

THE ESSENTIAL SINGULARITY

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The 2025 Nobel Prize in Physics

Jamie Erak

On the 7th of October, the 2025 Nobel Prize in Physics was announced! This year's prize was shared by John Clarke (UC Berkeley), Michel Devoret (Yale; UC Santa Barbara) and John Martinis (UC Santa Barbara; Qolab) for “the discovery of macroscopic quantum mechanical tunnelling and energy quantisation in an electric circuit”.

The prize was primarily awarded for work begun by the group in the 1980s. Quantum-mechanical effects at macroscopic scales can be observed in superconducting systems, and Clarke, Devoret, and Martinis sought to determine whether such effects, particularly tunnelling, could occur in a circuit containing a current-biased Josephson junction (two superconductors separated by an insulating barrier). By feeding a weak current into the Josephson junction and measuring the resulting voltage, they found that the system was able to tunnel out of the ‘zero-voltage’ state that arises in such a setup, despite the bias current being smaller than the critical value that would classically be required for a voltage to be observed.

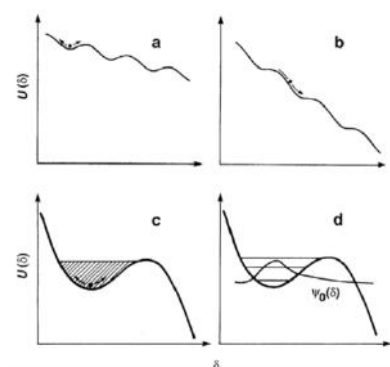
By using microwaves to increase the state energy, they were also able to observe tunnelling from excited states, demonstrating that the energy levels are quantised.



Above: The winners of the 2025 Nobel Prize in Physics: John Clarke (left), Michel Devoret (mid), and John Martinis (right). Below: Prof. Goran Johansson shows a chip of the type used in the experiment. Source: <https://www.nobelprize.org/prizes/physics/2025/>.

For those with broader interests, the other 2025 Nobel Prizes were:

- **Chemistry:** Kitagawa, Robson, and Yaghi for “the development of metal-organic frameworks”.
- **Physiology or Medicine:** Brunkow, Ramsdell, and Sakaguchi for “their discoveries concerning peripheral immune tolerance”.
- **Literature:** Krasznahorkai for “his compelling and visionary oeuvre that, in the midst of apocalyptic terror, reaffirms the power of art”.
- **Peace:** Machado for “her tireless work promoting democratic rights for the people of Venezuela and for her struggle to achieve a just and peaceful transition from dictatorship to democracy”.
- **Economic Sciences:** Mokyr, Aghion, and Howitt for “having identified the prerequisites for sustained growth through technological progress”.



Illustrative diagram of the effective potential $U(\delta)$ in the circuit as a function of the fictitious particle coordinate (where $V \propto \delta$). Diagrams (a) and (b) show $U(\delta)$ for bias currents $I < I_0$ and $I > I_0$ respectively. For $I < I_0$, the fictitious particle is trapped in a potential well (‘zero-voltage’ state), and diagrams (c) and (d) illustrate the expected classical- and quantum-mechanical behaviour respectively.

International summer research: Two experiences

Perth is a great city, and home to brilliant physicists, but it's no exaggeration to say it's a small city when it comes to physics. There are, however, ways to get international experience as part of your degree, which can be a valuable way to learn about different areas and get to know the global physics community. There are many different options, but it is important to know which ones are possible for Australian students and relevant for physicists, and organising them can be quite nontrivial. We spoke with two Curtin physics students, Kyna Schrick and Jamie Erak, to hear about their international experiences this year.



Top: Welcome lecture for the CERN Summer Student Program (with Kyna circled). *Bottom:* Jamie outside the Hoyle building at the IoA, Cambridge.

Kyna Schrick

Where and what was your international experience?

I participated in the CERN Summer Student Program for eight weeks over June and July, in Geneva. This involved a research project, workshops, and an intensive lecture series. I worked with AEGIS, one of the antimatter experiments, on trying to predict how different species would behave in their ion trap.

How did you organise it?

The application process (closes mid-January) isn't too involved, just a few worded questions, and the normal CV/transcript. Once you are through a screening round to check eligibility, the supervisors pick the students they want to work with. I heard from some other students that they had interviews, but that is uncommon (I didn't). They provide a travel/living-stipend that more than covers any expenses.

What was the most valuable thing you learned?

CERN is an incredible place, with science and technological development happening everywhere you look, but it is also held together by duct tape and zip ties. Everyone is busy all the time, so to do research as a student you have to be able to advocate for yourself. I also have much more appreciation for all the moving parts in these experiments.

Any advice for other students?

If you have even a tiny interest in particle physics, you should apply! This goes for most other things too, but it never hurts to put yourself out there.

Jamie Erak

Where and what was your international experience?

I travelled to Cambridge University for a four-week-long research project at the Institute of Astronomy. My supervisor and I worked on explaining the absence of rings systems around moons using constraints from magnetic fields, which is a really fascinating classical mechanics problem.

How did you organise it?

I was fortunate enough to already have funding from the Don Watts travel grant, so I simply wrote to researchers who had expressed interest in working with summer students, and eventually found a cool project! I was also required to formally register as a visiting student at Cambridge, but this process wasn't too hard.

What was the most valuable thing you learned?

I met many extraordinary physicists while in the UK, and the thing that impressed me most was the interconnectedness of different areas of research. At the IoA, for instance, there are collaborations with fundamental theorists, planetary scientists etc.

Any advice for other students?

Firstly, don't be afraid to write to people. If you're interested by someone's research, they'd be delighted to hear it!

Secondly, there are multiple ways to organise international experiences, so don't give up if you're encountering barriers (sadly, they do exist and can be very arbitrary). When one door closes, find a sledgehammer!

Book suggestions

Reading can be an enjoyable and restful way to take a break from studying. Here are our top recommendations for this month:

***The War of the Worlds* by H. G. Wells**

“Yet across the gulf of space, intellects vast and cool and unsympathetic, regarded this earth with envious eyes...”

At the turn of the 20th century, a flash of light and plume of smoke is seen on the surface of Mars. Months later in Woking, England, a mysterious cylinder falls from the sky. Read on to witness the invasion of our planet by the Martian race, with their tentacles, tripodal walkers and heat rays. First published in 1898, *War of the Worlds* was one of the first stories to tell the tale of an alien invasion of Earth. Wells shows us what an advanced alien race might look like, what technologies they may possess, and through this, brings the reader to wonder about our own future on planet Earth.

***When Breath Becomes Air* by Paul Kalanithi**

How does a neurosurgeon feel when they are diagnosed with cancer? Paul Kalanithi dedicated his life to saving others, so when he receives a terminal diagnosis of his own, he must grapple with what all of it *means*. He writes about the brain, about morals, and about duty and purpose. This deeply profound book chronicles his journey through research, medicine, fatherhood, and the end stages of his life. (Be warned, this book made me cry on the bus).

Movie suggestions

At times, some people might prefer things other than reading. For such times, here are two movie recommendations:

Interstellar

I think this recommendation is pretty unanimous among physics cohorts! With human civilisation on the brink of collapse, the remnants of NASA discover one last hope for a future among the stars, but the laws of physics make things *relatively* challenging for the pioneering crew sent to investigate. With a well-constructed and emotionally intense plot, and an excellent soundtrack, *Interstellar* is truly a masterpiece of cinema that will appeal to a variety of audiences. What makes this movie so appealing to physics enthusiasts is the integration of fascinating physics concepts. Some aspects are considered speculative, but the audience will enjoy spotting this, and it does not detract from the real physics upon which much of the plot is based.

A House of Dynamite

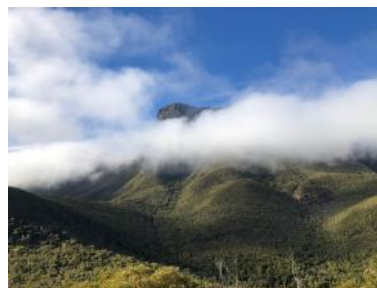
This movie tells the story of the U.S. Government's reaction to a single, unattributed ICBM launch from three different perspectives. Although a work of fiction, the vivid realism and references to real events creates a tone that feels somewhere between documentary and political thriller. With very complex and deep topics explored, this movie was clearly made to encourage thought and discussion, and makes one scrutinise their most fundamental assumptions regarding geopolitics, leadership, and mutually assured destruction.

Jamie's mountain suggestions

After all this serious thinking, what better activity than exploring a mountain? Options in WA are few, but here are my favourites:

Bluff Knoll

The tallest mountain in the south-west of WA, with a well-maintained path and a great view of the surrounding range (known as Koikyenneruff in the Nyoongar language) at the top.



Mount Toolbrunup

A quality mountain, and only slightly shorter than Bluff Knoll. It is much more 'off the beaten track', with a very quiet trail and a rock scramble to the summit.



Castle Rock

Not really a mountain, but a very nice uphill hike in the Porongurups with a great view.



Recap of events

Kyna Schrick

On the 8th of October, we held our Annual General Meeting, combined with pizza and some games. On the more formal side, we elected next year's executive committee:

- **President:** Emmanuel Foo.
- **Vice-President:** Yaolin Chen.
- **Treasurer:** Karissa Clarke-Liddell.
- **Secretary:** Flynn Holthouse.

Congratulations to Eman, Yaolin, Karissa, and Flynn for their election! We can't wait to see what you'll do with the club. After the formalities, we all regressed to iPad kids and enjoyed rounds of Among Us, Kahoot, and Gartic Phone. We discovered that less of us know the kinetic equations than expected, there is no CCC Kahoot (something to fix for next year?), and one particular professor is quite easy to draw.



Attendees play a game of Kahoot after the Curtin Physics Club 2025 Annual General Meeting.

On the 20th of October, we held the first Curtin Science Alliance joint study session. We booked a classroom in the library for an entire day of productive individual and collaborative study with a steady supply of snacks! Aside from the soup thief, who remains at large (you know who you are...), it was a remarkable success, and we are very grateful to all those who came along.

We also held the very first Curtin Science Alliance Sundowner on the 8th of November. It was great to see everyone dressed up a little, and enjoying good food and drinks as we celebrated the end of another semester. The Science Alliance was a new initiative this year, and it is nice to already see the connections forming between disciplines.

Editorial

Jamie Erak

As 2025 comes to a close, it is a bittersweet moment for me. Not only does this mark the end of my time as a student at Curtin, but also as the editor of the fantastic monthly publication we call The Essential Singularity.

This year was the first year of The Essential Singularity, and I would call it an incredible success. Including this one, we published six issues approximately monthly during the semesters (with some variation due to the demands of our studies). We had several recurring sections, such as club updates and upcoming events, and the book reviews and Ed's puzzle section were favourites.

We also published a wide variety of special articles, from general relativity to crane spotting!

Going forward, I hope that The Essential Singularity will continue its mission of providing a forum for students to share their enthusiasm for physics, and to gain writing experience by discussing topics that interest them. Although its primary purpose will always be as the Curtin Physics Club newsletter, it is my hope that The Essential Singularity will grow to serve the Curtin Physics community more broadly, and physics enthusiasts generally.

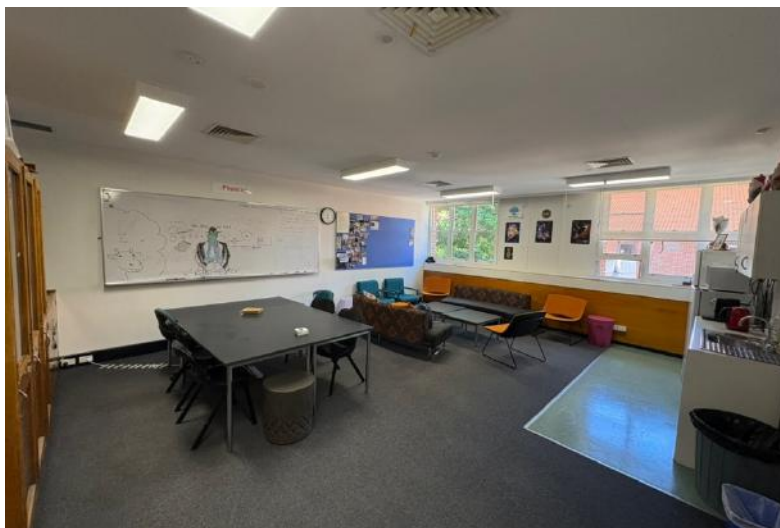
At this time, we are still looking for an editor for next year. To any readers who may be interested in the position, I

enthusiastically encourage you to consider it! Putting together a newsletter can seem like a daunting task, and constitutes a decent time commitment once a month, but an editor never works alone. The Essential Singularity would not have been possible without the contributions and support of our committee members, and for this, I wish to express my deepest gratitude. I have no doubt this help will be extended to our next editor.

It has truly been an honour to be your editor this year. I conclude this final editorial with a quote from Stephen Hawking: 'So remember to look up at the stars, and not down at your feet. Try to make sense of what you see and wonder about what makes a universe exist. Be curious.'

Common room updates

There have been some major changes in the common room, with the furniture having been re-arranged! We have also made room to start a photo collection on the pin-up board. Please feel welcome to add your own or remove any that include yourself if you would rather they not be displayed.



Farewell from the committee

Kyna Schrick (President)

This year has been a big one. We were aiming to establish ourselves as a club by figuring out what we could do, and how we could help the student body.

We ran a huge range of academic and social events, with the approach of throwing pasta on the wall to see what stuck. It was also a year for making connections: We worked with the Film Society and the AIP for certain events, and founded the Curtin Science Alliance. Besides events, we had several other projects running in the background. The Common Room facilities were upgraded, and we produced our first merchandise, making stickers and hoodies.

I would also like to thank the committee of 2025 for all their efforts throughout the year. We had Nathan, Nat, and Claire holding the fort as the other Execs, with Jamie, Jaime, Grace, Connor, Karissa, Tom, Ed, Sam, Eman, Yaolin, and Flynn in our general committee. Thank you for your invaluable contributions.

Thank you for having me as your President for 2025, and all the best for next year!

Claire Morley (secretary)

The Physics Club has been busy this year, having run many successful events. Between 2024 and 2025, membership decreased from 84 to 58, likely because it was free to join in 2024.

However, the general committee has increased from 7 to 15. We have held hour-long weekly meetings during the teaching semesters, totalling 24, which have been well-attended by the committee. All club decisions get made at these meetings, other than the few executive meetings held between semesters, or minor choices made via communication between the executives.

I'd like to thank all our committee members for being so enthusiastic and willing to help out with all our events this year. To the rest of the execs, we've done so much this year, and I'm very proud of our efforts. Thanks for helping me out and not getting mad when I forget to send emails. Kyna has masterminded all our activities this year and has been such an incredible President. It's been such a pleasure, and I wish next year's committee all the best!

Nat Langford (treasurer)

It has been great to be the treasurer of the Curtin Physics Club in 2025!

Financially this year has all worked out well for the Club. We started off 2025 with a generous \$2500 donation from the EECMS staff, which helped us greatly in placing our first merch order of Club hoodies! While these were a significant expense, they were popular and definitely worth investing in more in the future. Another popular expense was the stocking of the common room with soft drinks and chips, as well as complementary tea, coffee and milk. While we have also invested quite a lot in catering for our events among other things, the leftover money from this year, along with another EECMS grant, looks to have set the Club up well for next year.

Good luck to the new treasurer Karissa and the rest of the executives and committee, I look forward to seeing where you take the club in 2026!

Highlights of 2025



Gartic Phone artwork

In addition to our executive committee for next year, this year's Annual General Meeting gave us the material for The Essential Singularity's first-ever comic strip! Using the popular online game 'Gartic Phone', we created a series of beautiful pictures, with one of our favourite examples presented below.

For those unfamiliar with the game, each image was drawn in response to a preceding text prompt entered by another player, and was then interpreted by another player whose response became the next text prompt.



Quiz

1. Quantum field theory combines quantum mechanics with what theory?
2. What symmetry is broken in the Higgs mechanism?
3. Quasars are examples of what broader type of object?
4. What is the key postulate of general relativity?
5. What is the residue of a removable singularity?

Answers:
 1. Special relativity
 2. Electroweak symmetry
 3. Active galactic nuclei
 4. The equivalence principle
 5. Zero

Quote of the month

"Throughout history, three have understood chair mechanics. Now there are four."

- Dr. Sock
(first words)

Joke of the month

What is a statistician's favourite drink?
Chai-squared.

Interesting fact

Niels Bohr's younger brother, Harald Bohr, was an Olympic silver medallist. He played football alongside Niels, but went on to play for Denmark in the 1908 Olympics. He was also a mathematician, and introduced the concept of almost-periodic functions.

Puzzle

Edward Mirco

Puzzles have concluded for the year! Stay tuned for more puzzles from the *Puzzle Master*TM in the new year.

Answer to the previous puzzle

The order of the first two attempts don't matter, but the 3 attempts should go 1-1-3, 1-2-4, then 2-4-8. Note that it may be possible for there to be another solution; I have not been able to prove uniqueness, but as far as I can tell it is the only completely unambiguous solution.

A key idea is to consider, from Alice's perspective, each possible implication of the lights and tones and whether there exists a more direct/less ambiguous way of communicating it that Bob could have done instead, and if so, then Bob must have been communicating something else that required the code attempts that he used. For instance, if the code was 1-1-1 or 1-1-2, Bob should only use one attempt to communicate this, as it is immediately uniquely identifiable to Alice. If Bob took more attempts and 1-1-1 was a possible code implied by the resulting lights and tones, then we can eliminate it as a candidate, as if it was the code, Bob would have just done the most concise/least ambiguous way.

Word search

Theme: Quantum Mechanics

R G S P I N O R A S H K B P U
 O W R F L O L U M A T R K G N
 T E W E M A X L M Q X A H J O
 A E V T B N N I A W U A T Q B
 R L B E M N L C X R A U Q E X
 E X Y Y F T E S K I I B P C O
 P Z K X O Y S S B C H V B T B
 O K F N R E G N I D O R H C S
 Z Y I B Y D E D Z E G T P G E
 C A Q I K V T D Y Q H F C P R
 N R O T A T U M M O C H B P V
 U J B W O S C I L L A T O R A
 E G A Z Q J K Q U D K C N D B
 I U E L H F P K H C I N D P L
 S E D U T I L P M A X A I G E

Hamiltonian

Operator

Schrodinger

Wave

Commutator

Observable

Planck

State

Amplitudes

Heisenberg

Oscillator

Spinor

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Past issues, and full solutions to puzzles, can be found on the Curtin Physics Club website:

<http://curtinphysics.tidyhq.com>