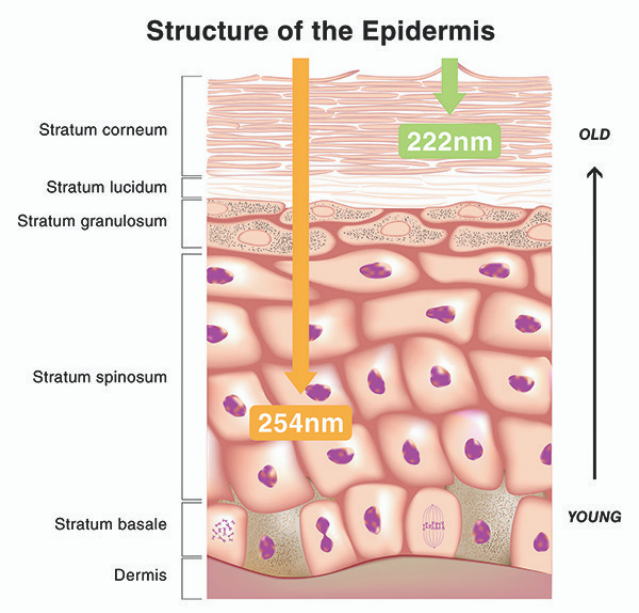
Whilst there is practically no evidence of UV-C causing skin cancer, exposure can result in significant skin and eye damage. The good news is that we have known about the killing capabilities of ultraviolet for decades! In other words, scientists have already worked out how they can exploit the UV's bug busting abilities, whilst simultaneously protecting us from these harmful rays. From slowing the spread of infection during the 1957 influenza pandemic, to cleaning the New York subway [4], and even in Russian prisons [5], this is a tried and tested disinfection method that has been around since the 1930s. The technology in question is known as '254 nm upper-room Ultraviolet Germicidal Irradiation (UGVI)' [6], and operates by enclosing the UV lighting within beams above head height, allowing the radiation to disinfect the circulating air in the 'upper room' without affecting us down below. If properly installed this can equate to 24 air changes per hour!

Not content to stop there, scientists took a closer look and found that some wavelengths of UV-C might actually be much safer than we first thought...

Far-UV-C technology - in Room 230 of the Physics building!

Far-UV-C' refers to wavelengths below 230 nm, and research undertaken in the last few years suggests that within this range, the radiation poses no risk of skin or eye damage whatsoever [7]. Why? As it turns out, our bodies actually have a natural armour that these wavelengths cannot penetrate. Both the outermost layer of our skin, composed of dead skin cells, and the tear layer of our eyes, contain proteins that readily absorb all far-UV-C, preventing the light from really getting anywhere.

This has motivated the production of new far-UV-C technology that, at 222nm, can be given the freedom to shine down on an entire room of people at no risk, whilst continually disinfecting the air that we breathe and the surfaces we touch.



As a relatively new technology, further evidence for both the efficacy and safety of 222 nm UV is continually being sought, including some new results sent to us by Dr Wood last week. In collaboration with Fluid Gravity Engineering, a local St Andrews company, they modelled how UV could reduce viral concentrations of COVID-19 in a classroom setting. To explain what the computer simulations found, let me first set the scene...

You're in Room 230 in the Physics building. There are four air grates and three open windows. 7000 viral particles are released simultaneously from random locations. A number of simulations are then run based upon two different configurations of the 222nm UV lights: the 'USHIO' illumination pattern, and an isotropic illumination pattern.

The results show that the simulation with an isotropic illumination of the entire room by eighteen 222 nm lamps at the current regulatory limits, the viral concentration would reduce to 0.1% in just over 25 minutes. If the wattages were increased by a factor of a hundred above those limits, however, the virus could be inactivated in less than a minute! A hundred times the current safety levels may sound like a lot, but ongoing safety studies suggest that this could definitely be a feasible reality.

New variant? No problem.

As you will be tired of hearing about from recent news stories, the virus behind Covid-19 is a rapidly mutating one, which leads to new variants. With the emergence of these new strains, there is growing concern over the efficacy of the COVID-19 vaccinations. So, is it the same with UV light? Could the virus evolve to become UV-resistant?

During a TED talk in July of last year, Dr David Brenner, one of Kenny's colleagues at Columbia University and a leading spokesperson for the largescale use of UV-C light, was asked a similar question [8].

In the answer lies perhaps the most distinguishing characteristic of UV-C light compared to other infection control methods. Brenner explained that, unlike vaccinations or drugs that act on a particular feature of viral RNA, UV light hits the virus "like a sledgehammer", causing "unpredictable damage" to the genome. In other words, COVID doesn't know what's coming! The virus could not possibly evolve to be prepared for ANY type of attack on EVERY part of its genetic material. Not only this, but as I said earlier, ultraviolet light has been used for decades with no evidence of viruses or bacteria ever having become resistant.

So, is UV-C the light at the end of the tunnel?

With the potential this work has, not only for the current pandemic but for the prevention of other infectious viruses in the future, as well as a solution for untreatable 'superbugs', it is no wonder that the government has taken interest in the work done by Dr Wood and his colleagues. In a report written for the UK and Scottish governments in October of last year, Kenny, together with Dr Ewan Eadie of the Ninewells' photobiology department, outlined the ways in which both the old and new UV technology could be put to use right now [9].

They advocate for the immediate installation of 254 nm upper-room UVGI in high risk areas with low levels of ventilation, such as care homes, dentists and particular hospital clinics. They also suggest that this technology could be rolled out to businesses such as those in hospitality, or indoor sports.

As far as the implementation of the 222 nm UV is concerned, further studies into the long term safety and efficacy of far-UV-C are needed, and are indeed already planned. However, given the positive results of recent human and animal safety studies, the two physicists believe 'the benefits of installing filtered far-UV-C lighting outweigh the risks'. As to the practicalities, ramping up manufacturing will be the primary battle. The 222 nm lamps are currently more expensive than the conventional ones, with production almost exclusively in Japan and America. Perhaps you know someone in optics looking for a new project – 222 nm LEDs, anyone?

by Rachel Black

Want to find out more?

Dr David Brenner of Columbia University, mentioned earlier in this article, will be giving the colloquium next Friday (the 12th of February) on everything far-UV-C. Kenny informs me that this will also be recorded and sent to some very interested government advisors...

An Interview with Dr. Bruce Sinclair

Transcript of highlights: Insight Ep. 2

We talk to Dr Bruce Sinclair, one of the faces that welcomes new students to the university in his role as Director of Teaching. We take a look at Dr Sinclair's achievements, he gives a shot at explaining what he would take to a desert island, and Dr Sinclair describes what it is that makes St Andrews so special.

Sam: Could you tell us about your positions here in St Andrews?

Bruce: I came to St Andrews as a student a very long time ago, back in 1979. I had the distinction of being the 1st year class rep, back all those years ago. I got my degree here. I got enthused by Physics, got enthused by some of the teaching staff here at the time. Then I did a PhD here with Dr Malcolm Dunn. From there I went to postdoc with Malcolm and Wilson, temporary lectureship, lectureship, Senior Lectureship Reader, and for the last while, I am absolutely pleased to be the Director of Teaching in the School. I've been here for a while. *laughs*

Sam: Is there something you are particularly proud that you have done in your life, like a hike, an adventure, something maybe a bit outlandish?

Bruce: I can try and join a couple of those together. I'm going to comment briefly on two hikes that were never intended to be so. A number of years ago, having been to a research conference in California, a small group of us went to Yosemite and decided to hike up a side of a valley. We just kept walking. We ended up walking up this thing and looking back to the valley, which was absolutely incredible. We had enough water with us, but frankly, we didn't have as many resources as we should have had. We got back to the car, rather hungry by the end of the day, and we drove to a Diners just outside the park. And this waiter at the service desk said: "Gee guys, I bet you got a story to tell!" just by how we looked. But it had been an absolutely fantastic day, albeit an unexpected one. I join that with a slightly different story of when I was with my family in north-west Finland, at the corner of three countries. We'd done a shorter walk earlier in the day, as with my older son who was, I guess, an early teenager at the time. We again started a short walk in a nature trail, and he and I just kept going to the top of...Saana I think it was called? Which is, you know, a respectable hike. We saw the midnight sun (or the midnight light at least) at the top of this thing, walked back down and just collapsed into the cabin at two o'clock in the morning having had a really satisfying day walking.

Sam: A question that was popular amongst the students was: What are the three things that you would take to a desert island? Popular with every interview.

Bruce: Three things, right...Well I think the first has to be the Hitchhiker's Guide to the Galaxy. Probably some modern equivalent of this in terms of a smart phone and a satellite connection. Is that permitted?

Sam: Oh, I don't know.. I mean...

Bruce: Or is that two things?

Sam: Well I think the smartphone connection is going to be patchy and bad...

Bruce: What about satellite connection?

Sam: I've been told I was too lenient last time, so... no.

Bruce: No, right. And... I was thinking about this... I can't really take my wife as a thing, can I? That would be a bit rude calling her a thing...

Sam: Yeah I think so... You can invite her along, but...

...(Bruce is denied an escape mechanism and assured that there are plenty of bananas and coconuts on that island)...

Sam: So what would you take? Maybe a favourite food?

Bruce: Some good chillies then. And am I allowed an occasional glass of cider? And there has to be some music as well, I think.

Sam: What was one of the concepts that you struggled with as a student?

Bruce: A story that quite a number of students already know about, because it's an example I use, is 2nd year Linear Algebra. I was doing ok with it, but there was one particular week when I had been working for a long time on tutorial problems and I was getting absolutely nowhere, or at least that's how I felt. My tutor in Mathematics at that time was a person who I was a bit nervous of. For no particularly good reason, but I was a second-year student! Something in this linear algebra just wasn't going right. I got on my bicycle, cycled from my halls of residence to the basement of the Maths building, knocked on the door of this person who I was nervous about. After ten minutes of talking with me, she found exactly where the miscomprehension was. It turned out that this person, who I'd thought of as being a tad dragon-like, I was an absolute fan of. She was really professional while helping to find where the issue was. She took me from a bit of mathematics where I had reached the stopping point and helped me to find a way around a stopping point. I frequently use this story – I'm sorry- with students that talk to me about their difficulties as an example where I hit a brick wall, contacted a member of staff and they helped me to find the door through it.

Sam: During your time here, could you maybe describe what changed – either in Physics at large, or here in St Andrews, or the University?

Bruce: What has changed... Well, I can say that some things stayed the same. I know that it's not the question you asked, but some things stayed the same and one of them is that we have a great bunch of students here, and we have a community that's here, and I think that's really important. Another thing that is important is that we still have students who are not afraid to be different. That was the case when I was a student here, and I understand that it's ok to be who you want to be, rather than who the crowd wants you to be, today. In terms of what has changed, the biggest change is that there are way more people here now than when I was a student. There's also, very positively, a much larger research programme in the school. It's really nice to see the school develop and be recognised in its research and its teaching even more highly than it was when I was a student. ... Clearly, there's ups and downs over the years, depending on how research funding does or doesn't flow into the building, or what's happening around us. The world can be a strange place sometimes, but I think there's a lot that we can be thankful for.

Sam: To finish off our interview, could you tell us one thing that you find the most special about St Andrews? We've already touched upon this, the community, but St Andrews, the university, the town... We'd love to hear what you think.

Bruce: I'm going to come back to the community. Because what makes my job so pleasant is the community I work in. It's a community of my colleagues, it's a community with the students in the town, it's a community with the town's people. And there are lots of overlaps amongst those. Something that I really value is this wide-spread recognition of each other's worth, this wide-spread idea that people are here to support each other and to enjoy each other's company. That crosses all sorts of potential barriers and we're all in this together. That feeling of mutual respect, of working together, in some cases playing together, doing things together in a whole variety of situations, that is something which is very special to me.

insight

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Dennis Goodtzov

Dennis tells us about progressing from BSc to MSc in St Andrews

Doing physics at St Andrews seemed like an unlikely target when I first applied here. My choice was motivated mainly by 'well, they have a great rating in physics'. So when I actually got my offer I was thrilled. I visited on one of the open days, and after Bruce's demonstrations during the open day lecture to all the prospective physics students, I just pulled out my phone and accepted my offer right there. It was a spur of the moment thing which I don't regret at all.

I'm really bad at taking exams. Under time pressure my adrenaline tends to spike and I lose the ability to think in the same way I can under normal conditions. Except I didn't realise that until I started failing exams in my first year. I thought I wasn't studying hard enough, so I started studying more and more, trying to learn everything I could. I also tried numerous ways of improving my nerves before exams. Of course, this was a learning process, and my exam grades didn't improve quickly enough for me to meet the grade 15 average needed at the end of second year to stay on the MPhys. At the time this was disappointing, but in retrospect it helped me discover that despite my weakness in exams, my strengths might lie in actually doing research. The BSc is 4 years long instead of the original 5 I had signed up for, but I was still committed to getting a Masters degree, so I decided not to stray and just apply to St Andrews MSc Astro program, a 1 year course split 50-50 between teaching and research. The MSc is set up like the final year of the BSc, with an additional 10 week summer project after the second semester. Also, instead of a 30 credit research project in semester 2, you do a full year 30 credit 'Research Skills' module, which includes a research project (in semester 2) making up a total of 80% of the credits. After 4 years, my exam grades improved just enough, and my BSc research project went pretty well, so I met the entry requirements.

My MSc year was difficult. It started with GR and ended with a global pandemic. Anyone who has done physics at St Andrews (especially third year) knows about the intensity and the pace of lectures, the frequency of deadlines, and the weird grading system, so I felt relatively prepared for this aspect of the degree, but it still felt overwhelming at times. I really struggled with the two exams I had in the first semester, even though I spent so much time preparing, watching multiple lecture series on the topics, reading all the books I had access to. That killed off any chance of getting a first very quickly.

Maybe a few of my exam grades were bad, I had still learned so much about everything I had studied. I knew so much new physics, regardless of if I was or wasn't able to answer 7 very specific questions about it in 2 hours. This is a truly wonderful feeling, and the best part of the MSc year was being able to consolodate physics I had learned in the past 4 years and apply it to new situations. The MSc was also valuable because I was able to do my first smaller research project in an area I hadn't worked in before, and allowed me to build additional skills and experience in a really interesting field.

By taking the alternate path to a Master's degree, I ended up getting 2 degrees, and doing 2 more research projects than if I hadn't switched from the MPhys. That isn't to say it's better, or worse; it's just different. Personally, it helped solidify my interest in doing more research, and improved my research ability drastically. Though I always knew on some level that I wanted to do a PhD, it's nice to know that I might actually also be good at it.

> **"Whatever you decide to do with your future, remember that exam grades don't define your intelligence, they define your ability to take a test. :)"**

Do you have an experience you'd like to share with us, or maybe an experience you'd like to hear about?
Email us at pandamagazine@st-andrews.ac.uk

Coronavirus Tutoring Initiative

Catherine Essex

Where did you do your internship and how long for?

I started tutoring for the Coronavirus Tutoring Initiative over the summer after exams, and have been doing so ever since. CTI is a non-profit organisation which connects volunteer university students with disadvantaged young people to provide them with free tutoring in KS3, GCSE and A level in all subjects (and Scottish equivalents). The pandemic has widened the education gap, with disadvantaged students 18 months behind their peers by the time they took their GCSEs.

What did you do?

I have been tutoring three students in GCSE Physics, GCSE Chemistry and KS3 maths.

What was it like?

I decided to tutor three students for one hour a week. It's been so rewarding seeing them all progress week by week, and I feel as though I have really made a difference to their education.

Where did you find out about your internship?

I found out through a friend.

Do you have any tips regarding the recruitment process?

It's super easy to sign up for, just fill in the form at https://coronavirustutoring.co.uk/tutor and wait to be matched to a student! You can choose how many students you want to tutor, and in which subjects you'd like to tutor. No experience is needed, and full safeguarding training is given. If you are finding it's too time consuming then you are easily able to lower the number of students you are tutoring or withdraw completely from CTI, with an email.

Internship Interview

Callum Donnan, Astronomy Summer Research Programme

Where did you do your internship and how long for?

I took part in the Institute of Astronomy Summer Research Programme at the Institute of Astronomy, University of Cambridge which lasted for 8 weeks.

What did you do?

I developed a new technique of measuring the spectroscopic redshift of the most distant galaxies. The overall goal of this research is to understand galaxies more precisely during this era and to work towards observing the very first galaxies that existed in the universe. With this new technique I was able to measure the spectroscopic redshift of a galaxy for which we previously could not, at a redshift corresponding to 500 million years after the big bang – one of the furthest astronomical objects ever observed.

What was it like?

Due to the Covid situation, this internship was done remotely. This meant I had two Zoom calls a week with my supervisor where we discussed my progress on the project. However, this did not limit my enjoyment of the experience and I was still able to get a lot out of the project. Also, there was the opportunity to attend virtual seminars in the department as well as a weekly zoom call with the other summer students. This was a great opportunity to conduct exciting research on a topic I am interested in as well as giving me lots of new research skills.

Where did you find out about the internship?

I first found out about the internship from an email that the head of school sent to all honour's students. As I have an interest in pursuing a career in Astrophysics research I decided to apply.

Did you have any funding and if so, how did you find out about it?

All the funding was internal with the University of Cambridge paying a small stipend for the work.

Do you have any tips regarding the recruitment process?

I would recommend emphasising your passion and relevant experience for astrophysics research. One thing to bear in mind is that these programmes can be quite competitive to get into, so it is good to apply for many places to increase your chances. The process of applying involved submitting a CV, a transcript of your grades and a description of your interest in the projects and in astronomical research. You also need an academic reference letter for the application (two for some other programmes). For this I recommend asking someone in the department who knows you well. For Cambridge there was no interview, but some other astronomy summer programmes do have an interview at the final stage. For interviews I would recommend trying to emphasise your interest and passion for the project and also making sure to ask them questions as well.

What should people who will do something similar expect?

A research-based internship will usually consist of the opportunity to conduct some new, original research under the supervision of an academic at the host institution. This gives you the chance to explore something no-one has done before and gives you lots of new skills. Some examples of these skills are coding (for me mainly in python), reading scientific papers, writing scientific reports and presenting your work to a research group.

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

This internship gave me lots of experience in astrophysics research and has confirmed that I want to do a PhD after I graduate. It has also sparked my interest specifically, in research into the first galaxies in the high redshift universe.

Were you lucky enough to have an internship this summer? Why not share your experience with us!

Email us at pandamagazine@st-andrews.ac.uk

ASTROPHOTOGRAPHY

Will Bowles, winner of the astrophotgraphy competition, tells us about how he took his stunning photograph.

I''m Will, a 4th year Biochemist at St. Andrews and here's some info about how I took the photo:

This photo was taken on the 10th of April 2019 from about 1am-4am. You get to see far more of the milky way core the further south you go in the UK, so taking this picture on Salisbury plain meant that I was able to see so much of the core of our galaxy.

After a run up the hill in the daytime to scout out a good location, I planned the shoot for that night, looking directly south. I then waited up until about midnight, making hot chocolate and making sure my camera cards were empty and batteries were charged. At this time of the year, the core rises up as the night goes on, so I hiked a few miles up the hill again in the pitch black and eventually got to the top at about 1am. I then set up my tripod to take the foreground shot. Because the stars appear to move across the sky, this means that any exposure longer than 20ish seconds gives blurry or streaky stars, so the foreground and sky photos have to be taken separately (although I never move the tripod in between shots to ensure that I have a 'real' photo at the end of the process).

An old, abandoned oil tanker looked like the perfect foreground, but I just wanted that extra bit of interest in the photo, so I had to set my camera on a self-timer and climb up on top of the tanker - rather hard to do in the dark. After taking a few photos in different positions (trying to stay absolutely still), I climbed back down and was happy with the results - now I just had to wait for the core to rise.

In the hour between 1am and 2am, I set up my star tracker - this is a piece of equipment that moves slowly with the rotation of the Earth so as to negate all star movement when properly aligned with the axis of rotation (i.e. pointing at the north star for northern hemisphere). This allows you to take photos of up to 3 or 4 minutes long, while keeping the stars pin sharp and round - of course the only downside is that the foreground gets very blurred as the camera moves in relation to the ground now.

Using this method, I then began to take photos of the stars - I took 17 pictures of the same portion of sky, each photo was 2 minutes long, at ISO 3200 and f5. I have worked out through trial and error that these are the absolute best settings for my camera (Nikon Z6 with 24-70mm f4 lens) to maximise detail and sharpness. I then took another 20 black photos with the lens cap on - you might think that's weird, but there's a good reason for it: the black photos create a 'map' of your sensor which show if there are any pixels that are stuck, and shows up all of the noisy grain that is background noise and isn't due to any light signal.

Why did I take so many photos of the sky and the black photos? Stacking. If you stack all of these images together, one on top of the other, this averages out all of the grainy noise and increases the effective signal strength of what's actually in the photo (The Milky Way!). So, after stacking together my 17 light pictures and my 20 dark pictures, I subtracted all the data in the dark stack from the light stack. This gives you a wonderfully clean and crisp image, which you can then really begin to push in your processing programme. To do all of this, I use a programme called Pixinsight. After I had tweaked the shadows and highlights and lights and darks, I merged my foreground photo up with my background (starry) photo and tweaked the colours slightly (for my taste - I love orangey yellows in The Milky Way). And that's the whole process!

So, in total, (scouting, planning, travelling, photographing, editing) I think this photo took around 14 hours to complete. I hope you agree it was worth it! Astrophotography is, I think, the most technical kind of photography you can attempt - there's so much to dig into (if you want to improve), and the incremental improvements you make really add up to give something special. For me, I have learned how to do this over the past few years, and it's great fun, but the thing I really love is setting my camera off taking photos and just sitting quietly on the ground and looking up - it really humbles you to what's out there and what a tiny part of it all we are.

If you wanted to see any more of my photos or had any questions about anything, feel free to contact me:

Instagram will_b133

Website https://willbowles.myportfolio.com

Pizza Snails

Estimated time
25 minutes

Ingredients

Puff Pastry	1 roll
Sliced Cheese	4 slices
Sliced Ham	4 slices
Ketchup	a bit

Optionals

Olives cut into pieces

Basil, oregano...

Anything else that you'd put on a pizza!

Preparation

1. Pre-heat your oven to ~180°
2. Spread the puff pastry
3. Put the cheese on top, leave 2cm at each side empty
4. Put the ham on the cheese
5. Put a bit of ketchup on the top, spread. Sprinkle with herbs if you're using them
6. Roll it!
7. Cut the roll into ~1cm thick slices (the trick is to have a sharp kife, and if it's still sticky, wet your knife with some water)
8. Place on a baking tray covered with baking paper
9. Pinch a piece of an olive right into the middle of each spiral
10. Stick it in the oven for 15-20 mins (this is really oven-dependent, and also the only step that could possibly go wrong...)
11. That's you done! Enjoy!

SNAILED IT

Alterations

Sweet tooth? Try this: just mincemeat and puff pastry. Just spread it, roll it, chop it, bake it.

For both variants: If you can, keep them in an airtight container until the next day - they become softer. But you might need to double the ingredients to achieve that.

Mincemeat

Pizza

PUZZLES

7					6			
3		6	9					
2					3	7		
						9	4	
			3		5			
	6		4	2		8		
6	7		1		4		3	
	1			3	9			
5		9		7				

Sudoku

Make each column, row, and 3×3 subgrid contain all of the digits from 1 to 9.

Riddles

The boiled egg conundrum
Given two eggs (one raw and one hard boiled) both at room temperature, how can you determine which one is which without cracking them open?

Anagrams

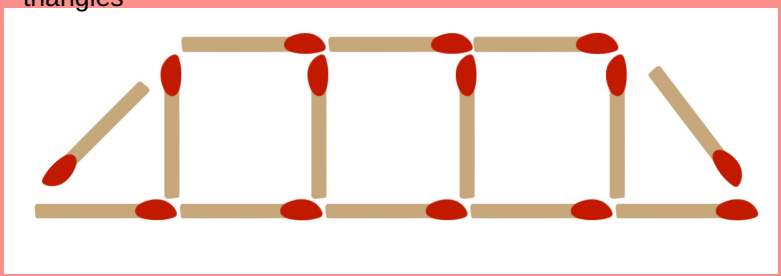
Piece of cake
if led (1 word)
parcel it (1 word)

Rather challenging
hello back *(2 words)*
cosy gloom *(1 word)*
telegram conceit *(1 word)*

Rocket Science
age it irrelevantly *(2 words)*

Matchstick Puzzles

Rearrange the matchsticks to create 5 squares and 6 triangles



Solutions on page 34

Poster Board

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!

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

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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.

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.

Bookshop

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

Puzzle Solutions

Sudoku

7	4	1	2	5	6	3	9	8
3	8	6	9	4	7	1	2	5
2	9	5	8	1	3	7	6	4
1	5	3	7	6	8	9	4	2
4	2	8	3	9	5	6	1	7
9	6	7	4	2	1	8	5	3
6	7	2	1	8	4	5	3	9
8	1	4	5	3	9	2	7	6
5	3	9	6	7	2	4	8	1

Anagrams

Piece of cake
FIELD
PARTICLE

Rather Challenging
BLACK HOLE
ELECTROMAGNETISM
COSMOLOGY

Rocket Science
GENERAL RELATIVITY

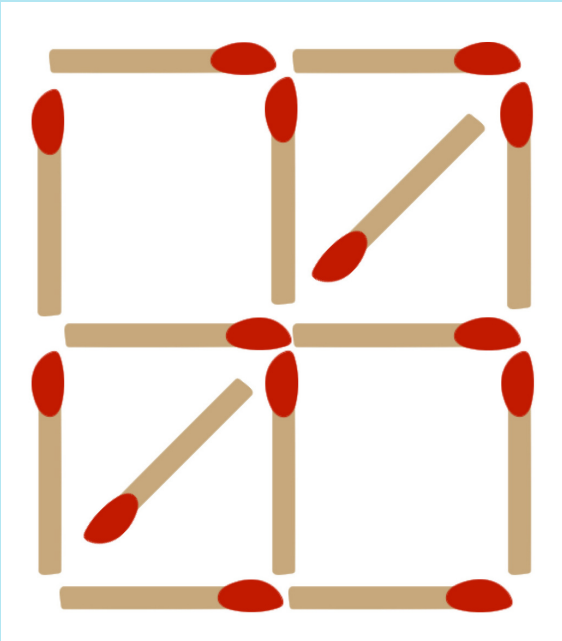
Riddles

The boiled egg conundrum

Spin them! The boiled egg spins for longer than the raw one. This is because the fluid inside the raw egg dissipates energy from viscous forces.

Another way of testing this would be to spin the eggs then touch them to bring them to a stop. The raw egg continues spinning, but the boiled egg does not. This happens for a similar reason – the fluid in the raw egg continues spinning even after the shell has briefly been stopped.

Matchstick Puzzles



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