

# CavMag

ISSUE 34 DECEMBER 2025

## ILLUMINATING THE UNIVERSE'S DARK AGES WITH COSMOCUBE

**NICOLA MARZARI:  
THE 10<sup>th</sup> CAVENDISH PROFESSOR**

**THE GOLDILOCKS ZONE OF  
BOUNCING DROPLETS**

**HARVESTING LIGHT WITH ORGANIC  
RADICAL SEMICONDUCTORS**

**ALSO INSIDE:**

A tactile history of  
science in print



**UNIVERSITY OF  
CAMBRIDGE**

Cavendish Laboratory  
Department of Physics

Winners announced for the Cavendish  
Photography Competition 2025



# Welcome to CavMag 34

**This special issue of CavMag represents something new, as we, a group of postgraduate students, step into the editorial role to shape this edition. For us, this has been a chance to see the Cavendish from a fresh angle: not only as a place of research, but as a living community of ideas, people, and shared curiosity. We hope this issue reflects the vibrancy, imagination, and sense of discovery that make the Department of Physics what it is today.**

Working on CavMag has reminded us how deeply the Cavendish story is intertwined with both history and innovation. Across its generations, the Department has been renewed time and again by new instruments, new buildings, and above all, new minds. Editing this magazine has been our way of joining that tradition, offering our perspective as the next generation of physicists.

It is therefore especially meaningful that this issue coincides with another moment of renewal for the Department: the arrival of Nicola Marzari, who only recently took up the Cavendish Professorship of Physics. His appointment continues a lineage that stretches back to James Clerk Maxwell, through Lord Rayleigh, J. J. Thomson, Ernest Rutherford, and Nevill Mott, to Richard Friend, and now opens a new chapter in the Laboratory's story. In our interview, Professor Marzari reflects on this legacy and looks ahead to the possibilities of computational and theoretical physics, from understanding complex materials to harnessing artificial intelligence as a tool for discovery. He also speaks movingly about the human side of science: mentorship, creativity, and responsibility in a world where physics touches every aspect of life.

This issue, like the Cavendish itself, brings together many ways of seeing. From reflections on our scientific past to cutting-edge experiments, and from nanoscale droplets to cosmic radio waves, each article reveals how curiosity connects us across scales and generations. The outreach feature highlights recent work with pre-university students, which has grown since some of us attended these events as school students! Finally, the results of the

latest photography competition remind us that wonder can be captured as much through a lens as through a formula.

Editing this edition has been both a privilege and an education. We are grateful to Harry Cliff, Vanessa Bismuth and the Cavendish Communications team for their guidance, and to the researchers and alumni whose works fill these pages.

As always, we are delighted to hear from you, so please do contact us using the details opposite with your comments or suggestions. We hope you enjoy this special edition of CavMag as much as we enjoyed creating it.

The Student Editors -

**Daniel Robins, Bofeng Xue, Minglei Zhang**

Daniel is a second-year PhD student in the Astrophysics (radio cosmology) group. He works on constructing radio maps using the REACH telescope.

Bofeng is a second-year PhD student in the Optoelectronics group. His research interests focus on developing ultrafast spectroscopy and microscopy to unravel charge carrier dynamics and transport mechanisms in novel semiconductor materials.

Minglei is a third-year PhD student in the Molecular Engineering group. Her research is to design materials with desirable mechanical properties using data-driven methods.

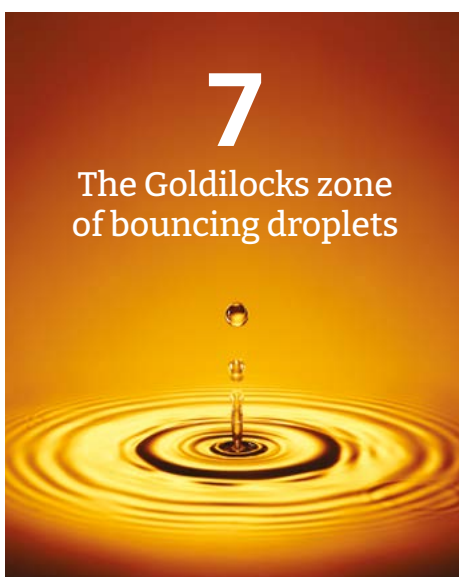
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### Write to us:

Do you like this redesigned issue? Would you like to read more articles about our staff, or find out what other alumni are doing? We are always delighted to hear from our readers, please contact us by email, postal mail or on social media. Letters may be published in future issues. Please mark your email or letter: 'for publication'.

CavMag is the free magazine produced by the Cavendish Laboratory for its Alumni community. It is published twice a year.

**Editors** Daniel Robins, Bofeng Xue, Minglei Zhang

**Contributor/Managing Editor** Vanessa Bismuth


**Cover** m-gucci, IStock

**Design** Matt Bilton / Pageworks

 [cavmag@phy.cam.ac.uk](mailto:cavmag@phy.cam.ac.uk)

 CavMag, JJ Thomson Avenue, Cambridge CB3 0US

 @DeptofPhysics

 [linkedin.com/school/cavendishcambridge](https://www.linkedin.com/school/cavendishcambridge)

 [instagram.com/cambridgephysics](https://www.instagram.com/cambridgephysics)

# BRIGHTS future for quantum objects

Richard Friend is one of the leading researchers to win a European Research Council's (ERC) award in its latest round of Advanced Grant competition, one of the most prestigious and competitive funding schemes in the EU. The funding, worth €2.5 million per grant, gives senior researchers the opportunity to pursue ambitious, curiosity-driven projects that could lead to major scientific breakthroughs.

**F**riend, a Research Professor at the Cavendish Laboratory, leads a team studying electronic properties of novel semiconductors like carbon-based organic semiconductors and metal halide perovskites.

Their new project, named Bright High Spin Molecular Semiconductors (BRIGHTS), builds on Friend's breakthrough in creating bright materials that operate in higher electronic spin states, potentially revolutionising quantum science and optical tech by combining luminescent and spin properties.

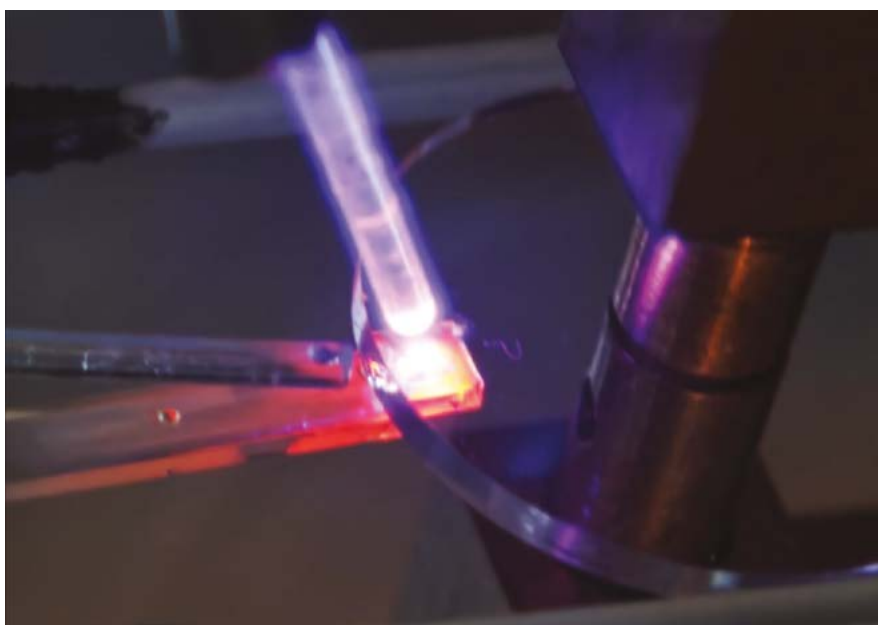
Friend explains that their long-term LED work and unexpected findings led to molecules with high electron spin being extraordinarily luminescent. Understanding the mechanisms allows for designing systems where interactions between spins are controlled.

These breakthroughs enable molecules to support complex spin states while remaining luminescent, creating spin-optical quantum objects. The project aims to develop materials that emit light efficiently and support high-energy spin states for uses like sensors detecting magnetic or biological signals, electronics controlled by spin states, and improved solar cells.

Friend highlights the powerful versatility of manipulated molecular structures to transform light emitters into quantum objects, every atom carefully positioned for specific goals. This research opens opportunities in quantum sensing, data storage, and optical tech with European funding securing these ambitions.

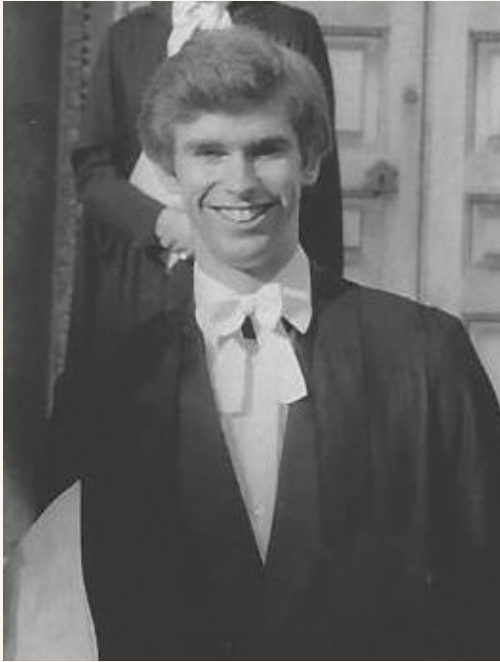
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Find out more about Richard Friend's research at [friend.oe.phy.cam.ac.uk](http://friend.oe.phy.cam.ac.uk)



**One of these materials glowing red with excitation from a blue laser.**

## NGC 1023



**Nigel Allsopp PhD graduation, Cambridge, summer 1980.**

One of my first research projects during my time at the Radio Astronomy Group at the Cavendish Laboratory (1975–78) was to map neutral hydrogen in the NGC 1023 galaxy, under the supervision of John Baldwin, using the Half-Mile Radio Telescope at Lord's Bridge. We were allowed to use the old Department moped to get there. I did the mapping, but was disappointed to find that the signal was too weak to show any rotation of the galaxy. So I dumped the deck of computer cards on the floor in my office and moved on to the next project.

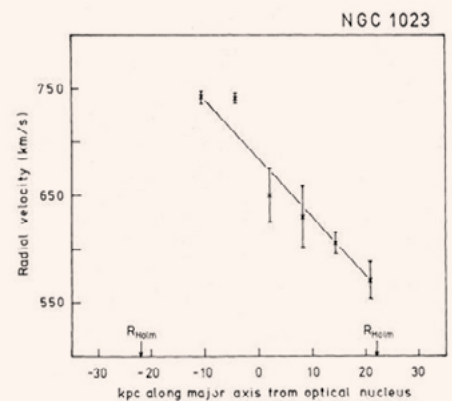
Quite some time later, a lady working on computer software showed me a programme she had developed to display galaxy rotation even with weak radio signals. I grabbed my deck of punched cards from off the floor, ran the data through her programme, and got NGC 1023 to rotate! Nobody had done this before for such a type of galaxy (S0, intermediate between ellipticals and spirals). Shortly afterwards, out came a paper with the results (Allsopp, N.J. 1979. Mon. Not. R. astr. Soc., 187, 537).

Ever since then, whenever I see 10:23 on the clock, I think of 'my galaxy' that I 'managed to rotate'!

**Nigel Allsopp (Radio Astronomy group, 1975–78).**



**The Half-Mile Radio Telescope at Lord's Bridge, Cambridge, August 1979.**



**Figure 4. Observed radial velocities along the major axis of NGC 1023.**

# Illuminating the Universe's Dark Ages from the far side of the Moon with CosmoCube

To explore how the first stars emerged from cosmic darkness, Cavendish astronomers are turning their ground-based expertise toward a mission to the far side of the Moon. This satellite will listen for faint radio signals from the Universe's Dark Ages, offering a rare chance to study the cosmos before the first stars were born.

Kaan Artuc

**H**idden behind the Moon, far from the constant buzz of Earth's radio noise, Cambridge scientists are preparing to detect one of the faintest signals in the Universe – the 21-cm signature from neutral hydrogen that filled space before the first stars were born. The CosmoCube mission, led by the Cavendish Laboratory, aims to capture this ancient signal from lunar orbit, offering a new window into the Universe's Dark Ages. Supported through two successful funding phases totalling £1.7 million from the UK Space Agency, the project has already reached major milestones in design and testing, and now seeks Phase 3 funding to complete its path to launch.

The Dark Ages began about 380,000 years after the Big Bang and lasted until the first stars ignited. During this time, the Universe was filled with neutral hydrogen gas, and its only light was the afterglow of the Big Bang, known as the Cosmic Microwave Background (CMB). As the Universe expanded, this hydrogen produced a faint 21-cm signal, now stretched (or redshifted) into the 5–45 MHz range.

Detecting this faint radio signal offers a direct look at the early Universe's temperature, density, and the influence of dark matter. It's a scientific milestone akin to the first detection of the CMB in the 1960s, but vastly more challenging. From Earth, the 21-cm signal from the Dark Ages is completely masked by our ionosphere and the human-made radio interference. The solution: take the telescope somewhere truly quiet – the far side of the Moon.

## The lunar advantage

The far side of the Moon is a naturally radio-silent zone in the inner Solar System. There, the lunar body itself blocks Earth's transmissions, creating an occultation where cosmic signals can be heard unspoiled. CosmoCube will orbit this region, spending long stretches of time within the Moon's radio shadow to observe the untouched radio Universe.

Unlike bulky landers or arrays, CosmoCube is a satellite, roughly the size of a small suitcase. Its compact form hides a sensitive radiometer that measures the brightness of radio waves across a range of frequencies. By tracking tiny temperature variations in these radio emissions, the radiometer reconstructs the global history of hydrogen's cooling and heating over the first hundred million years after the Big Bang.

The primary goal is to detect the faint radio glow from hydrogen during the Dark Ages, specifically the all-sky 21-cm features between 5 and 45 MHz. This corresponds to when the cosmos was just 4 to 100 million years old. Measuring the depth and shape of this feature will trace how hydrogen cooled and how the first light sources began to reheat it.

The data will also provide a new way to measure the expansion rate of the Universe, helping to address the long-standing "Hubble tension" between early and late Universe measurements.

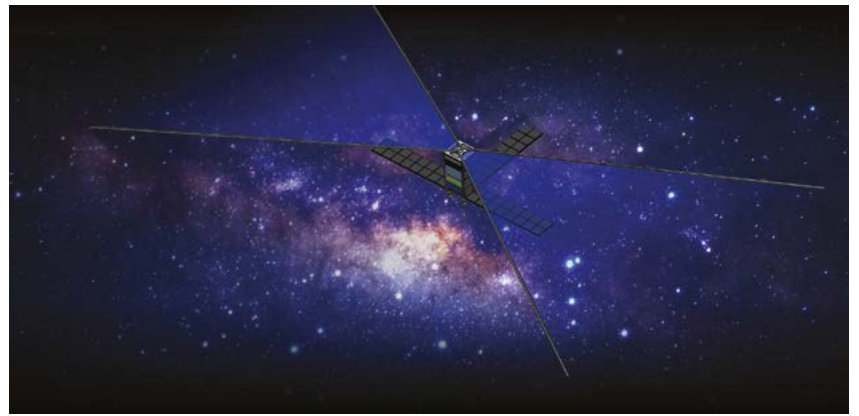
Furthermore, the observations will test key ideas about dark matter by constraining its interaction with ordinary matter, revealing how cosmic darkness gave way to light and structure.

The Cavendish Laboratory provides scientific leadership, hardware design, and signal-processing expertise, as well as modelling and advanced data analysis frameworks. As a pathfinder, CosmoCube will pave the way for future lunar radio arrays, laying the foundation for a new era of radio cosmology from space.

### Engineering the instrument

At CosmoCube's centre is a highly stable radio spectrometer that listens for faint hydrogen signals from the early Universe. It separates incoming radio waves into thousands of frequency channels, searching for the delicate 21-cm imprint buried beneath brighter cosmic foregrounds. Designed and tested at Cambridge, the instrument stays steady across wide temperature swings, ensuring that tiny variations in its readings reflect the sky, not the hardware. A precise internal calibration system, refined through experience with the REACH experiment, another 21-cm effort led by the Cavendish Laboratory, maintains sensitivity stable to within a few thousandths of a degree, allowing CosmoCube to measure the Universe's earliest radio whispers with confidence.

CosmoCube carries a 6-metre deployable bow-tie antenna that stows compactly for launch and unfolds in the orbit of the Moon to capture faint cosmic radio waves. The spacecraft orbits the Moon, spending about 15–20 minutes per lap on the far side. Over the mission's lifetime, these intervals will total more than 1,000 hours of observation time, enough to detect the Universe's first hydrogen signal.



Artist's illustration of CosmoCube.

### A race against time

The far side of the Moon may not remain quiet for long. As lunar exploration expands and communication satellites fill its orbit, the pristine radio silence that makes CosmoCube possible could soon vanish. As Eloy de Lera Acedo, the project's Principal Investigator, puts it:

**“This might be our first and last chance to hear the Universe’s Dark Ages before human noise fills the lunar sky.”**

CosmoCube encapsulates the best of Cambridge's scientific spirit: precision engineering and cosmological ambition. When it launches, it will carry not just a radiometer but a new kind of telescope: one that listens to the Universe's forgotten ages from the quiet side of the Moon.

#### Reference:

K. Artuc & E. de Lera Acedo, RAS Techniques and Instruments, 4 (2025).

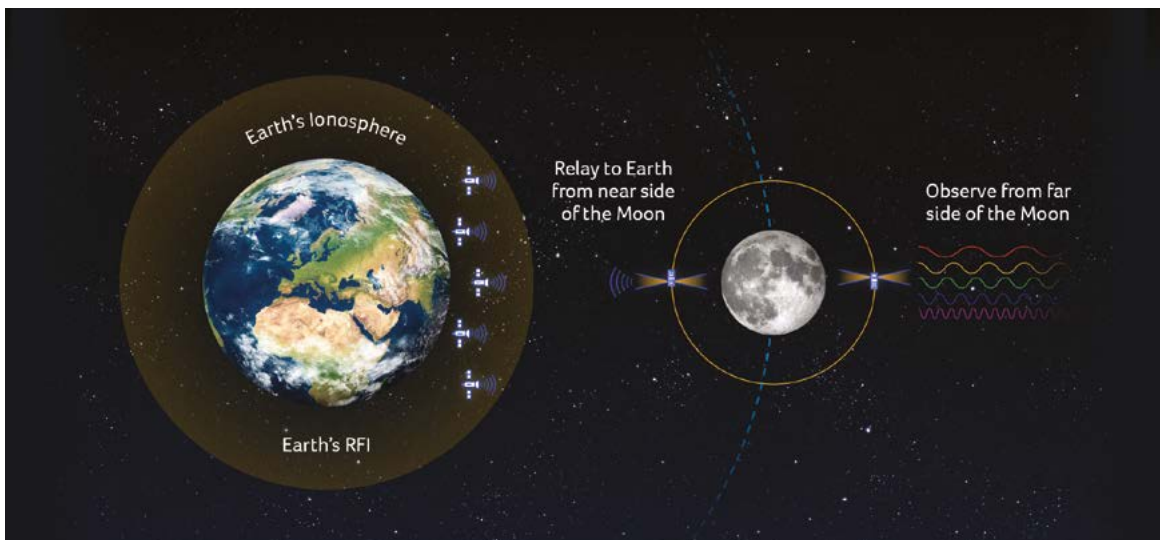


Illustration of what CosmoCube will see.

# The Goldilocks zone of bouncing droplets

Scientists have discovered that microscopic water droplets rebound off surfaces only in a narrow “just-right” speed range, a finding with real-world implications from inkjet printers and crop sprays to the behaviour of virus-carrying aerosols.

**Jamie Mclauchlan and Anton Souslov**



**W**e encounter droplet impacts in our everyday lives, from raindrops splashing on tree leaves to inkjet printers depositing droplets on A4 paper. Understanding how droplets spread, bounce and splash is not only intuitively relatable but also crucial in everything from how rain interacts with buildings and crops to how we design better waterproof coatings, cooling sprays and water-repellent materials. For everyday, millimetre-sized droplets, the fluid mechanics governing such intuitive behaviour as spreading, bouncing and splashing has been extensively explored. On highly water-repellent surfaces, such droplets rebound across a broad range of conditions that include different droplet sizes and liquid properties, and this behaviour generally does not depend strongly on the

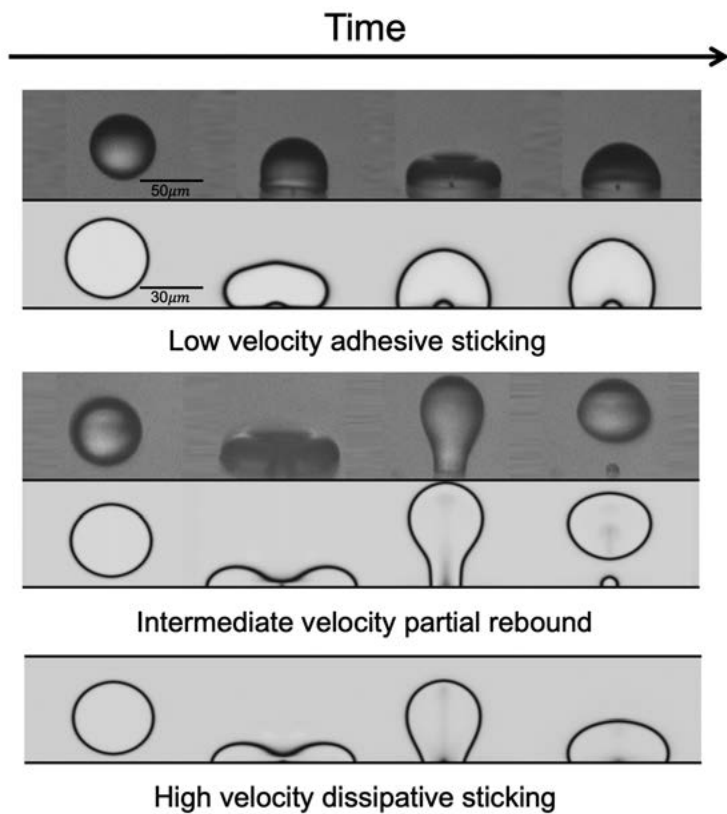
velocity. However, droplets that are too heavy or too viscous stop bouncing. On flat surfaces droplets can bounce off a trapped air film, and on all surfaces increasing impact speed eventually prompts splashing.

At micrometre scales, new fundamental phenomena emerge. Splashing is suppressed as interfacial effects become dominant. These are the surface-level forces that control how liquids meet the surrounding air or a solid surface. Any air films become unstable and gravity is negligible. In this regime, a droplet can either stick or bounce. Despite the relevance of microscopic droplets to aerosol transport, disease transmission, printing and surface engineering, the conditions that govern bouncing at this scale have remained unclear.



**Droplets impacting a nanoparticle coated glass surface, increasing in speed from top row to bottom. From 2m/s to 7m/s, each image taken 0.01ms apart.**

# Feature



**Time-sequence images showing low-velocity sticking, intermediate-velocity rebound, and high-velocity dissipative sticking as droplets impact the surface.**

To investigate this, we worked together with colleagues at the Universities of Amsterdam, Durham, Bristol, and Bath. We generated water droplets with diameters between approximately 30 and 50 micrometres and directed them towards hydrophobic Teflon and nanoparticle coated glass surfaces at velocities between 1 and 10 metres per second. These impacts unfold on microsecond timescales and were recorded using high-speed imaging at 100,000 frames per second. The resulting images capture fine details of microdroplet deformation and rebound that have not previously been resolved at this scale.

At these tiny scales, we found a new relationship between the velocity of the droplets and whether they bounced or not. Droplets that approach too

slowly will spread out and stick to the surface, since they lack sufficient kinetic energy to overcome the solid-liquid adhesive force as the droplet retracts from the surface. At intermediate velocities, droplets retract and then rebound from the surface. Complementary finite-element simulations show that at even higher velocities, droplets again fail to rebound, as the droplets spread out on the surface, dissipating too much energy for the droplet to detach.

We chart these outcomes in a dimensionless phase space spanned by the Weber number, which compares inertia (a droplet's resistance to changing its motion) to surface tension, and the Ohnesorge number, which captures the influence of viscosity (how thick the liquid is) relative to inertia and capillarity (the surface-tension effect that makes droplets pull themselves into a sphere). Together, these two numbers show whether a droplet's motion is dominated by momentum, viscosity or surface tension. We find dependence on both. This representation allows us to translate dimensionless limits into experimentally relevant physical criteria. For instance, the Ohnesorge threshold can correspond to a size cut-off: on surfaces such as Teflon, water droplets smaller than about 20 micrometres never rebound, regardless of impact speed. In this regime, viscous forces dominate, and because there is no inertia after retraction, bouncing is no longer possible.

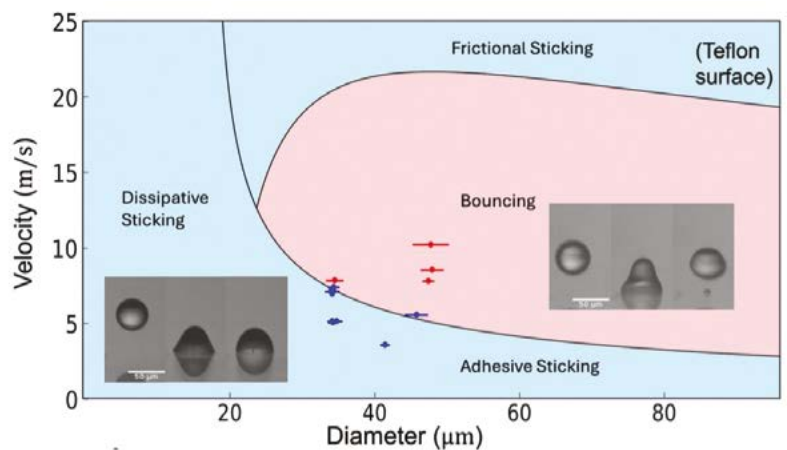
To rationalise this behaviour, we constructed a minimal mechanical model in which the droplet behaves as a mass-spring-damper-mass-spring system subject to a weak adhesive force of the second spring, where a large extension means a bounce. Despite its simplicity, the model reproduces the observed rebound boundary and highlights the central balance between inertia, surface tension, viscous dissipation, and adhesion. A non-wetting surface is one that water cannot easily adhere to. Instead of spreading out, a droplet sits on top of it like a tiny bead, much as rain rolls off a lotus leaf or a freshly waxed

# “ It even influences the performance of everyday products, such as how effectively cleaning sprays or disinfectants wet a surface rather than bouncing off.”

car. In our model, we represent this by letting the second spring constant become extremely small, meaning the droplet feels almost no adhesive pull from the surface. As a result, the range of conditions in which the droplet can bounce becomes much wider and no longer depends on how fast it hits.

This transition between microdroplets depositing or rebounding off a surface has practical consequences. In indoor environments, droplets that stick to surfaces are removed from the air, whereas droplets that rebound can remain airborne. In agriculture and printing, reliable deposition depends on controlling this boundary. The same principle also plays a role in anti-icing, where rebounding droplets are less likely to freeze onto aircraft wings or power lines, and in spray cooling, where good contact between droplets and hot surfaces improves heat removal. It even influences the performance of everyday products, such as how effectively cleaning sprays or disinfectants wet a surface rather than bouncing off. Engineering surface properties to shift the rebound threshold, therefore, offers a route to influencing droplet behaviour in real systems.

Future work will extend these studies to droplets containing surfactants and polymers. Surfactants are soap-like molecules that gather at a liquid's surface and make it easier to stretch, meaning the droplet's surface tension can change over time. Polymers, in turn, can give the liquid viscoelasticity, allowing it to behave partly like a flowing liquid and partly like a springy solid that stores and releases energy. These behaviours are common in biological systems that introduce additional energy storage and dissipation mechanisms. These effects are expected to change the rebound phase space. The present results provide a foundation for interpreting these more complex cases and for developing predictive control of microscopic droplet impacts.



**A velocity-droplet diameter graph showing bouncing and sticking with water on Teflon.**

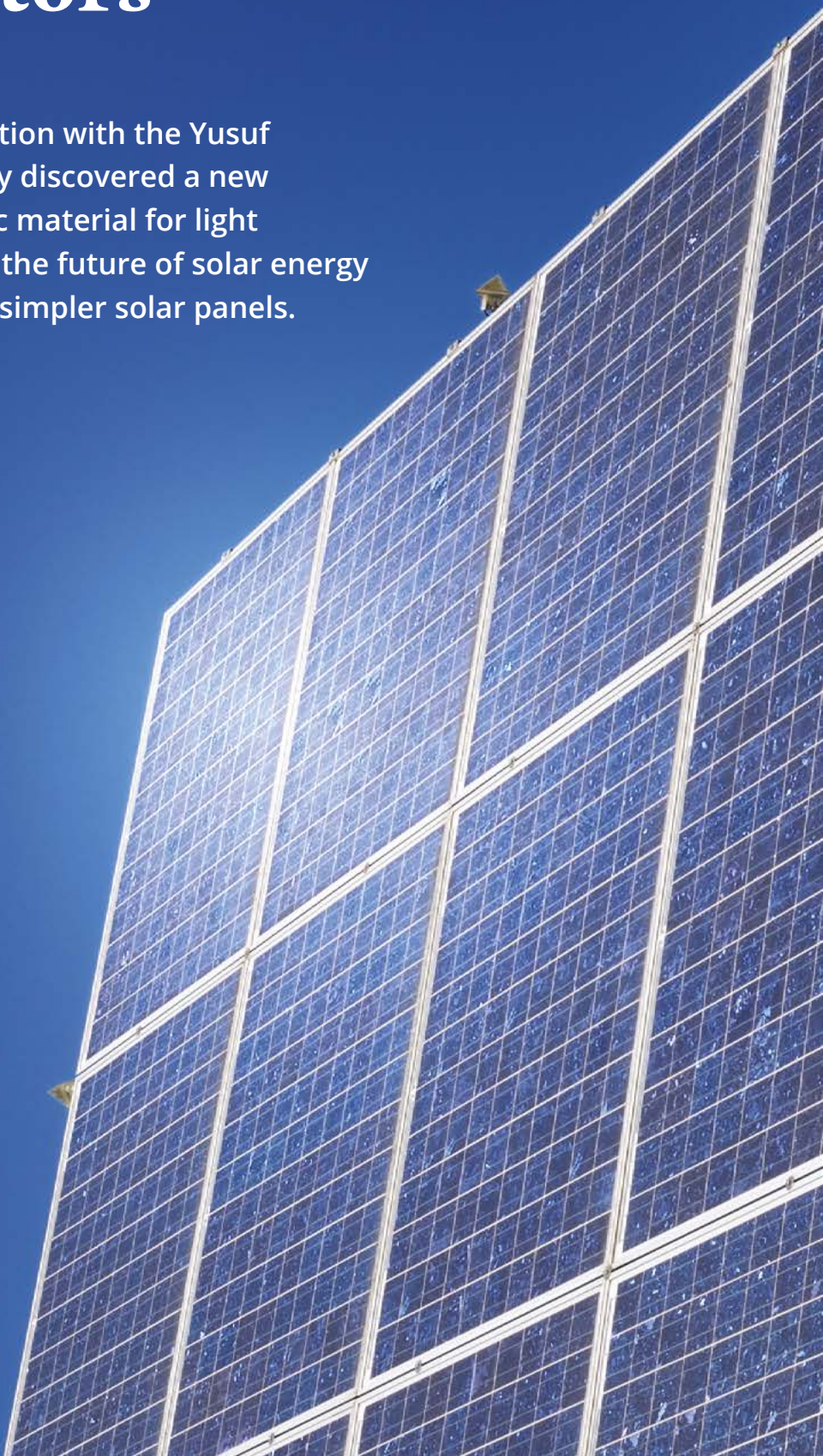
#### Reference:

J. McLauchlan, J.S. Walker, V. Sanjay, M. Jalaal, J.P. Reid, A.M. Squires, & A. Souslov, 'Bouncing microdroplets on hydrophobic surfaces', Proc. Natl. Acad. Sci. U.S.A. 122 (36) e2507309122, (2025).

# Harvesting light with organic radical semiconductors

Cavendish physicists in collaboration with the Yusuf Hamied Department of Chemistry discovered a new mechanism using a single organic material for light harvesting, which could redefine the future of solar energy and lead to lighter, cheaper, and simpler solar panels.

**Biwen Li**



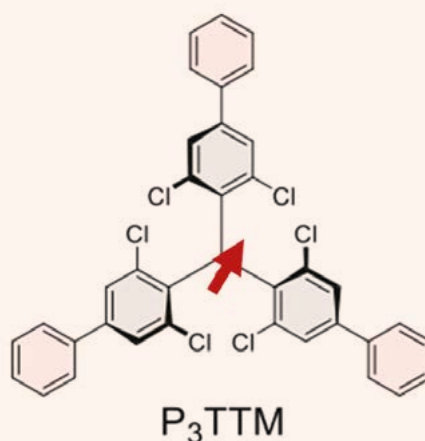
**R**adical molecules contain an unpaired electron that gives them unique magnetic and electronic properties. Chemists have long viewed radicals as unstable, but carefully designed organic radicals can form stable solids that conduct charges and emit light. These so-called '*radical semiconductors*' have already shown promise in biomedical imaging, quantum information, optoelectronic and spintronic devices.

Among organic radicals, chlorinated trityl radicals have attracted significant interest due to their exceptional performance in organic light-emitting diodes. They have special open-shell structures where not every electron is paired up, with the highest occupied molecular orbital having only one electron. Generally, for all other closed-shell molecules, each occupied molecular orbital has two electrons with opposite spins. Upon the electrical excitation of closed-shell molecules, either a spin-0 singlet state where the two electron spins point in opposite directions, or a spin-1 triplet state where both electron spins are aligned, is generated, but only the singlet state emits light. The generation of the 'dark' triplet state is thus a significant disadvantage when producing light-emitting diodes.

However, in radicals only a 'bright' doublet-excited state is formed, avoiding the formation of the non-light-emitting triplet state upon electrical excitation, which improves the internal quantum efficiency (the fraction of electrons injected that actually produce photons). In addition, trityl compounds stand out for their remarkable stability and high photoluminescence efficiency, which is the ratio of the number of photons emitted by a material to the number of photons it absorbs, in the red or near-infrared region. The trityl radical itself is inherently non-emissive due to its alternant hydrocarbon structure and molecular energy level degeneracy. In alternant

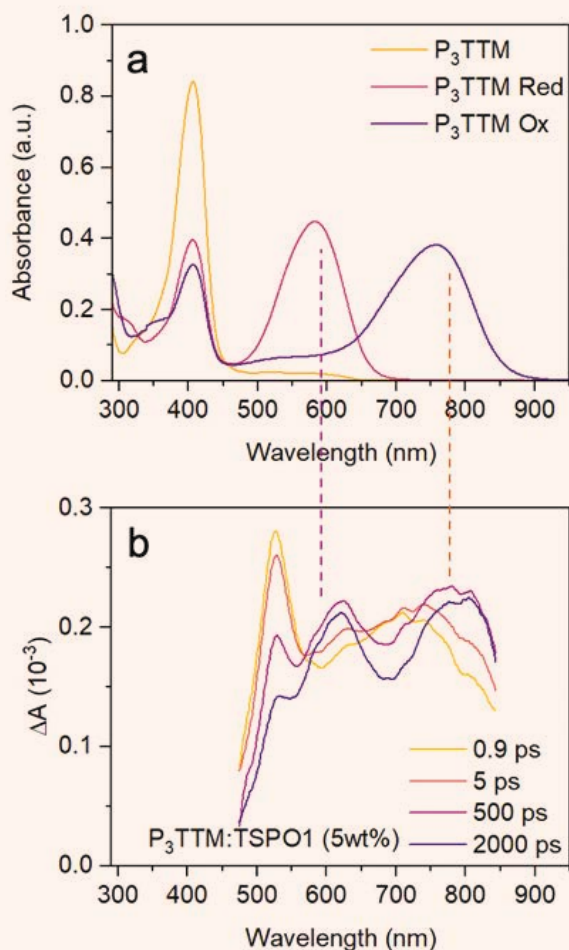
hydrocarbons, the molecular framework forces the unpaired electron to be distributed in a symmetrical way across the molecule. This symmetry causes the excited states of the radical to relax primarily without emitting photons.

However, when trityl radicals bond with the electron-donating or electron-withdrawing groups, a non-zero transition dipole moment of photoluminescence is produced, making the trityl radicals emissive. The inversion of molecular energy levels contributes to the high stability of trityl radicals, making them ideal candidates for organic light-emitting diodes. Our group has also reported a series of tris(2,4,6-trichlorophenyl) methyl (TTM) radical derivatives, in which the para-chlorine atoms are substituted with phenyl-based groups to tune the emission colour and efficiency by altering the spatial distributions of the atoms in the molecule. This structural modification provides a versatile platform for the development of red and near-infrared organic light-emitting diodes.



**Chemical structure of P<sub>3</sub>TTM.**

# Feature



**Top: Spectroelectrochemistry of P<sub>3</sub>TTM.**  
**Bottom: Time-resolved absorption spectra of doped TSPO1 film.**

Extensive research has been conducted on the electroluminescent properties of TTM radicals; however, their potential to generate electric charge when absorbing photons remains largely unexplored. To investigate the possibility of employing TTM for light harvesting applications, P<sub>3</sub>TTM is selected as the model system. The para-chlorine atoms of TTM are replaced by the phenyl ring to enhance the intermolecular interaction. We first studied the P<sub>3</sub>TTM photo-physics in

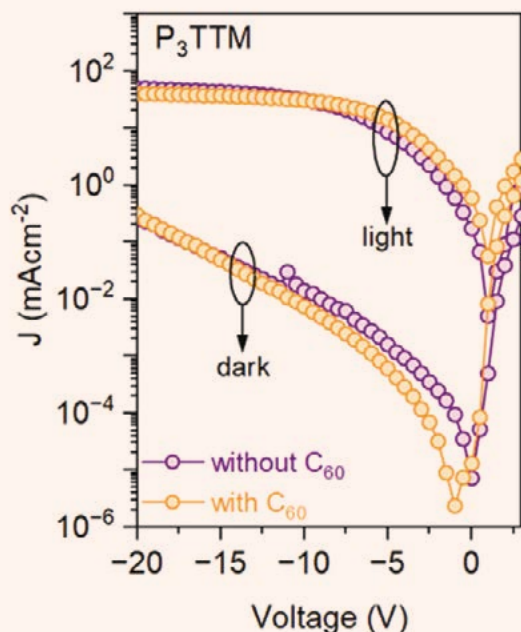
toluene solution with different concentrations. In highly diluted solutions, P<sub>3</sub>TTM behaves as an isolated molecule, exhibiting red emission at 645nm with a mono-exponential decay lifetime. However, as the concentration increases, the photoluminescence is partially quenched, and a new broad emission band appears in the near-infrared region, suggesting possible intermolecular interactions.

A similar phenomenon is observed in solid-state doped thin films, with P<sub>3</sub>TTM radical dopants. In thin films, red-shifted emission bands are observed in addition to the molecular emission. Broad red-emission bands are often attributed to the formation of short lived excited states known as 'excimers', a common phenomenon. However, excimer formation requires strong non-covalent 'π-π' interactions between relatively planar molecules. Interestingly, the propeller-shaped geometry of the TTM radical should prevent such strong π-π interactions. Here, we provide evidence that the red-shifted photoluminescence originates from a fully charge-separated anion-cation pair rather than from a conventional excimer state.

To understand what causes the unusual red-shifted emission we observed, we used time-resolved absorption spectroscopy, which lets us watch how excited states evolve in the first few billionths of a second after a material absorbs light. As can be seen in the thin-film absorption spectra, at the earliest times, we see two clear absorption features that come from ordinary molecular excitations. As time passes, these features gradually change into two new absorption peaks.

To identify these new late-time absorption peaks, we compared the measurements with spectroelectrochemistry, where we generate positively and negatively charged versions of the molecule and record how they absorb light. The later-time spectra in our time-resolved

**“This means we can build a single-component light-harvesting device, dramatically simplifying the architecture of future organic electronic technologies.”**



**Current density-voltage plot of P<sub>3</sub>TTM device.**

measurements match almost perfectly with the spectral fingerprints of these radical cations and anions. This tells us that, after absorbing light, an excited P<sub>3</sub>TTM molecule can pass an electron to a neighbour, creating a pair of oppositely charged radicals. When these charges later recombine, they emit the broad, red-shifted light observed earlier – explaining why we see emission that cannot be due to conventional excimers.

Crucially, these charge pairs can also be pulled apart by applying an external electric field. To test this, we fabricated standard multilayer diode structures using P<sub>3</sub>TTM as the only light-absorbing material. In the dark the current is essentially zero, but under blue illumination the current increases by a factor of about 1,000 at -10 V, showing that P<sub>3</sub>TTM can indeed generate photocurrent. When the applied voltage is large enough to fully separate the charges, the device collects nearly all the generated electrons and holes.

What makes this particularly exciting is that, unlike traditional organic solar cells – which require two different materials to provide an energetic “push” for charge separation – P<sub>3</sub>TTM can achieve this on its own. The energy stored in the initial excited state is high enough that forming a separated electron-hole pair is actually favourable. This means we can build a single-component light-harvesting device, dramatically simplifying the architecture of future organic electronic technologies. While complete charge separation is common in inorganic semiconductors like silicon, achieving the same behaviour in molecular materials is extremely rare. Our findings open the door to new types of solar energy conversion and light-driven chemistry using only one organic material, potentially transforming how lightweight, low-cost solar devices are designed and leading to a new generation of light harvesting applications.

**Reference:**

Li, B., Murto, P., Chowdhury, R. et al. 'Intrinsic intermolecular photoinduced charge separation in organic radical semiconductors', *Nat. Mater.* (2025). DOI : 10.1038/s41563-025-02362-z



# Nicola Marzari: the 10<sup>th</sup> Cavendish Professor

We're sitting down with the new Cavendish Professor to bridge computation, curiosity, and the human side of physics.





THEORY OF CONDENSED MATTER GROUP March 1996

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52	37462 Nicola Marzari	539	37005 Andrew Williamson



Staff details from the Theory of Condensed Matter (TCM) roster.

When Nicola Marzari officially assumed the Cavendish Professorship of Physics at the University of Cambridge in September 2025, he joined a distinguished lineage that stretches back to James Clerk Maxwell in 1871. Following figures such as J. J. Thomson, Lord Rayleigh and Nevill Mott might appear a daunting legacy, but Marzari meets the challenge with humility and quiet confidence.

He smiles at the mention of his predecessors. "It's both humbling and inspiring," he says. "The best way to honour the past is to help the next generation thrive. For me, it's about creating the right environment for my students and colleagues to do well. That's where the real impact lies."

**From Lausanne to Cambridge**

Before returning to Cambridge, Marzari was for ten years on the faculty at MIT, and for another fourteen years at the École Polytechnique Fédérale de Lausanne (EPFL), where he led one of Europe's leading groups in condensed-matter physics and computational materials science. The transition, he explains, will be gradual. "This semester I'm still mostly in Lausanne, but already planning future proposals and projects. From next spring I'll start being in Cambridge more frequently, and by September I'll be fully based here. Moving is not only about packing boxes – but also about moving people, ideas, and the rhythm of work."

He speaks warmly of the new Ray Dolby Centre, now home to the Cavendish Laboratory. "It's an incredible building," he notes. "For theoretical and computational work, what matters most isn't instrumentation but atmosphere, community, and connectivity. The new space brings energy, collaboration, and a sense of renewal."

**Rethinking theories, expanding frontiers**

Marzari's research lies at the intersection of quantum mechanics, materials science, and computing. Over the years, his group has developed novel electronic-structure theories, algorithms, and open-source software to predict materials properties from first principles.

Looking ahead, he sees two major directions shaping the field. "We're entering a new phase of theoretical understanding," he explains. "We're exploring correlated-electron systems using functional theories that go beyond the traditional non-perturbative or diagrammatic methods. The challenge is to capture complexity while keeping calculations tractable."

He also sees artificial intelligence as a transformative force. "AI is already able to analyse scientific papers in surprisingly deep ways. It sometimes makes mistakes but then again, so do experts. What's fascinating, and slightly unsettling, is that we don't yet fully understand how it arrives at its conclusions."

**Science with responsibility**

For Marzari, physics does not exist in isolation from society. "I believe physics must remain useful," he says. "Discovery for its own sake is beautiful, but science should also help people and a distressed world."

He cites energy as an example for some of humanity's central challenges. "Access to electricity correlates strongly with education, health, and life expectancy. Ensuring global access to clean and affordable energy is essential. It's not only a technical issue, it's an ethical one."

# Interview



**“Discovery for its own sake is beautiful, but science should also help people and a distressed world.”**

**TCM students and visitors in the Spring of 1994. Marzari is on the bottom left.**

## A Journey from Trieste to Cambridge

Marzari’s own journey into physics began in Trieste, Italy. “I always loved mathematics,” he recalls, “though I didn’t enjoy physics in high school because I was missing the conceptual foundations. I was also drawn to philosophy. Coming from a non-academic family, I had little guidance. I initially wanted to study to become an engineer, and even won a scholarship at the Sant’Anna School of Advanced Studies in Pisa to pursue this.”

A twist of fate and the advice of a close friend brought him to Cambridge in 1993 to pursue his PhD. “This was before the web, although we had emails” he laughs. “My future supervisor (Mike Payne) had to retype my entire EU application, lost in transit, and convince DHL to ship it on a Saturday. Without him, I would never have made it here.”

His years as a doctoral student left a lasting impression. “College was wonderful. I discovered choral music, which I still love. One unforgettable memory was hearing Keys’ graduate choir sing Allegri’s Miserere on Ash Wednesday. The sound in that space was transcendent.”

## Beyond equations

Outside the lab, Marzari finds creative renewal through photography. “Years ago, I used to do street photography in distant countries,” he recalls. “People would rush to change into their cleanest shirts and pose for a group picture which it was a joyful event in itself.”

He now focuses more on wildlife, both above and below water, and finds energy in city life. “Switzerland was perhaps a bit too peaceful,” he admits with a laugh. “Cambridge, with London just around the corner, strikes a perfect balance.”

He remains passionate about both the art and the history of photography, and promises he would gladly help judge the Cavendish Laboratory’s annual photography competition.

## Advice for the next generation

Asked what message he would offer to current Cambridge students, Marzari answers without hesitation. “Three words: driven, passionate, dedicated. Whatever you do, do it because you love it. I never thought I was particularly gifted in physics (math was my calling), but I was drawn to it. Success depends on how much you care and persist.”



**With a colleague in the Cavendish’s TCM offices.**

If he could write to his undergraduate self, he would offer reassurance. "Don't worry about not being good enough. Everyone feels that way sometimes. Physics is vast and diverse so there's room for everyone who truly wants to contribute."

### Coming full circle

When asked which of his predecessors he would most like to meet, he smiles. "Probably Nevill Mott, since his field is closest to mine, or J. J. Thomson, to ask how he managed to mentor seven Nobel laureates!"

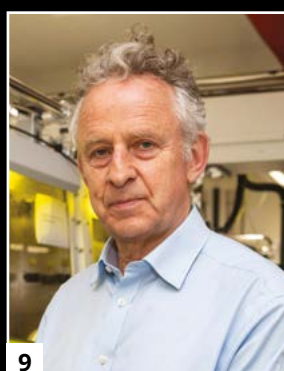
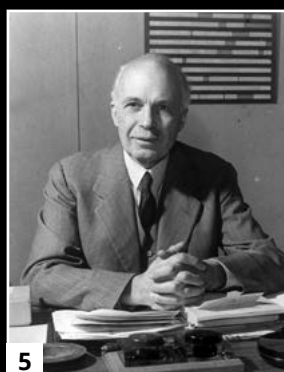
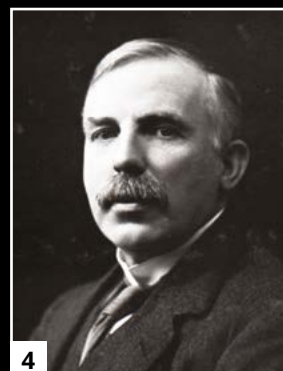
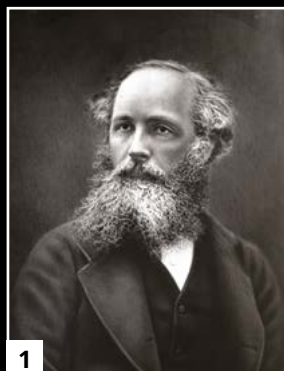
Returning to Cambridge as Cavendish Professor feels, he says, "like coming home but with new responsibilities and new energy. Cambridge has always been a place where ideas and people meet, and I'm excited to be part of that dialogue again."

From Trieste to Cambridge, from theory to inspiration, Nicola Marzari's journey reminds us that physics is not only about equations and models, but about curiosity, creativity, and connection are the very qualities that continue to define the Cavendish spirit.

The pioneering work has earned Marzari wide recognition. Most recently, he received the 2026 David Adler Lectureship Award in Materials Physics from the American Physical Society. The award citation commends him "for new theory and method developments that have advanced the predictive power of first-principles calculations, and for sustained leadership and community-building in computational materials physics". Marzari will receive the award during the 2026 APS Global Physics Summit in Denver, Colorado, where he will give an invited talk on electronic-structure simulations.

On the award, Marzari commented that "it is always deeply honouring to be recognised by peers, and for an award that has such a distinguished record; equally satisfying is the recognition of the impact of electronic-structure calculations in science and technology, and their role in building scientific communities worldwide".

Marzari also just received the Theory Feynman Prize in Nanotechnology from the Foresight Institute. The Feynman Prizes recognise exceptional contributions to nanotechnology. According to the award citation, he is recognised "for the development of novel theories of heat transport at the nanoscale, including the exact relaxon solution of the Boltzmann transport equation, its coarse graining into mesoscopic viscous heat equations, and the introduction of the Wigner transport equation."



- The Cavendish Professors
1. 1871-1879: James Clerk Maxwell
  2. 1879-1884: Lord Rayleigh
  3. 1884-1919: J. J. Thomson
  4. 1919-1937: Lord Rutherford
  5. 1938-1953: William Lawrence Bragg
  6. 1954-1971: Nevill Mott
  7. 1971-1984: Brian Pippard
  8. 1984-1995: Sam Edwards
  9. 1995-2020: Richard Friend

# Twists in the flow

Cambridge-led physicists show that voltage-driven torque spins DNA into supercoils (plectonemes), not just knots – reshaping how we interpret “tangled” nanopore signals.

Fei Zheng



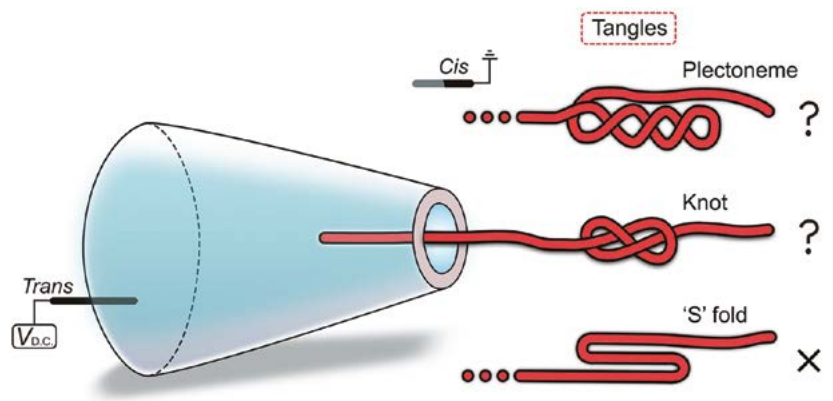
Torsion-driven plectoneme formation. Credit: Fei Zheng.

For years, unusually deep, multi-level blockades in solid-state nanopores were widely interpreted as knots: transient entanglements slipping through under tension as DNA is pulled by an electric field. A Cambridge-led team has now shown that many of these events are not knots at all, but plectonemes – twisted supercoils that arise because the nanopore makes DNA rotate. Recognising this “second axis” of motion, torsion, reframes how we interpret complex nanopore signals and opens routes to sense DNA integrity.

The core observation is simple. Double-stranded DNA is a right-handed helix. Inside a biased nanopore, electro-osmotic flow grazes the helix and exerts a tangential drag – a torque – that spins the in-pore segment. Because translocation is fast and far from equilibrium, that twist does not relax in place; it propagates along the cis side and winds the external strand into plectonemic loops. When a loop reaches the pore, multiple strands pass together, deepening the current blockade and mimicking the amplitude of a knot – but with a very different timescale.

Two signatures make the case. First, the fraction of “≥3-strand” events rises steeply with voltage and polymer length in both glass and Si<sub>3</sub>N<sub>4</sub> nanopores, far exceeding the maximum knotting probability predicted by equilibrium polymer statistics. Increasing voltage cannot create new knots, yet it consistently produces more deep blockades – pointing to a torque-driven origin. Second, time traces separate the culprits: knot signals are brief spikes, typically lasting only tens to hundreds of microseconds as tension tightens and pulls them through; plectonemes linger as millisecond-long plateaus at the same blockade level, reflecting extended supercoils sustained by ongoing twist.

To decouple force and torque, the team turned to coarse-grained molecular dynamics, modelling DNA as a twistable elastic chain. Applying controlled pulling forces and torques to an 8 kilobase pair (kbp) strand reproduced the experiments: above a torque threshold that increases with pulling force, plectonemes nucleate and survive to the pore, and the simulated ionic current shows the same long level-3 plateaus. When starting from unknotted, torsionally relaxed configurations, every ≥3-strand event was a plectoneme; knots appeared only if present initially, and their signals were short.



**Possible DNA structures inside the nanopore. Credit: Fei Zheng.**

A critical control is to block twist propagation. The researchers engineered three 7.2 kbp constructs with identical sequences but different torsional continuity: intact dsDNA; a “nicked” version with regularly spaced phosphodiester breaks; and a “1-nt gap” variant with an extra missing base at each nick. Across 400–800 mV, the probability of tangled events followed  $P_{\text{intact}} > P_{\text{nicked}} > P_{\text{1-nt gap}}$  at every bias and increased with voltage – exactly what one expects if extended twist is required to build and maintain plectonemes, and inconsistent with equilibrium knotting, which is insensitive to local nicks.

Why it matters goes beyond tidying up signal assignments. Distinguishing plectonemes from knots by duration and voltage scaling improves structural calling in nanopore sensing, reducing false positives in studies that rely on deep blockade levels. Because nicking disrupts torsion and suppresses plectonemes, their statistics offer a potential proxy for backbone integrity, hinting at label-free assays for DNA damage. More broadly, voltage-driven nanopores emerge as dual-role platforms that both generate torsion and sense the resulting supercoils, enabling controlled studies of supercoiling dynamics and topoisomerase action at the single-molecule level. In this picture, nanopore translocation is not just one-dimensional pulling; it is the coupled propagation of tension and torsion along a helical polymer – turning “ambiguous tangles” into a predictable, tuneable class of signals.

**Reference:**

F. Zheng et al., Torsion-Driven Plectoneme Formation During Nanopore Translocation of DNA Polymers, *Physical Review X* (2025).

History

# A tactile history of science in print

Daniel Robins



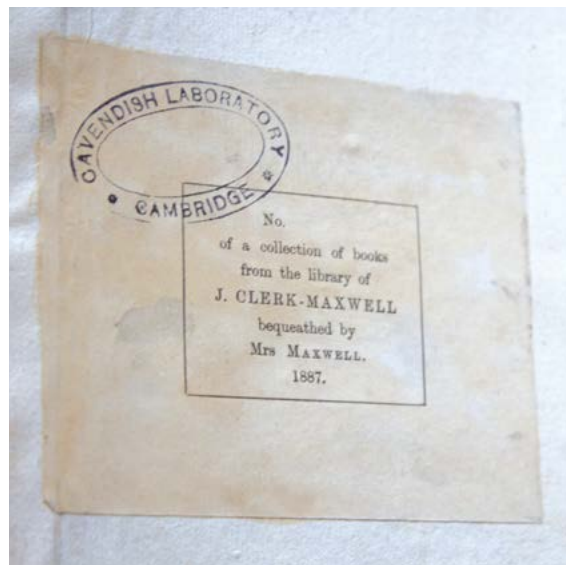


Physics is communicated in many forms, but perhaps the most enduring is the printed book. For centuries, physicists have filled their shelves with volumes both weird and wonderful, and the bindings, annotations and doodles within those volumes record the lives of the people who leafed through them.

I visited the Whipple Library on Free School Lane - whose staff, Jack Dixon and Liz White, are immensely enthusiastic guides - in search of some of these stories. The collection spans hundreds of years of scientific thought, ranging from a 16<sup>th</sup>-century astronomy text bound inside an 11<sup>th</sup>-century manuscript fragment of Genesis, to some books donated to the Cavendish Laboratory from James Clerk Maxwell's collection. The smallest is a thumbnail-sized edition of Galileo's letter to Cristina di Lorena. Most striking of all is an unbound copy of Galileo's *Dialogue Concerning the Two Chief World Systems*, its pages still uncut - a 400-year-old book that, almost paradoxically, has never truly been opened.

Interactive teaching tools may have exploded in recent years, fuelled by online demonstrations and problem-solving platforms like Isaac Science.

Yet many early textbooks were astonishingly tactile too: they had tabs to unfold, and diagrams to rotate, all bound with string. An enduring example is the undergraduate astronomy textbook *De Sphaera Mundi* by Johannes de Sacrobosco. Originally written in manuscript circa 1230, it was first printed in 1472 and reissued into the 17<sup>th</sup> century. As such, it survives in both lavish, pristine editions and well-used pocket copies.



Above:  
An example of interactive spinning volvelles in Sacrobosco's *De Sphaera Mundi*.

Left:  
Bookplate from one of the volumes donated to the Cavendish from James Clerk Maxwell's collection.

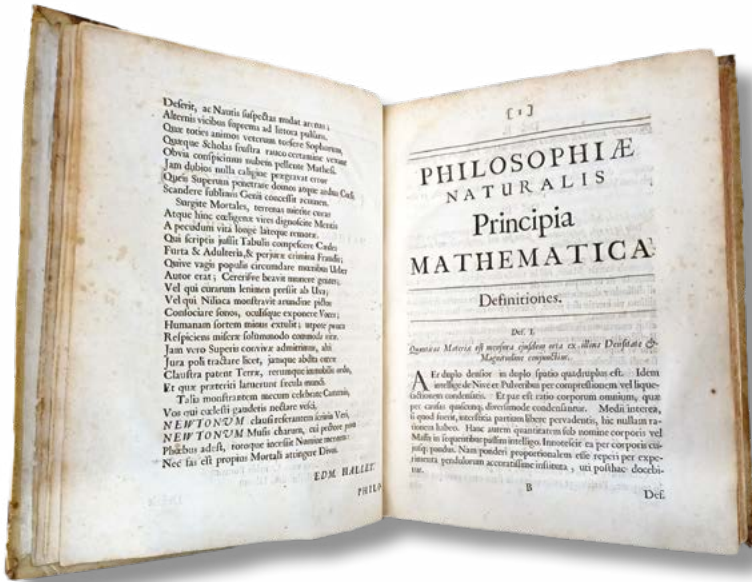
Opposite:  
Gerard's *Herball or Generall Historie of Plantes*.



Above left:  
**A tiny bound copy of Galileo's letter to Cristina di Lorena.**



Above:  
**A foldout diagram of a comet orbiting the Sun, from Newton's *Principia Mathematica*.**



Above:  
**Newton's *Principia Mathematica*.**

Its spinning volvelles and tabs were practical tools, designed to be manipulated while answering problems in the text.

When I asked the librarians to choose their favourite books, the first was a wonderfully ambitious attempt at universal order: *An Essay towards a Real Character and a Philosophical Language* by John Wilkins, one of the Royal Society's founders. Wilkins sought to categorise everything in the world and to encode it in a perfectly logical language. One of its curious features (apart from the unexpected four-page discourse on Noah's Ark inserted in the middle) is that its branching, hierarchical structure looks curiously like a precursor to HTML, albeit published in 1668.

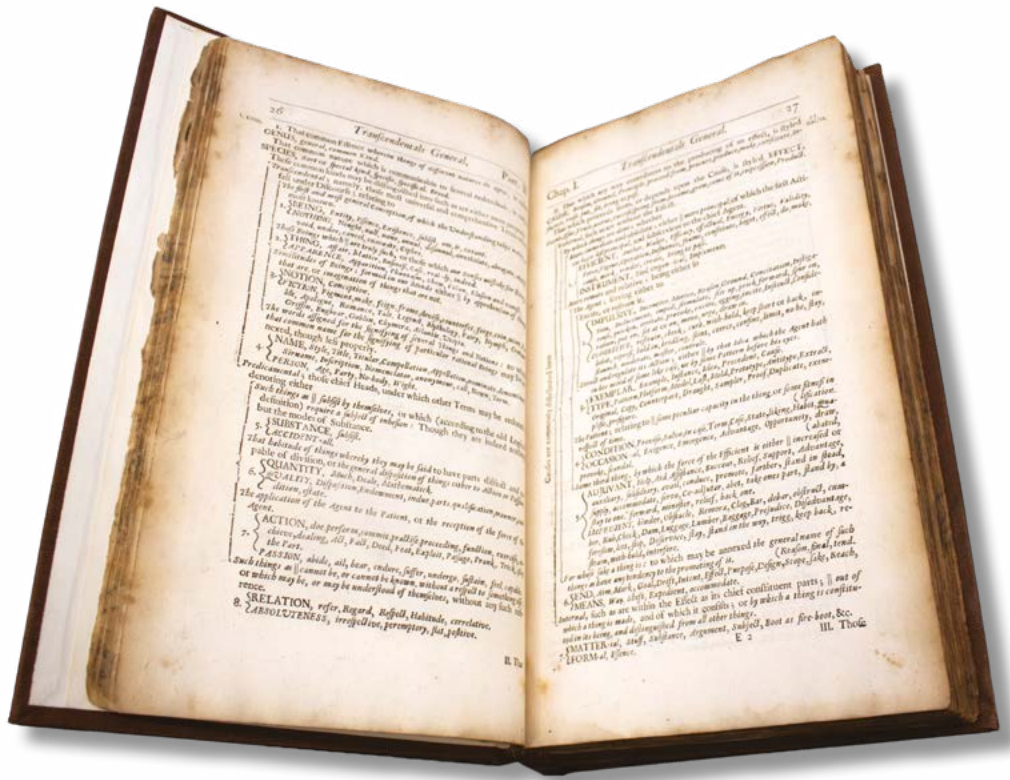


Another favourite is John Gerard's *Herball or Generall Historie of Plantes*, annotated by an owner named Anna Prince. The book's marginalia blur the line between science, diary and poetry; before the Enlightenment increased the separation between scientific disciplines, she treated the book as a space for both botanical observation and creative expression. The volume was so

Left:  
**Galileo's *Dialogue Concerning the Two Chief World Systems*.**



Right:  
**John Wilkins' *An Essay towards a Real Character and a Philosophical Language.***



Below:  
***The Theory of Sets of Points* by Grace Chisholm Young.**

culturally significant that several noblewomen had themselves painted with it, alongside the Bible and Ovid.

Beside these sits *The Theory of Sets of Points* by the Girton College mathematician Grace Chisholm Young. After placing between 23<sup>rd</sup> and 24<sup>th</sup> in the mathematical Tripos rankings (the women's ranking was published separately to men), she informally sat the equivalent Oxford exams - perhaps on a dare - and outperformed everyone. (Interpret this how you will)! She thus became the first person to achieve a first-class grade at both universities. Her copy in the Whipple is dense with postcards, corrections and notes in five languages in preparation for a second edition - signs of a mind thinking across borders.

These personal traces - the doodles, the folded diagrams, the pencilled corrections - make each book not just a witness to scientific history, but a participant in it. They invite us to imagine the hands that turned the pages and the lives lived alongside the science. And they leave me wondering: if someone were to leaf through my books, hundreds of years from now, what story would my own scribbles tell about me, and my place in 21<sup>st</sup> century physics?

For more information about the Whipple Library, visit [whipplelib.hps.cam.ac.uk](http://whipplelib.hps.cam.ac.uk).



For more information on the life and works of Grace Chisholm Young, a former Cambridge student, Ruby Gray, has produced an excellent [podcast](#), and given a recent talk, available on [YouTube](#)

# News in brief

## Awards and recognitions

### Cavendish alumnus John Clarke awarded 2025 Nobel Prize in physics

**John Clarke** has been awarded the 2025 Nobel Prize in Physics, jointly with Michel H. Devoret and John M. Martinis, for revealing quantum physics in action. Born in Cambridge, Clarke studied Natural Sciences at Christ's College and completed his PhD at Darwin College in 1968, conducting research at the Cavendish Laboratory.



**(left) John Clarke (circled) as a PhD student at the Cavendish Laboratory; (right) Illustration of John Clarke. Credit: Nobel Prize Outreach, Illustration: Niklas Elmehed.**

His pioneering work focused on superconducting quantum interference devices (SQUIDs), ultrasensitive detectors of magnetic flux. Clarke's PhD research at the Cavendish demonstrated the operational principle of the superconductor-normal-superconductor (SNS) Josephson Junction, a key component of modern superconducting qubits. This foundational work paved the way for today's quantum technologies, developed further by Devoret and Martinis. Clarke, Devoret and Martinis conducted experiments with an electrical circuit in which they demonstrated both quantum mechanical tunnelling and quantised energy levels in a system big enough to be held in the hand.

John Clarke is the 126<sup>th</sup> affiliate of the University of Cambridge - and the 36<sup>th</sup> of the Cavendish Laboratory, to be awarded the Nobel Prize.

### Sarah Bohndiek named one of The Photonics100 2026

**Sarah Bohndiek** has been recognised as one of The Photonics100 2026, celebrating the 100 most innovative people shaping the future of photonics worldwide. Her pioneering work in biomedical imaging and optical technologies has made a significant impact on both research and real-world applications, earning her a place among this year's global honourees.

The Photonics100, published by Electro Optics, highlights leaders driving innovation across advanced lasers, quantum technologies, integrated photonics, optical communications, and novel sensing. Against a backdrop of global disruption, shifting supply chains, and rising demand for AI-driven

solutions, this year's list showcases the ingenuity and resilience of the field.

The UK takes the lead in 2026 with 21 honourees, reflecting the strength of its £18.5bn photonics sector. Many congratulations to Sarah.

### Institute of Physics award for international quantum initiative QunTour

QunTour, a collaborative initiative featuring a travelling quantum light source hosted by Cambridge and 11 other institutions across Europe, has been awarded the 2025 Institute of Physics (IOP) Lise Meitner Medal and Prize for innovative public engagement across the UK and Europe, offering live insights into the work of physicists.

At the heart of the QunTour outreach project, conceived by **Doris Reiter** (TU Dortmund, Germany) and **Tobias Heindel** (University of Münster, Germany), is a chip containing a quantum dot light source, a cutting-edge device capable of emitting single photons – fundamental particles of light – on demand and in very fast succession. Travelling across 12 laboratories in 12 European countries over 12 months, throughout the International Year of Quantum 2025, the source arrived in Cambridge in October 2024, halfway through its journey, where it was hosted by the Cavendish Laboratory in **Mete Atatüre's** Quantum Optical Materials and Systems group. The project was closely supervised by **Christian Schimpf** and **Yusuf Karli**, whose dedication played a crucial role in QunTour's overall success and the Cavendish's specific contribution.



**The QunTour light source and the IOP Lise Meitner medal reunited. Credit: Doris Reiter.**

Other IOP award winners this year included our former Head of Department **Peter Littlewood**, who received the Richard Glazebrook Medal and Prize for leading international research institutions and Cavendish Affiliate **Sam Stranks**, who was awarded the Nevill Mott Medal and Prize for outstanding contributions to the understanding and development of emerging semiconductor materials.

## Undergraduate Prize Winners' Dinner 2025



**Prize Winners 2025, from left to right, Joshua Wu, Long Hei Kwan, Yotam Margoninski Morrag, Max Lu, Owen Hunter, Zebedee Summerfield, Dr Anton Souslov, Alba Burgos Mondejar, Prof Ulrich Schneider, Louis Kirkpatrick, Francesca Di Cecio, Prof Chiara Ciccarelli, Jacob Mittoo, Eero Jaaskelainen**

We were delighted to host the Cavendish Laboratory Undergraduate Prize Winners' Dinner 2025 in October. This annual event, held for the first time at the Ray Dolby Centre, served to formally acknowledge the achievements of our most exceptional students. On this occasion, **Ulrich Schneider**, Director of Undergraduate Education, presented prize certificates to each of the winners.

These annual awards recognise outstanding achievement in physics across all undergraduate years, from excellence in theory, experiment, and computation to exceptional research reviews and overall academic performance. For the full list of 2025 winners, visit [phy.cam.ac.uk/news/annual-prizewinners-dinner-2025](http://phy.cam.ac.uk/news/annual-prizewinners-dinner-2025)

## Cavendish astrophysicists win prestigious Student Prizes

Many congratulations to **Ignas Juodžbalis**, PhD student working under **Roberto Maiolino**, and **Dávid Puskás**, PhD student in Sandro Tacchella's group, for being awarded the prestigious Monthly Notices of the Royal Astronomical Society (MNRAS) Student Prize 2025.

This recognition highlights their papers as the best submitted to the journal in a given 12-month period with a student as the corresponding author. Ignas was recognised for his paper that studies the components of a JWST-bright but X-ray weak active galactic nuclei (AGN). David received this award for his first ever first-author paper which explores a wide cosmic epoch offered by JWST data in order to constrain one of the major mechanisms to grow galaxies.

## TCM researchers win inaugural Psi-k CECI award for collaborative research excellence

**Bo Peng** from the TCM group and **Gunnar Felix Lange** (TCM alumnus) have been awarded the inaugural Psi-k Collaborating Early-Career Investigators (CECI) Award at the Psi-k 2025 Conference in Lausanne. Psi-k is a Europe-based, worldwide network of researchers working on the advancement of first-principles computational materials science.

The award celebrates the power of collaboration in advancing science, where creativity grows through dialogue, exchange of ideas, and teamwork.

Their project 'New concepts of topology from theory to modelling and applications' was chosen as the winning entry from five finalists, earning them the €2,000 prize.



**Gunnar Felix Lange receiving the award in Lausanne.**

## Funding news

### Advancing quantum science combined with chemistry

A team of experts in quantum science and chemistry, led by **Rakesh Arul**, Research Fellow at the Cavendish Laboratory, has been awarded a Research and Innovation's Engineering and Physical Sciences Research Council (EPSRC) grant to show evidence of quantum entanglement in molecules.

The project, titled Nanoscale Spin Entanglement and Chemistry (NanoSPINEC), has secured £500,000 for the Cavendish Laboratory and \$600,000 for the University of California San Diego (UCSD) as part of a three-year collaborative partnership.

# News in brief

NanoSPINEC aims to control quantum behaviour in single molecules at room temperature using tiny light-based devices called nanocavities. These will allow the researchers to manipulate electron spins, the fundamental units of quantum information.

## Funding boost to revolutionise optical metamaterials

Cambridge researchers, led by **Jeremy Baumberg**, **Ulrich Keyser**, and **Anton Souslov** from the Cavendish Laboratory, together with **Michael de Volder** from the Department of Engineering, have secured funding to create materials with radically new optical and mechanical properties, that can be produced at scale and low cost.

The new funding, comprising of a UK metamaterials hub grant and a follow-up funding grant led by the University of Cambridge, will allow the multi-disciplinary team to push the boundaries of what is possible with metamaterials.

Optical metamaterials are special materials designed to control light waves in ways that natural materials cannot. These materials can bend, absorb, or reflect light in unusual ways, making them useful for a variety of applications.

With the Reconfigurable Nano-Opto-Mechanical Metamaterials (RENOMM) project, researchers aim to create metamaterials using nanoscale building blocks that can be self-assembled and disassembled for reuse at the end of their life.

## Department news

### Celebrating 70 Years of Theory of Condensed Matter

On 25 July, the Cavendish Laboratory was delighted to welcome back alumni, colleagues, and friends for a special event marking the 70<sup>th</sup> anniversary of the Theory of Condensed Matter (TCM) group for a day filled with science, stories, and celebration.



**Group photo of all the TCM anniversary attendees at the Ray Dolby Centre. Credit: Vivien Perez.**

It was truly heartening to see so many members of the TCM community, past and present, come together to honour the legacy and spirit of a group that has shaped generations of physicists. The programme of talks captured not just the scientific brilliance of the group, but also its enduring sense of support, family, and belonging.

Highlights included an inspiring talk by Nobel Laureate **Duncan Haldane**, who took the audience on a journey and deep understanding of the development of topological concepts in condensed matter physics. **Chris Smith** reflected on his own path, sharing how the skills and resilience he developed during his PhD at TCM laid the foundation for a very successful career in machine learning and artificial intelligence.

## A landmark move for Physics

Our cryogenics facility was the last piece of equipment to be moved into the Ray Dolby Centre (RDC) last October, marking officially the end of our move to our new home.

Over 11 months and 14 phases, this monumental project saw the relocation of 31 research teams, two specialist workshops, 47 cryostats - each transported vertically, 98 optical tables - many of them moved fully loaded with active research setups, countless pieces of sensitive research equipment including several precision microscopy suites, the Cavendish Museum collections and its vintage cases, and finally the cryogenics facility.



**Dan Cross in front of the newly moved cryogenics facility at the Ray Dolby Centre.**

This complex operation took not only logistical expertise, but also plenty of creativity and bespoke solutions to safely move highly sensitive research equipment. None of this would have been possible without the dedication of our partners Restore Harrow Green and MovePlan.

A huge thank you to our research groups, professional services, Move Champions, and all our staff, for their efforts, resilience and flexibility, which have made this landmark relocation a true team success.

We extend our heartfelt thanks and gratitude to the members of the Logistics Committee members and to the small RDC Project Team. Their dedication and tireless commitment over many years have been instrumental in making this wonderful new addition to the Cavendish Estate possible.



**Gen 2 moving day to the RDC cleanroom in January 2025.**

### Save the date for the Dolby Symposium

The inaugural Cavendish Science Festival last June was a resounding success. We are pleased to announce that the event will return in 2026 with a refreshed format and under a new name.

The Dolby Symposium will consist of one day of talks and panel discussions focused on a single, unifying theme, designed to foster engaging dialogue and provide fresh insights on the topic.

Don't forget to mark your calendar for Thursday 18 June 2026 in Cambridge, at the Ray Dolby Centre.

We will announce the theme and more details about the programme, speakers, and how to register in due course.

### Jochen Guck (1973 – 2025)

We were deeply saddened by the passing of **Jochen Guck**, former Reader in Biophysics at the Cavendish Laboratory.

An expert in optics and imaging, Jochen's pioneering work advanced understanding of cell mechanics and the physics of life. He was a great contributor to our Department. He played

a key role in designing the Physics of Medicine laboratories and inspiring a generation of scientists through his teaching, research, and contagious enthusiasm for discovery.

He will be deeply missed by his former colleagues and friends here at the Cavendish, and we send our sincere condolences to his family.

### Farewell to...

In October, we bid farewell to **Martin Underwood**, who has been an integral part of the Cavendish Stores team since October 1999. Over more than two decades, Martin has been a reliable presence, ensuring that the Department's day-to-day needs ran smoothly - from supplying everything from stationery and safety equipment to chemicals, glassware and electrical components, to overseeing deliveries and helping colleagues locate that elusive item just when it was needed.

We thank Martin for his dedication and helpfulness and wish him every success and happiness in the years ahead.

### Professional Services appointments

- **Neil Baxter** – Programme Manager
- **Ellen Coveney** – Course Administrator
- **Bethany Falconer** – HR Administrator
- **Nicole Robinson** – Receptionist
- **Joel Subash** - Electronics Engineer
- **Saad Umar** – Finance Assistant

### Alumni news

#### Physics fixes all the facts

The idea of emergence is found throughout science. But what if it doesn't actually explain anything? In his new book "Physics Fixes All the Facts" (Springer Nature, 2025), Cavendish Alumnus **Liam Graham** (Robinson 1986-89) argues that emergence is an empty concept and explores what this means for our understanding of the physical world and the aspects of it we call life, free will, and consciousness.

Blending philosophy and physics, the book offers a radical perspective on reality, illustrated with plenty of concrete examples. An ideal gift for any scientist and philosopher in search of unexpected ideas, as well as all the individually curious with some scientific background. The book is available from any good bookshop.

Graham is also the author of "Molecular Storms: the Physics of Stars, Cells and the Origin of Life" on popular thermodynamics. He is planning a third one on the physics of cognition.

## Outreach

# Physics at Work and other highlights from the outreach team

Celebrating four decades of inspiring young minds, the Cavendish Laboratory's annual Physics at Work exhibition returned in 2025 with record-breaking attendance and a fresh venue at the Ray Dolby Centre. Alongside highlights from the exhibition, Jacob Beward Butler, Outreach Officer, explores the Cavendish's expanding outreach to primary schools, new partnerships, and a calendar packed with engaging events.

## Jacob Beward Butler

### Physics at Work 2025

In September, over 2000 students from around the UK descended on the Department for our annual Physics at Work exhibition. This year marked several milestones; 40 years since the first exhibition in 1985, the first hosted in the Ray Dolby Centre, and our largest event since the COVID pandemic forced the exhibition online. Physics at Work aims to showcase the variety of careers to which studying physics can lead, and features presentations from groups across industry and academia for 14-16 year-olds – a key age in which students are making choices for their final years in high school and the A-levels they will go on to take.

Initially an Institute of Physics event started in the late 1960s, Mick Brown and Brenda Jennison organised the first Cavendish exhibition in 1985 and it has grown and evolved since then to become the large, successful event it is today. While much has changed in that time, we have had the pleasure of hosting an exhibit from the British Antarctic Survey and students from Norwich High School for Girls at every one of our exhibitions. This year we welcomed new exhibits from Espire Education's STEM on Track, the National Science Academy, and



**The STEM on Track stand during Physics at Work 2025.**

Nokia, whose presenter was a former Cavendish academic and had previously taken part as a member of his research group.

The new Ray Dolby Centre was a fine venue, allowing us to host larger groups of students and highlighting the world-leading nature of the Cavendish

Laboratory. Physics at Work will be taking place again in September next year, and we welcome any expressions of interest from prospective exhibitors.

### Primary developments

The new programme of events aimed at primary school students continue



**2Department of Computer Science stand during Physics at Work 2025.**

## Continuing activities

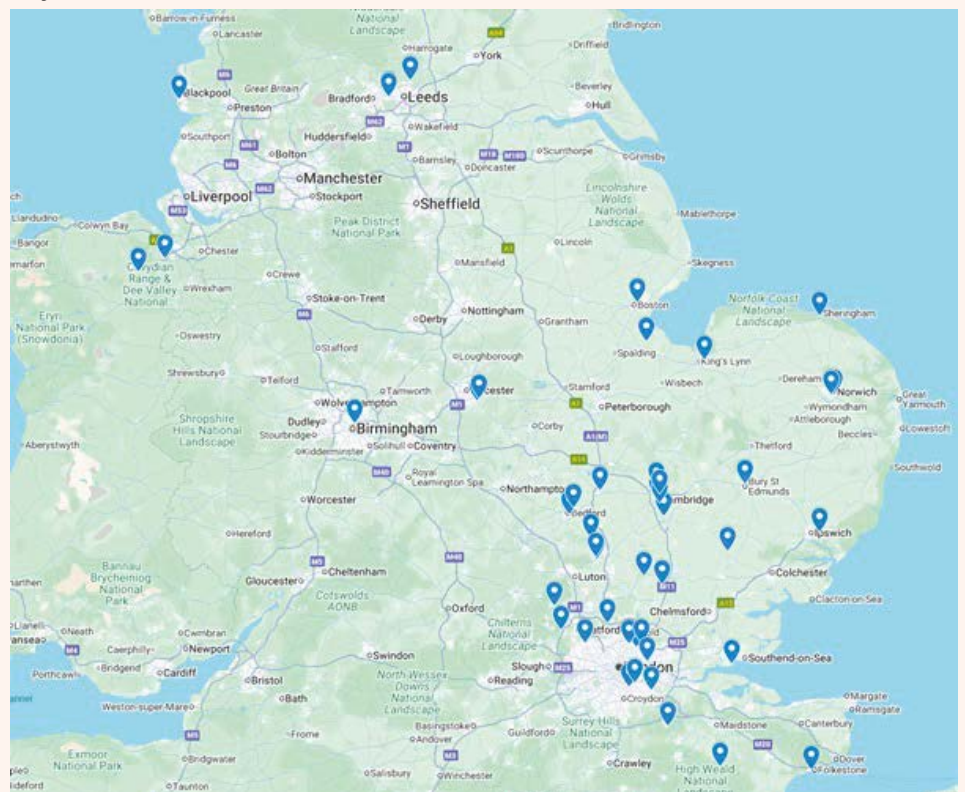
Now into its 13<sup>th</sup> year, the Cambridge Physics Experience continues to be well attended and positively reviewed by its attendees. Aiming to dispel misconceptions about university and physics, the programme brings hundreds of students from areas with low uptake to higher education into Cambridge for talks on higher education and curriculum-linked practical sessions in the Cavendish Laboratory. Our series of Cambridge Physics Centre lectures have started, continuing to draw large crowds of keen A-level students each month, and preparations are beginning for our inaugural Cavendish Festival event at the Ray Dolby Centre, which will take place on 21<sup>st</sup> March next year. Please visit the Outreach website: <https://outreach.phy.cam.ac.uk> for information on all our activities.

to progress, with the first of our experiment packs being loaned to local schools. These boxes contain the equipment, problem sheets, and teacher guides needed to run physics practicals identified as being particularly tricky by our local teacher contacts. Initial feedback has been good, and we will continue to develop a catalogue of packs before rolling them out more widely. Alongside this, we continue to develop our Primary offering and are working on strengthening our connections with schools in and around Cambridge.

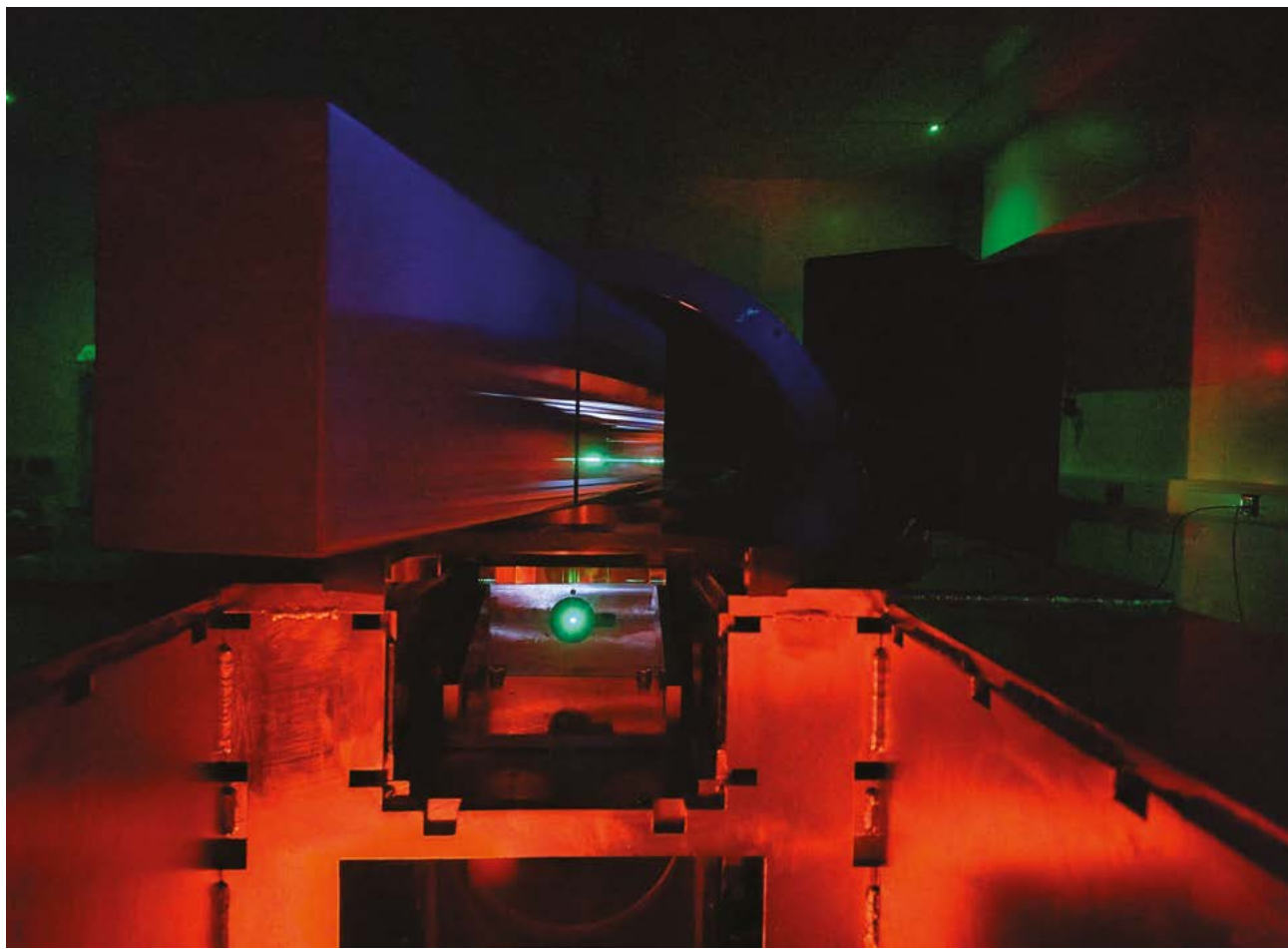
Further afield, our partnership with the Atom Valley Education Challenge Consortium and Ogden Trust is continuing into its second year. This programme, "Think like a Scientist", has primary school students from Rochdale and the surrounding areas develop investigations into questions around sustainability in their local environment. These open-ended projects challenge students to think beyond the curriculum, developing the critical thinking and practical skills needed to succeed in science at secondary school and beyond, and helping to bridge the jump between primary and second education that many students struggle with. This

programme forms part of the wider Atom Valley project, which looks to develop the industry, education, and infrastructure of the Greater Manchester area.

## Map of the schools that attended Physics at Work 2025.



We would also like to share our thanks and best wishes to Nicki Humphry-Baker, who has been the Cavendish Outreach Officer for the last five years, alongside her role in Isaac Science (formerly Isaac Physics). From November, she will be moving to Isaac Science full-time to oversee the growing team there.



*The Hidden Heart of HARPS3, by Samantha Thompson.*

## Winners announced for the Cavendish Photography Competition 2025

The 2025 Photography Competition showcased some impressive images celebrating our theme, 'The Next 150 Years of Physics at the Cavendish', reflecting innovation, collaboration, and the pioneering spirit that continues to shape the future of science at the Ray Dolby Centre.

The winning photographs reflect the Department's vibrant and interdisciplinary research culture, spanning areas such as Energy Materials, Physics of Soft Matter and NanoSystems, Theory of Condensed Matter, and Astrophysics.

All entries were judged anonymously on the basis of thematic relevance, scientific accuracy, uniqueness, and visual appeal. While two entries received prizes, the judging panel also commended three additional submissions, including one in the AI category, for their creativity and alignment with the competition theme.

**The 2025 prize winners and commended entries are:**

### First prize

**Awarded to *The Hidden Heart of HARPS3, by Samantha Thompson from the Astrophysics group.***

"The High Accuracy Radial velocity Planet Searcher 3 (HARPS3) is a high-resolution astronomical spectrograph built to enable the Terra Hunting Experiment, a radial-velocity survey to detect exoplanets akin to Earth. As the next 150 years of physics dawns throughout the new Ray Dolby Centre, HARPS3 is making its way from the Cavendish to the Isaac Newton Telescope where a new era of our own research endeavours begins: we and our ten international partners will start our 10-year experiment to expand the current detection threshold into long-period-low-mass exoplanets, taking us into the next decade and beyond of novel exoplanet discoveries.

At the heart of HARPS3 is this rarely seen marvel of optics – an 840 mm long mosaicked Echelle diffraction grating. Once the spectrograph system is aligned, the 3-metre-long vacuum vessel housing will be sealed, and it will remain unseen for the

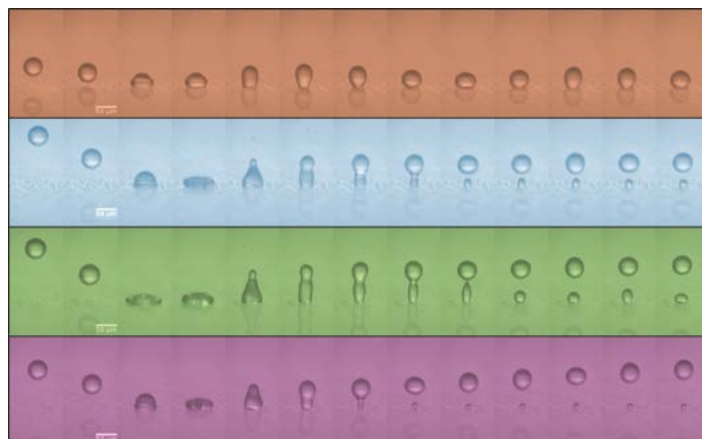
duration of the experiment to ensure the utmost stability for the measurements.

However, the real hidden heart of HARPS3 is the amazing team of physicists and engineers – my colleagues and friends – that have worked alongside me for so many years, turning a decade of dedication into an instrument poised to reshape our understanding of our place within the universe.”

### Head of Department prize

**Awarded to *Wrinkles*, by Elliot Goldberg from the Optoelectronics group.**

In relation to the theme “Next 150 Years of Physics at the Cavendish” I think what strikes me most is that it really strongly resembles a maze, with lots of intersecting paths and ways to turn. To me this is a strong reminder of how physics works – the path in front of us is often obscured but in taking the long way round we can come to unexpected and exciting new discoveries, even if different from where we initially wanted to go. I was not planning to get these wrinkles when I started making the film, and I have experienced many twists in my own research journey, but they led to this nice piece of art. The Cavendish has been a great place to explore new directions and my hope is that the next 150 years offer just as many new paths for physics to take.”

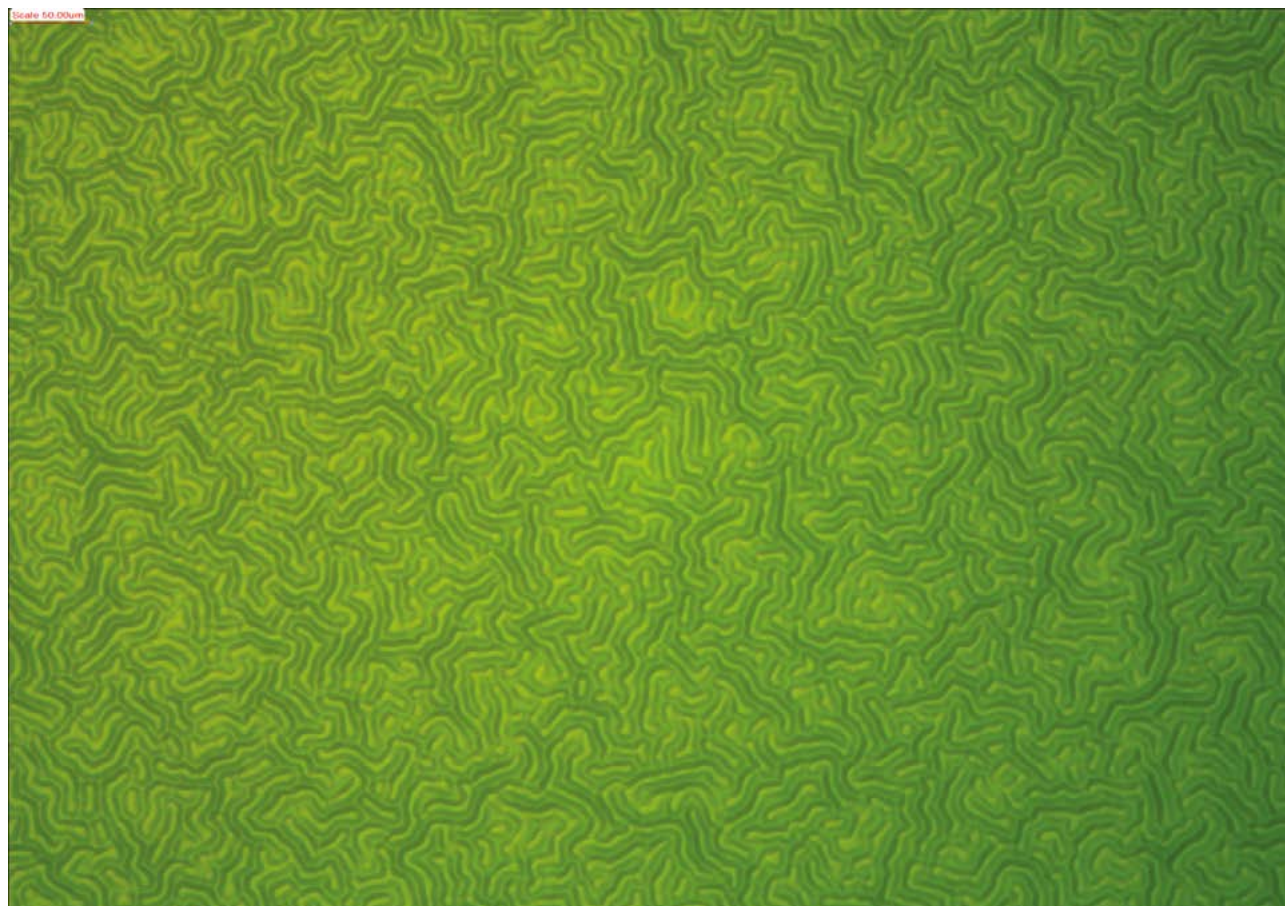


***Bounce or Stick? Microdroplet Impact Dynamics*, by Jamie McLauchlan.**

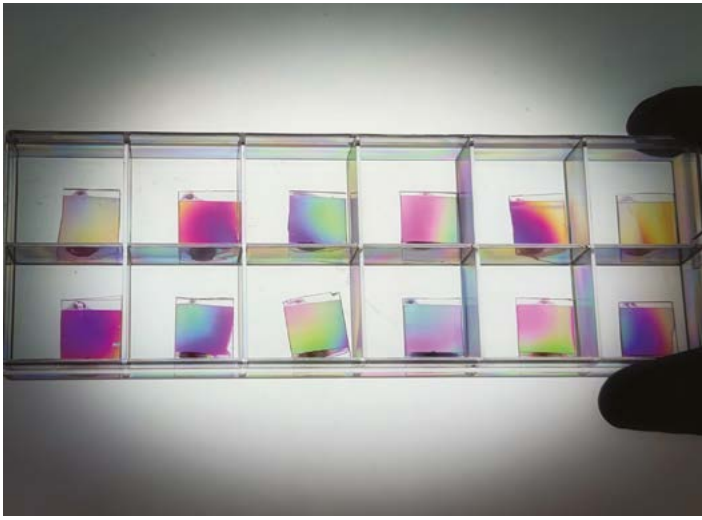
### Commended entries

***Bounce or Stick? Microdroplet Impact Dynamics*, by Jamie McLauchlan from the Theory of Condensed Matter group**

“This image shows tiny water droplets, each smaller than the width of a human hair, striking a water-repellent surface while traveling at around 20 kilometres per hour. The speed increases from top to bottom: at gentle speeds the droplets cling to the surface, while at higher speeds they spring back



***Wrinkles*, by Elliot Goldberg. “It is a microscope image of a PDMS (polydimethylsiloxane) film which has become wrinkled after exposure to a vacuum.**



**Rainbows from Order Hidden in Disorder, by Juncheng Fan.**

up, leaving traces of liquid behind. What you see here unfolds in less than a thousandth of a second, yet it reveals the delicate balance of forces that governs droplets in the world around us, from how sneeze droplets hit a face mask, to how crop sprays bounce off leaves or rain clings to aircraft wings.

These snapshots capture fluid physics in motion that we could not have captured even 10 years ago. Though such events have occurred since the dawn of fluids, our ability to study them today reminds us how much more we may come to understand in the next 150 years of technological and scientific progress at the Cavendish. This work, a collaboration between the Universities of Bath, Bristol, and Cambridge, also embodies the same spirit of collaboration and shared discovery that will continue to define physics in the next 150 years.”

**Rainbows from Order Hidden in Disorder, by Juncheng Fan from the Optoelectronics group**

“Polymer materials are often considered disordered, lacking the long-range symmetry of crystals. Under normal light, these thin polymer films appear simply pink and almost ordinary. Yet when placed on a transparent holder and viewed through a polarised light source (such as an LCD screen), they suddenly burst into dazzling rainbows. This transformation arises from birefringence. The films are highly anisotropic, containing regions of molecular alignment interwoven with areas of disorder. As polarised light passes through, it experiences different refractive indices along different directions. The split rays then interfere, producing wavelength-dependent constructive and destructive patterns.

The outcome is a spectrum of vivid colours – an optical fingerprint of hidden molecular order within apparent disorder. These structural features are not only beautiful but also highly functional. Aligned polymer chains provide efficient charge transport pathways, dramatically enhancing performance in organic electronics, thermoelectrics, and bio-integrated devices.

The delicate balance of order and disorder is thus both scientifically intriguing and technologically vital. This image embodies the Cavendish spirit: revealing the invisible,

uncovering patterns in complexity, and transforming them into opportunity. As the Cavendish enters its new era at the Ray Dolby Centre, such materials symbolise the next 150 years of physics – turning hidden order into innovation that reshapes how we see and use the world.”

**Cavendish IV: A Space Odyssey, by René Tronsgaard from the Astrophysics group**

Image submitted under the AI category.

“Welcome to the Orbital Frontier, the new home of the Cavendish Laboratory. This fully modular, self-sustaining space station is built to demonstrate the ultimate form of architectural adaptability required for a new era of physics. Just like the old, now demolished Ray Dolby Centre was built to facilitate the next generation of discovery on Earth, the Orbital Frontier symbolises the commitment of the Cavendish Laboratory to tackling the most challenging, fundamental problems of the universe – and our fast-decaying home planet.

A new building is never perfect from Day 1. Initial difficulties with the central fusion reactor and artificial gravity generator have now been resolved. Facility Management are actively addressing reports of a strong sulphur smell emanating from the wastewater discharge subsystem, but we are told it is a complex issue that may take a while to resolve. Please come see us in the Migration Café in the Mott Module, if you have any concerns. We kindly remind all staff members to complete the mandatory H&S module, “Working in Microgravity”, in order to gain access through the airlocks.

Please note that space suits must be worn at all times outside the station, and tailgating through the airlocks is strictly forbidden. All visitors must sign in with Reception immediately after docking. The Orbital Frontier Café is now open and runs a special throughout the month of October. For only £5M you can try the delicious Tube of the Day. Add a tube of rice for only £1.5M (subject to further correction for inflation).”



**Cavendish IV: A Space Odyssey, by René Tronsgaard, generated with Google Gemini.**

# How you can contribute

## Online giving

The University's Office for Development and Alumni Relations (CUDAR) has made it easier to make donations online to the Department and to two of our special programmes. If you wish to make a donation to the Department, please go to: [campaign.cam.ac.uk/giving/physics](https://campaign.cam.ac.uk/giving/physics)

If you wish to support the graduate student programme, please go to: [campaign.cam.ac.uk/giving/physics/graduate-support](https://campaign.cam.ac.uk/giving/physics/graduate-support)

If you wish to support our outreach activities, please go to: [campaign.cam.ac.uk/giving/physics/outreach](https://campaign.cam.ac.uk/giving/physics/outreach)

If you would like your gift to be applied to some other specific aspect of the Development Programme, please contact the Head of Department.

## A gift in your will

One very effective way of contributing to the long-term development of the Laboratory's programme is through the provision of a legacy in one's will. This has the beneficial effect that legacies are exempt from tax and so reduce liability for inheritance tax. The University provides advice about how legacies can be written into one's will. Go to: [campaign.cam.ac.uk/how-to-give](https://campaign.cam.ac.uk/how-to-give) and at the bottom of the page there is a pdf file entitled **A Gift in Your Will**.

It is important that, if you wish to support the Cavendish, or some specific aspect of our development programme, your intentions should be spelled out explicitly in your will. We can suggest suitable forms of words to match your intentions. Please contact Samantha Stokes ([hoo@phy.cam.ac.uk](mailto:hoo@phy.cam.ac.uk)) who can provide confidential advice.

If you would like to discuss how you might contribute to the Cavendish's Development Programme, please contact Mete Atatüre ([hod@phy.cam.ac.uk](mailto:hod@phy.cam.ac.uk)), who will be very pleased to talk to you confidentially.

## Contact

### The Cavendish Laboratory

JJ Thomson Avenue, Cambridge, CB3 0US  
Tel: +44 (0)1223 337200  
[phy.cam.ac.uk](https://phy.cam.ac.uk)

### Head of Department

Professor Mete Atatüre  
Tel: +44 (0)1223 337429  
Email: [hod@phy.cam.ac.uk](mailto:hod@phy.cam.ac.uk)

### Head of Operations

Samantha Stokes  
Tel: +44 (0)1223 747360  
Email: [hoo@phy.cam.ac.uk](mailto:hoo@phy.cam.ac.uk)

