Café Scientifique Newsletter

Half Term 4:4/4/22

Physics, Technology and the world around us

INSIDE

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Academic Articles

View a range of articles written by Physics Students in the lower sixth.

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Entertainment reviews

Reviews of some books, podcasts and documentaries that we've watched this half term

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Events summaries

What happened this term around events – in case you missed them or wanted to read more.

Editors Welcome

Well done for making it through another busy term! Congratulations on everyone's achievements and goals.

This term we had a Physics theme, alongside the British Science Week leading to many amazing events running. We hope this newsletter provides plenty of interesting content for you to look at.

Thank you to everyone who participated in Science Week events, for the artwork that was contributed to the newsletter (above), and for all of the articles submitted.

Please enjoy!

Café Scientifique Newsletter: Articles

Is Time Travel Possible?

By Jessie

Time travel is one of those concepts that seems to be restricted to science fiction; ranging from *Doctor Who* to *Avenger's Endgame*, many franchises attempt to use this complex concept to create adventures for their characters. But not all of this is purely fictional – in fact, some movie explanations for time travel are quite close to the truth.

One aspect of Einstein's Theory of Relativity is time dilation: when an accelerating object experiences time differently to a non-accelerating observer. This phenomenon occurs when an object's speed approaches the speed of light (approximately 300,000,000m/s), and the closer the object gets to this value, the slower it perceives time to be. If an object reaches the speed of light, it supposedly experiences no effect of time at all. This means that photons, particles of light that move at this speed, are technically frozen in time. Therefore, if an astronaut were to board a spaceship moving at the speed of light and travel a certain distance (e.g. one lightyear), then theoretically no time would elapse for them between setting off and arriving. However, to an observer, an entire year would have passed. So, if this astronaut sets off from Earth, travelling in a loop of one lightyear and returning exactly where they set off, then they have travelled a year into the future.

One issue with this method of time travel is that there is currently no way of travelling this fast in a safe manner. The current record is just over 11,000m/s, achieved by the Apollo 10 mission returning from the moon, and as time dilation is exponential, they would have returned only a fraction of a second younger that everyone else.

This concept of time dilation is explored in the film *Interstellar*, whereby the planet's proximity to a huge black hole means that time runs much slower that it does on the observing spaceship. For the man left on the spaceship, 23 years had passed when the crew, who had only been on the planet for a few hours, finally returned. Despite other aspects of the film being more fantastical, this part was calculated by the writers, and scientifically conceivable. *Interstellar* also uses cryogenic preservation to explain time jumps, which is another, less theoretical way to travel to the future. It involves lowering a person's body temperature to absolute zero (-273°C), so that their atoms have no energy and can be defrosted in exactly the same state they were frozen in. This has already been attempted in modern science, with people paying vast sums of money to freeze them moments after death in the hope that a cure to their disease will be found in the future.

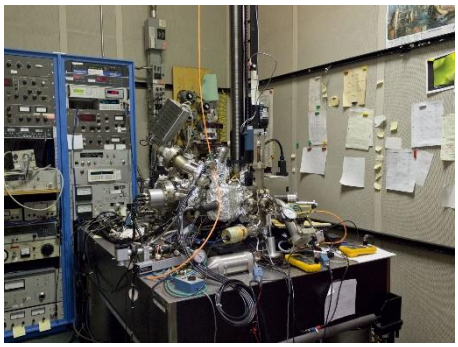
Although there are several ways to slow down your own perception of time and travel to the future, travelling to the past is a much more complicated idea. It brings up many issues such as the grandfather paradox, where travelling back in time to kill your own grandfather results in you never having been born, and so there is no one to travel back in time to kill him in the first place. *Avenger's Endgame* attempts to solve this paradox by proposing the idea of multiple timelines. Their theory is that altering something in the past causes a new changed version of events to branch off from the original timeline, creating parallel universes. Another Marvel theory, explored in *Agents of Shield*, is that small adjustments to the past will resolve themselves, and eventually all branches will converge into one timeline again.

But how exactly can we travel back in time? In *Avenger's Endgame*, Tony Stark's solution to this is to enter the Quantum Realm, a dimension so small that time works differently, and exit it at a different place. But what scientific merit does this theory really have? There are many aspects of quantum physics that are not yet understood; events happening at a microscopic scale can bring about many odd phenomena, such as quantum entanglement, time crystals, which appear to exist in perpetual motion outside of time. There is even debate as to whether quantum particles exist in this dimension, or in 11 dimensions, as proposed by string theory. All of these concepts make time travel seem slightly less ridiculous.

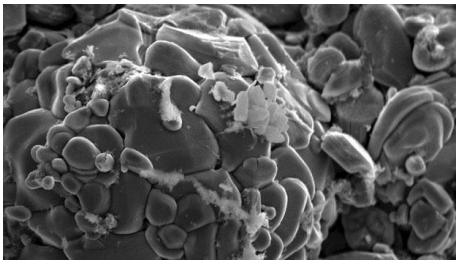
To conclude, time travel can be approached in many ways, from cryogenic preservation and time dilation to worm holes in the quantum realm. Some of these theories are entirely plausible, and some far more suited to science fiction. As *Doctor Who* eloquently puts it, it's all just a '*big ball of wibbly-wobbly, timey-wimey stuff.*'

The Invisible word: scanning tunnelling microscope

-By Olivia



The scanning tunnelling microscope was invented by Gerd Binnig and Heinrich Rohrer who went on to win a Nobel prize for their invention in 1986. The scanning tunnelling microscope works by passing a very thin and sharp tip of a metal wire over the surface of an object. The quantum mechanical effect of tunnelling is used to keep the tip of the wire a set distance away from the object being scanned. Electrons have both particle and wave-like properties. The wave-like properties mean that when they hit a very thin barrier (roughly a nanometre thick) the wave does not suddenly stop, like a particle would, but part of the wave is able to get through the barrier meaning that some electrons can be detected on the other side. The number of electrons that can pass through the gap is very much dependent on the thickness of the barrier. In the case of the scanning tunnelling microscope, the gap between the tip of the wire and the object being scanned is the barrier that the electrons need to pass through. Electronics are used to measure the current passing through the barrier and adjust the height of the tip accordingly to ensure that the current remains the same and therefore the gap between the tip and the object remains consistent. The adjustments of the height of the tip are recorded by a computer and the information is then translated and presented in an image. Alternatively, the height of the tip can be kept the same and the current passing through the barrier can be measured and this information can be used to create an image of the surface of the object.



The scanning tunnelling microscope is used for imaging the surface of objects and materials 'at the atomic level with outstanding accuracy' which enabled multiple discoveries at atomic level and of the specific structures of materials. Some of these discoveries include Alexei Ekimo's discovery of semiconducting quantum dots in a glass matrix in 1981; the discovery of Buckminsterfullerene in 1985 and Louis Brus's discovery of colloidal semiconductor nanocrystals in 1985.

In 1989 the scanning tunnelling microscope was used not only to see atoms, but to move individual atoms at will. Scientists at IBM were able to manipulate 35 individual xenon atoms, adjusting their positions in order to spell out the IBM logo. It is possible to use the scanning tunnelling microscope to manipulate individual atoms by controlling the interactions between the atoms at the end of the tip and the singular atom that is being manipulated (also called adatom). This can be done by moving the tip as close as possible to the adatom without coming into contact with it. The height of the tip can be adjusted in picometres (1 picometre = 1 x 10^{-12}m) meaning that the tip is able to get extremely close to the adatom. In fact, the atoms get so close together that the electrons from each atom begin to overlap, allowing a form of chemical bond to form between the tip and the adatom which can be adjusted by altering the distance between the tip and the adatom. When the tip now moves across the surface, the adatom is trapped due to the form of chemical bond that has formed and is carried along with it. Being able to use the scanning tunnelling microscope to move and alter the position of individual atoms at such a small and accurate scale enables scientists to have the possibility of developing nanostructures.

Café Scientifique Newsletter: Documentaries

TikTok - Amazon Prime

-By Katy

TikTok is the online sensation app that blew up in 2020 just as the world went into lockdown, amassing over 3 billion downloads. As the most downloaded app in 2020 and 2021, users average an hour and a half per day due to its addictive algorithm. The endless scrolling allows them to determine you interests and encourages you to stay online for as long as possible so that data can be collected such as facial data, data on your personality and your history. This data can then be sold on to secondary companies who are looking to make the most profit for their product.

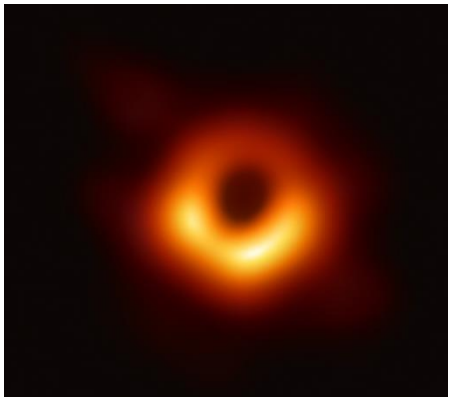
The TikTok algorithm is known to have inequalities on what content can be promoted including factors such as disabilities, age, race and beauty standards. It is also known to attempt to hide political speech conversations that it deems controversial, even if this may be considered a topic where conversations are being held in mainstream media. Unfortunately, the app is also known to induce disordered eating in young members of the population due to content that can be promoted. This documentary is one in a growing field of many attempting to expose the brutal truth behind these addictive social media apps. Click here to watch.

Coded Bias -Netflix

-By Katy

Can technology be taught racism, sexism, ableism, or any other form of bias? This engaging documentary argues that it can be, and it is in fact already starting to affect our day-to-day life. Biometrics are the study of the physical and behavioral characteristics to identify a person. Facial recognition systems are being increasingly employed by national companies. However, they have already started to misidentify many citizens leading to unnecessary threats and aggressive behaviors.

There are still no laws about facial recognition, and it continues to be used to attempt to identify possible threats to society. Click here to watch the trailer or watch on Netflix for the full documentary.



Black holes: the edge of all we know - Netflix

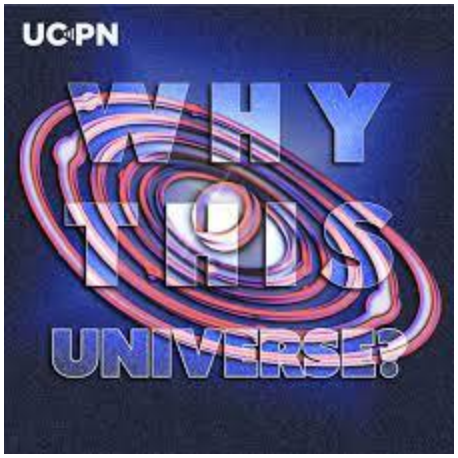
Review by Katy

This fascinating documentary follows a group of academic physicists as they attempt to take the first picture of a black hole. The main challenge of this being that it must be taken through multiple telescopes as they are too complicated to be picked up by just one and not enough is yet known about them. Physics is all about understanding the universe and the predictability of the universe breaks down is black holes which could suggest that it could break down in other situations. Find out what its like to be on the inside of a revolutionary project and how research students are able to assist with mind blowing discoveries. Watch the documentary on Netflix or the advert by clicking here to find out more.

Quirks and Quarks

Review by Olivia

Hosted by Bob McDonald, Quirks and Quarks is a radio show originating in Canada, exploring all areas of science, especially that of physics. Some of the most intriguing episodes include that of 'the Earth is at the centre of a cosmic bubble created by supernovae', and 'are we getting closer to practical fusion power?'. Follow this link to find out more.



Why this universe?

Review by Olivia

Within this podcast, the most vast and thought-provoking concepts in physics are discussed by the theoretical physicist Dan Hooper and Shalma Wegsman, a pHD student. From Dark Matter to Quantum Mechanics, a variety of subtopics are discussed, such as the signs as to the existence of Dark Matter. Click here to find out more.

Sean Carroll's Mindscape

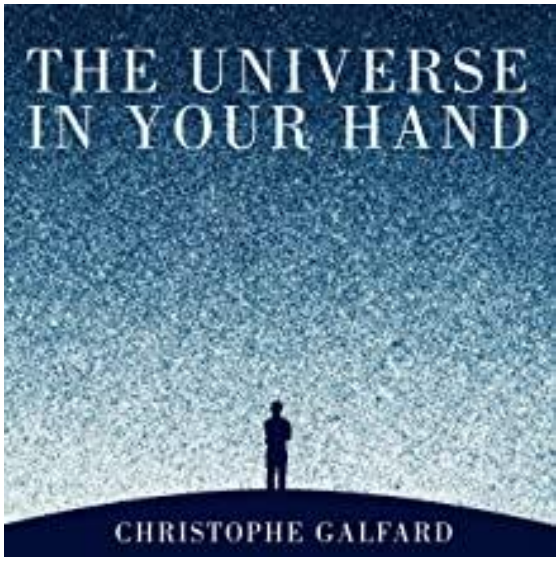
Review by Olivia

Would you like to understand the concepts of gravitational lensing? Keen to understand ideas of openness, bias and rationality?

Sean Carroll, theoretical physicist, and philosopher, specializes his work on the fields of quantum mechanics and cosmology. This fascinating podcast combines the likes of the sciences, philosophy, and society on the whole, discussing topics from the impact of technology on humanity to the links between physics and evolution. One particularly interesting episode was presented with Adam Riess, exploring the Expansion of the Universe and Cosmology.

To find out more, click here.

The Universe in Your Hand – By Christophe Galfard



"The Universe in your Hand" by Christophe Galfard is a fascinating journey from the impossibly tiny to the unimaginably large. Spanning the history and breadth of the universe, the book answers the big questions about our cosmos and far more besides! What are we made of? How old is the Sun? How come Physics is so cool? OK, the last one should be obvious.

What I liked was the author's humour and great storytelling, making big ideas really engaging. It also gives lots of information which makes me feel super smart if I understand it, and if I don't, it is clear enough so the reader can actually make sense of it all. So, if you want to explore the deep cosmic waters of existence, The Universe in Your Hand is a great place to start.

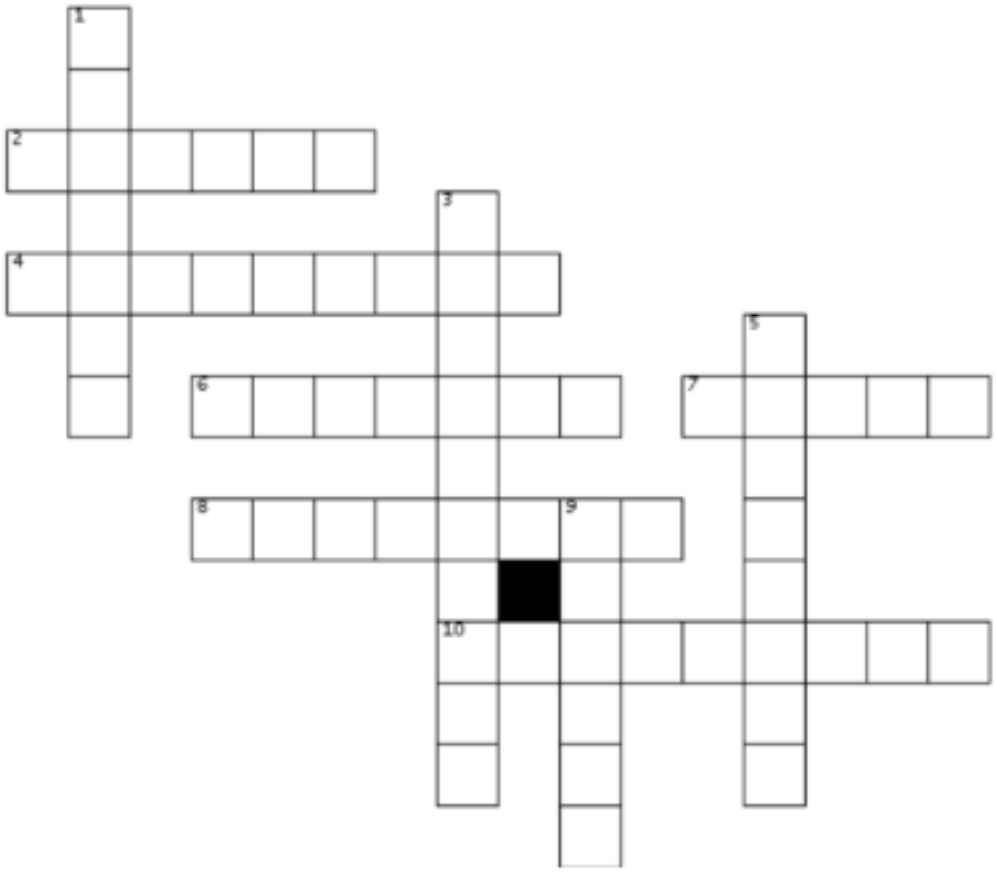
Particle Physics

-By Jemima

Recently at King's the Lower Sixth physicists had the privilege of attending a Virtual Particle Physics Masterclass run by the Rutherford Appleton Laboratories. The masterclass included a day of different talks and interactive workshops, with a talk on the Standard Model of particles, a virtual tour of a particle accelerator, as well as an introduction to the Large Hadron Collider with a data workshop.

The highlight of the masterclass for me was learning about the Large Hadron Collider at CERN. The Large Hadron Collider (LHC) is the world's largest and most powerful particle accelerator and it first started up on 10 September 2008. The collider consists of a 27-kilometre ring of superconducting magnets with a number of accelerating structures to boost the energy of the particles along the way. Inside the accelerator, two high-energy particle beams travel at close to the speed of light, in opposite directions, before they are made to collide. The beams travel in two beam pipes kept at ultrahigh vacuum. They are guided around the accelerator ring by a strong magnetic field maintained by superconducting electromagnets. The electromagnets are built from coils of special electric cable that operates in a superconducting state, efficiently conducting electricity without resistance or loss of energy. This requires chilling the magnets to -271.3°C – a temperature colder than outer space. For this reason, much of the accelerator is connected to a distribution system of liquid helium which cools the magnets.

Café Scientifique Newsletter: Game



ACROSS

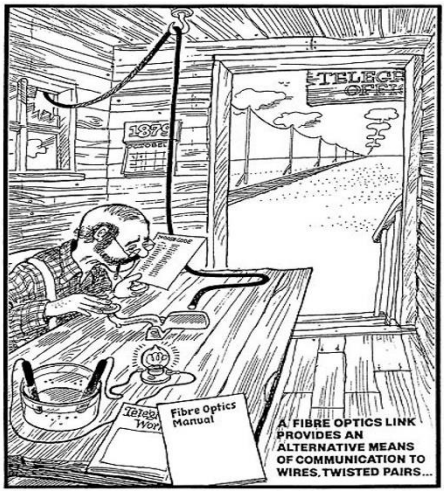
2. SI Unit of Heat.
4. Instrument used to measure gas pressure.
6. Universal force of attraction acting between all matter.
7. The scientist who discovered the photoelectric effect in 1887.
8. SI Unit of Mass.
10. A solid whose arrangement of atoms and molecules has no definite pattern.

DOWN

1. The force allowing an object to rise to the top of a container after being submerged.
3. The instrument used to communicate by light.
5. The person who is credited with the discover of Infrared Radiation.
9. The point of an orbit of an object (such as a satellite) orbiting the earth that is at the greatest distance from the centre of the earth.

The Fibre Optics Revolution: How optical fibres have shrunk the world – By David Archer

Review by Katy



On the 16th of March, Mr. Archer came in to talk about how the world has changed since the introduction of fibre optics. He began by introducing fibre optics cable and the physics ideas of total internal reflection and then proceeded on to ideas about application of optical fibres for telecommunication. He compared the use of copper wire with the glass used in optical fibres and also discussed how if an image is projected onto one end of a set of optical fibres, it will be projected directly throughout the wires and the same image should be reproduced at the other end of the wires. Perhaps most fascinating is their use in speaking to people over the phone and how they have a much larger bandwidth than copper wires, allowing for a progression from 400 or so copper wires in transatlantic cables in the 1960s to 4 billion optical fibres in transatlantic cables in 2014. This means that half of the world's population could stand on one end and have a conversation with every person on the other end as the population of the world is just under 8 billion people!

Café Scientifique x Science Club - cross over

-By Grace and Alex

During science week, two of us went to Warwick Prep to help with Year 5 Science Club. The chicks had all hatched the evening before and the morning of our session, so we were able to take the chicks out while we weighed and measured them. They were small and very noisy, but everyone loved them! We also did an experiment where we put some tablets in water in an air-tight container before we turned it upside down and watched the container fly around the room. We changed the volume of water in the container to see which would cause a larger pop and which reaction would happen faster. Everyone loved this exciting experiment! The last thing that we did was check how well we washed our hands. Each of us looked at our hands under the UV light and rubbed some chalk into them before we washed our hands as we would normally. We then went back to the UV light to see if we had removed all of the chalk and therefore had washed our hands properly.

Science Week Events

-By Katy

The Week 14th – 18th of March was British Science Week with a multitude of events available for students at King's (and across the foundation) to participate in! Activities ranged from master classes and talks, to slime making fun and the fair in the quad with the Prep.

Multiple competitions were also running across the week. A huge well done to everyone who entered the poster cometition, the cress head growing competition and to Year 7s for displaying their cell models. Friday hosted the Science Fair in Warwick Hall for students wishing to display their research and work – also in the form of a key stage competition. Thank you to everyone who came along for the Science Festival of Fun in the Quad – it was beautiful weather for such a lovely day of interactive activities. Wednesday saw the talk on Fibre Optics by David Archer that can be read about above. Finally, some of our Café Scientifique Team went along to help out at the Prep School Science Club!

Café Scentifique Newsletter: The Future

We hope that you have enjoyed reading through the newsletter this term! We are pleased to announce that next term the theme is Biomedicine and we will be having a talk from members of the lower sixth that have completed medical EPQs.

Year 10 will be completing biology and physics challenge and Year 12 will be participating in the schools analyst chemistry challenge.

Memes and Answers