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News from the Cavendish Laboratory

Major Dolby Family gift creates a new fund for excellence in physics

Transformational gift from the Dolby Family for Teaching and Research in Physics

Following their extraordinary generosity in 2016 in establishing the Ray Dolby Professorship and fund the Ray Dolby Centre at the Cavendish Laboratory, the Dolby family has made a further gift to fund teaching and research.

'Great minds have always been drawn to Cambridge, and Ray steadfastly believed that by Cambridge educating the most brilliant and the most curious, those students could and would solve some of the most important unanswered questions of our world,' said Dagmar Dolby. 'We feel passionately about ensuring that Ray's belief in the power of physics research and teaching at the University continues to be realised.'

'The Dolby Family Fund for Excellence in Physics will transform the Cavendish Laboratory's ability to enable and expand scientific excellence on an international scale,' she added. 'This additional investment in human talent and intellectual capital will help the University realise the full potential of the Ray Dolby Centre and Ray's vision. We are delighted to partner with the University of Cambridge and the Cavendish Laboratory to achieve great things through their scientific research and teaching.'

The Dolby Family Fund for Excellence in Physics will enable the University to ensure it always has the financial resources needed to recruit and retain successfully distinguished academics across the Cavendish Laboratory's three overarching areas of distinction – Fundamental and Emerging Physics, Biomedical Physics and the Physics of Medicine, and Quantum Systems and Technologies.

Andy Parker, Head of the Cavendish Laboratory, said,

'We're already seeing the difference Ray Dolby's legacy has made as we recruit for the inaugural Ray Dolby Chair. The funding, resources and opportunities the Dolby Family Fund will provide for students, researchers and academics set the Ray Dolby Centre up for success even before it opens in 2024.'

It is envisaged that the fund will establish six permanently endowed academic chairs, six permanently endowed postdoctoral research fellowships and twelve permanently endowed PhD studentships at the Cavendish Laboratory. It will also support a new annual symposium and provide flexible funding for start-up costs associated with the work of the endowed academic chairs.

Emeritus Vice-Chancellor, Stephen Toope, added:

'The Ray Dolby Centre stands to transform the future of physics, not just at Cambridge but around the world. I can think of no better testament to Ray Dolby's legacy than ensuring the brightest minds in physics, regardless of background, have the support they need to thrive at Cambridge and unlock the discoveries of tomorrow.'

This news item was first published on the Development and Alumni Relations Website, University of Cambridge.

Andy Parker – Master of Peterhouse Elect

Many congratulations indeed to Andy Parker on his election as Master of Peterhouse, a post he will take up in July 2023.

Andy has been Head of Department since 2013 and has faced some of the severest challenges which any Cavendish Head has had to deal with. The job is demanding enough during normal times but during his tenure, he had to cope with Brexit and its consequences, Covid-19, the consequences of the War in the Ukraine, on top of which has been the rebuilding of the Cavendish Laboratory, now entering its final phases. Andy steps down as Head of Department at the end of September this year.

Andy has done an outstanding job in coping with this myriad of challenges which included a reorganisation of the management structure of the Laboratory. Some objective measure of his success is the excellent rating the Cavendish received during the REF 2021 exercise – the highest score of the large Physics and Astronomy Departments in the UK. We also remain within the top three Physics Departments worldwide.

One might have thought that he would have wished to get back to full-time research in High Energy Physics, in which he has a worldwide reputation, particularly through his long association with the European Centre for Nuclear Research (CERN). This began when he was a summer student at CERN, before starting a PhD in Particle Physics at University College London in 1978. His association with the Cavendish began when he was appointed a Lecturer in 1989. But, no – out of the frying-pan and into the fire of becoming Master of Peterhouse with which he has been associated since his arrival in Cambridge.

Undoubtedly, in the long-term, Andy will be remembered as the Head of Department who led the project to design and build the Ray Dolby Centre, the heart of the Laboratory's new home, which will contain state-of-the-art facilities for research and teaching, as well as operating as a National Facility for physics, supporting researchers across the country.

We wish Andy all the very best for his future endeavours, coupled with our profound gratitude for everything he has done to maintain and enhance the Laboratory and to support all its members during years of stress and turmoil.

EDITORIAL

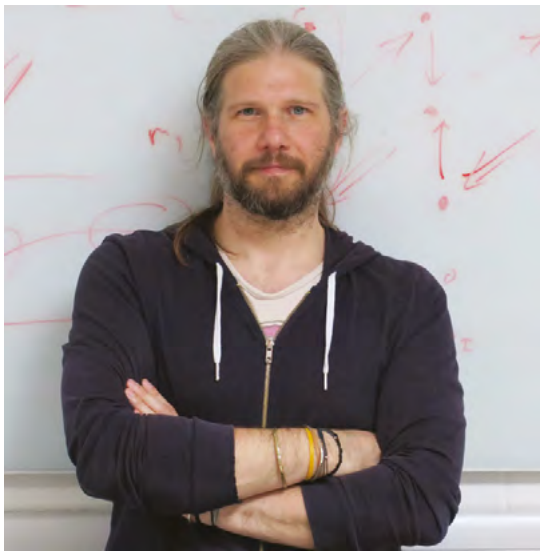
A time of change indeed! After 20 years since the gleam in the eye of a New Cavendish Laboratory, the move to the magnificent Ray Dolby Centre will be underway within a year. Andy Parker, who has done an outstanding job as Head of Department, will hand over the reins to Mete Atatüre, who outlines his vision for the future in an interview in this edition of CavMag. Over the same period, we begin our role as a National Facility for Physics, welcoming colleagues from the University community to make use of our facilities.

Mete faces wonderful challenges in pulling off this transition to new ways of working. The environment may change, but our dedication to excellence in scientific research and teaching remains unchanged. The disciplines will undoubtedly evolve to frontiers unimagined when we moved to the West Cambridge site in 1974, let alone when the original Laboratory was opened in 1874. What a time to be a student of 'physics'!

INSIDE

Mete Atatüre
Head of the Cavendish Laboratory Elect

We are delighted to congratulate Mete on his appointment as the next Head of the Cavendish Laboratory from October 2023. Mete joined the Laboratory as an Assistant Professor in 2007 and moved up the academic ladder to become full Professor of Physics in 2015.



Mete describes his prime areas of research as:

- Light-matter quantum interfaces in solids for quantum network hardware and approaches
- Optics of atomically thin quantum devices and emergent many-body physics based on heterostructures
- Nanoscale quantum sensing and imaging for novel phenomena and material discovery research

Being Turkish, his first degree was an honours B.Sc from Bilkent University, Ankara. This was followed by a PhD at Boston University and a postdoctoral research position at Stuttgart University, culminating in his appointment as Privat Dozent at the ETH, Zurich where he was awarded his Habilitation in Experimental Physics - the title of his Dissertation was 'Quantum Optics with Quantum-Dot Spins'.

Your editor had the privilege of interviewing Mete about his career and his thinking about taking over this exciting and demanding position.

Many congratulations on your appointment as Head of the Cavendish. What are your reflections about the post and the challenges involved?

It is a very difficult and important job. I was not intending to take over this role at this time but, on reflection, I decided it was the right time to put my name forward. It is a time of major changes in the Department, with many new appointments, the move to the new Cavendish beginning at the end of the year and taking on our new role as a National Facility for Physics. The whole nature of research on the West Cambridge campus is changing with the breaking down of the 'silos' of individual departments, moving much more to an interdisciplinary approach between cognate departments.

Looking at your CV, you benefited greatly from your research experience in the USA, Germany and particularly from working at the ETH in Zurich.

Yes, I found it invaluable to be able to experience physics in different localities, each department and country having a different view on the problems we were tackling. You could say my thinking is somewhat 'non-local' because of this. My period at the ETH was incredible – we had the chance to set up our labs from scratch. The atmosphere for creative research was outstanding with wonderful senior staff, including my supervisor and mentor Atac Imamoglu, research fellows and students and, I should say, with remarkably generous funding for research!

It is a time of new understanding of how quantum mechanics works. Could you describe the significance of this paradigm shift?

The big shift has been that, in developing the tools and techniques to gain fundamental understanding of quantum mechanics over many decades, we also uncovered ways of converting these into practical quantum mechanical devices. This resulted in a change from quantum science to quantum technology. We have moved from experiments to understand the fundamentals to the means of controlling and exploiting quantum systems. This shift in emphasis has had an impact upon many of the departments on the west Cambridge site and offers tremendous scope for future collaborations.

The Laboratory's research programme has changed enormously over the last ten years. I am thinking of

exoplanets, new technologies for particle physics, you and your colleagues' remarkable quantum initiatives in cold atoms and quantum information, as well as the major advances in theory. How would you characterise this change of approach?

The astrophysicists and particle physicists have enjoyed large collaborative programmes out of the necessity of being able to fund and build major ambitious instruments. In many other areas of physics researchers tend to consider the next advances within the areas in which they had developed special expertise. The evolution from this somewhat 'business as usual' model is now towards 'challenge-led' science where expert investigators have to find the role they can play along with others. There is undoubtedly a shift to larger, more expensive programmes which have to be multi-disciplinary involving collaboration between frontier research groups. An excellent example of this is the 'Life in the Universe' programme which necessitates collaboration between astronomers, physicists, chemists, biologists, geophysicists, material scientists, zoologists and so on. Within the context of the grand challenges, researchers find their own niches and contribute to the whole.

It seems to me that our future role as the provider of state-of-the-art equipment and resources for the wider physics community must play an important role in realising this vision.

Yes, it is a very fortunate conjunction of many developments that now is the time to move forward with this exciting vision for the future of multi-disciplinary research. It goes much wider than just the Cavendish and the West Cambridge campus. It involves collaboration across all Cambridge Departments, particularly in the life sciences, as well as throughout the UK and our international collaborators.

Do you have any specific new areas which you would like the Department to develop?

Well, everyone will have their own view, which is a very helpful situation. In my opinion, I believe studies of complexity in its many manifestations is a very important and exciting area. We now have so many problems, both physical and sociological, that need this detailed understanding not only at the theoretical and experimental level, but also for the benefit of the many problems facing society at large. But this is just my personal vision. We need to pull researchers together to agree on the future grand challenges and then deliver an imaginative and compelling programme of research.

The Department also has major responsibilities for teaching and for administering the programme. How do you see this developing in the next few years?

The teaching is an essential part of our responsibility and we have to update continually what we teach and how we teach it. Our teaching has to be at the highest level and involve all the academic staff. We need the staff to buy-in to the necessity of the very best minds in the department passing on their understandings to the wonderful students we are privileged to teach. On the administrative side, everyone has in their contracts the requirement to contribute to the management and administrative functions of the Department and the key thing is to distribute these fairly to all members of the academic staff. I hope this will be feasible without the need to exert extra pressure on the staff. But, full involvement in the health of the department is everyone's responsibility. This involves transparency about what a 'fair work-load' means and making it clear that the system is fair and not just relying on the willing.

This brings us naturally to the issue of what we expect of staff and students. I worry a great deal about the enormous pressures on young staff members to carry out effectively the many things they have to do while producing world-leading science. How do we tackle the problem of work-life balance?

This is a major issue for all of us. Exhaustion is not a good state to be in if you want to be creative. Nonetheless, you have to put in many hours of effort if you want to be creative. These periods of intense concentration are needed to produce original research, but they should be time-limited – the last thing we want is for excellent researchers to suffer 'burn-out'. It is not so different from the way artists work. They have to work fantastically hard for an up-coming exhibition, for example, but then there should be a period of rest. The same rule applies in pondering a research problem. Work fantastically hard for a limited period and then rest. While you are resting, the problems are still in the back of your mind and new ideas might come to you unexpectedly. Early-career scientists should be aware that, in choosing a physics career, you are in it for the long-haul. The questions will change, your understanding will change but don't burn out before the big challenges come within your grasp.

This is a very exciting time for the Laboratory. We have new posts available thanks to the generosity of the Dolby family and a wonderful new building. Your last thoughts?

I am very grateful indeed to Andy Parker and all our past and present colleagues for making this all possible. Andy leaves a tremendous legacy and he set the bar high for attracting generous support for our department. The Ray Dolby Centre will also change our social culture hopefully maximising interaction between colleagues and groups. A lot of thought went into designing it by the Logistics Committee and Richard Phillips in particular, and the Project Team worked hard throughout the process to make sure we get the building we want in the end. Although the new building is really terrific, our main resource is people and we will do everything we can to support them through the new era which will soon be upon us.

Major Advance in Preserving Quantum Coherence for Quantum Dot Spin Qubits



LEON ZAPORSKI, CLAIRE LE GALL and METE ATATÜRE are co-authors of a recent paper on a major advance in preserving quantum coherence in quantum dots.

Spin-photon interfaces and their coherence times are elementary building blocks for quantum networks that allow the conversion of stationary quantum information into photons that can be distributed over large distances. A major challenge is to find an interface that both stores quantum information and is efficient in converting it into light.

Optically active semiconductor quantum dots are the most efficient spin-photon interface known to date but extending their storage time beyond a few microseconds has puzzled physicists in spite of decade-long research efforts. Researchers at the University of Cambridge, the University of Linz and the University of Sheffield have recently shown that there is a simple materials solution to this problem that improves the storage of quantum information beyond one hundred microseconds.

Quantum dots are crystalline structures made out of many thousands of atoms. Each of these atoms' nuclei has a magnetic dipole moment that couples to the quantum dot electron and can cause the loss of quantum information stored in the electron qubit. The research team have created a device constructed with semiconductor materials that have the same lattice parameter so that the nuclei 'feel' the same environment and behave in unison. As a result, it is now possible to filter out this nuclear noise and achieve a near two-order magnitude improvement in storage time.

Claire Le Gall of Cavendish Laboratory, who led the project, said:

'This is a completely new regime for optically active quantum dots where we can switch off the interaction with nuclei and refocus the electron spin over and over again to keep its quantum state alive. We demonstrated hundreds of microseconds in our work, but really, now we are in this regime, we know that much longer coherence times are within reach. For spins in quantum dots, short coherence times were the biggest roadblock to applications, and this finding offers a clear and simple solution to that.'

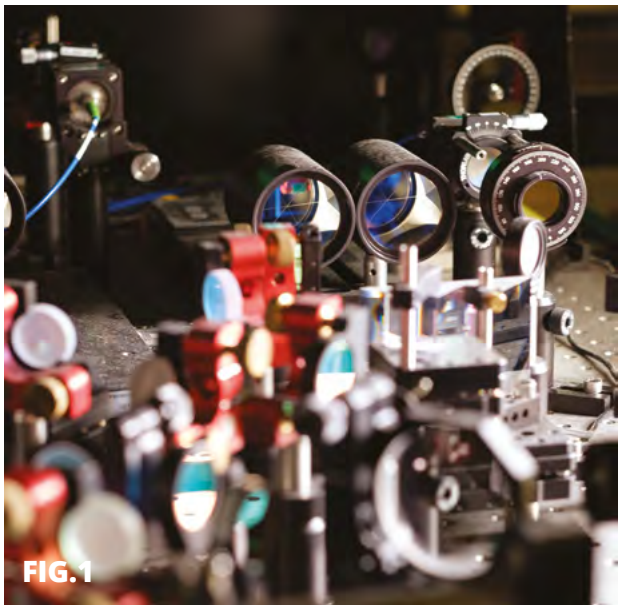


FIG.1

While exploring the hundred-microsecond timescales for the first time, the researchers were pleasantly surprised to find that the electron only sees noise from the nuclei as opposed to, say, electrical noise in the device. This occurs because the nuclear ensemble is an isolated quantum system, and the coherent electron provides a gateway to quantum phenomena in the large nuclear spin ensemble.

Another surprise was the 'sound' that was picked up from the nuclei. It was not quite as harmonious as was initially

FIG.1. The spin control set-up.

FIG.2. Leon (left) and Noah Shofar (right), second author of the paper, on the job. Photography by Martin Appel.

FIG.3. Artist's impression of an electron spin in a quantum dot, interfaced with light and strongly-coupled nuclear spins (viewed through a lens). Credit: Leon Zaporski.

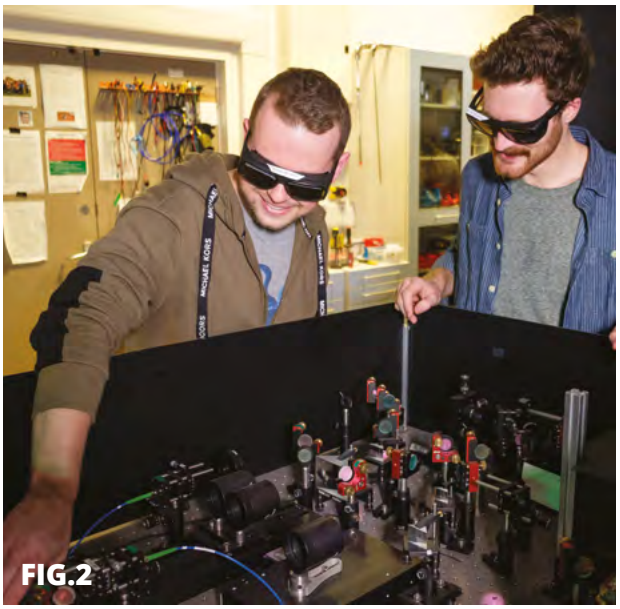


FIG.2

anticipated, and there is room for further improvement in the system's quantum coherence through further material engineering.

Armando Rastelli, co-author of the paper at the University of Linz remarked:

'When we started working with the lattice-matched material system employed in this work, getting quantum dots with well-defined properties and good optical quality wasn't easy. It is very rewarding to see that an initially curiosity-driven research line on a rather ´exotic´ system and the perseverance of skilled team members Santanu Manna and Saimon Covre da Silva led to the devices at the basis of these spectacular results. We are thrilled by the perspective of further engineering their properties together with our collaborators.'

Cavendish PhD student and first author of the paper, Leon Zaporski explains:

'One of the most exciting things about this research is taming a complex quantum system: a hundred thousand nuclei coupling strongly to a well-controlled electron spin. Most researchers approach the problem of isolating the qubit from the noise by removing all the interactions. Their qubits become a bit like sedated Schrödinger's cats, that can barely react to anyone pulling on their tail. Our 'cat' is on strong stimulants, which – in practice - means we can have more 'fun' with it.'

Mete Atatüre, co-author of the paper also explained:

'Quantum dots now combine high photonic quantum efficiency with long spin coherence times. In the near future, we envisage these devices will enable the creation of entangled light states for all-photonic quantum computing and allow foundational quantum control experiments of the nuclear spin ensemble.'

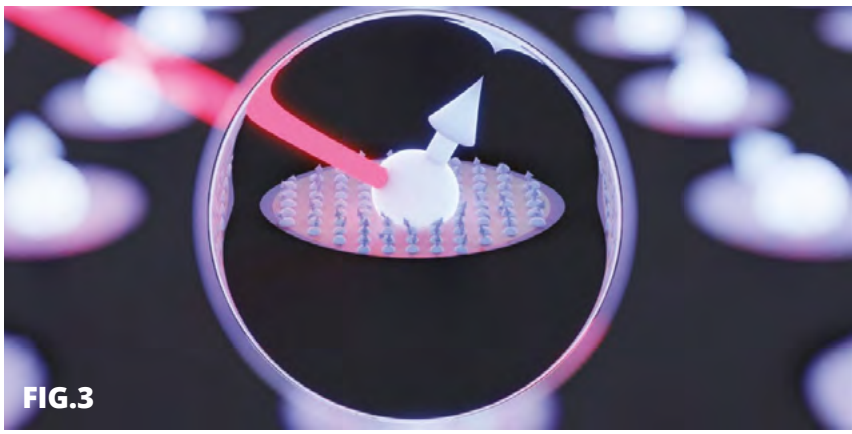


FIG.3

These technologies will be transformative for a broad range of industries and research efforts: from the security of information transfer, through the search for materials and chemicals with novel properties, to measurements of fundamental physical phenomena requiring precise time synchronisation among the sensors.

Reference:
Leon Zaporski et al, 'Ideal refocusing of an optically active spin qubit under strong hyperfine interactions.' Nature Nanotechnology (2023). DOI: 10.1038/s41565-022-01282-2

A version of this article was prepared by Pooja Pandey and others who contributed to the text. It appeared on the Cavendish News Web pages at **phy.cam.ac.uk/news/researchers-find-ways-improve-storage-time-quantum-information-spin-rich-material**

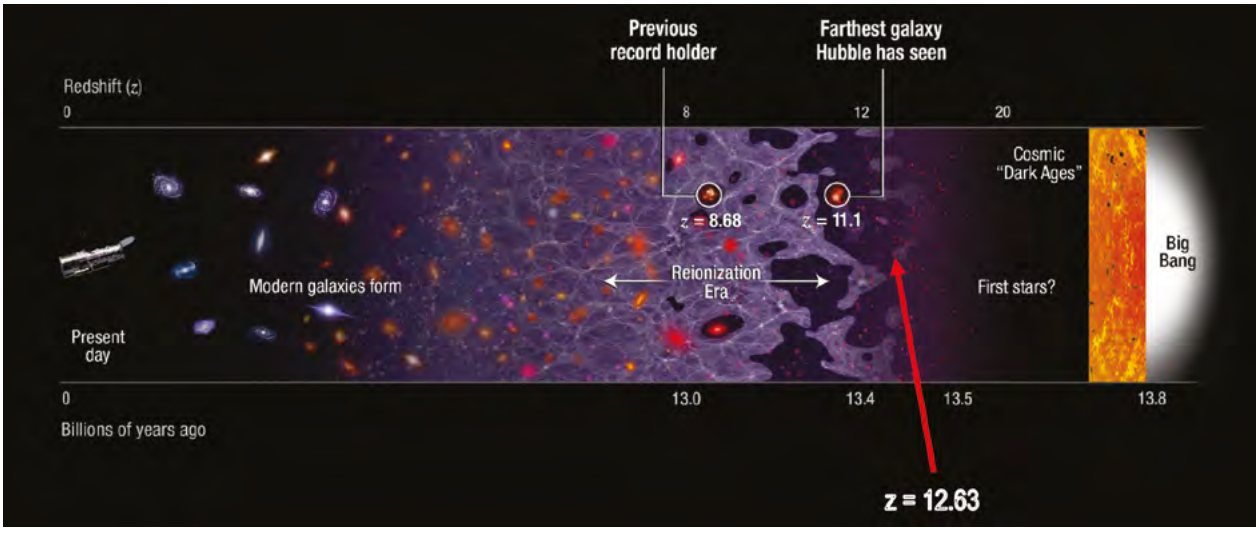
The James Webb Space Telescope delivers!

No sooner had we introduced the successful launch of the James Webb Space Telescope (JWST) and welcomed SANDRO TACCHELLA to the Laboratory in CavMag28, than the first scientific fruits of his and his colleagues' observations of the extremely distant Universe have produced spectacular results. These foreshadow the great riches in store for studying the origins of structures we observe about us in the Universe today.

One of the prime scientific motivations for the JWST project was the study of the physical processes which took place in the early Universe as stars and galaxies began to form to create the galaxies we observe about us today. The standard cosmological history of the processes involved is illustrated schematically in Figure 1, time progressing from the Big Bang on the right of the diagram to the present day on the left. Redshifts and timescales are shown on the upper and lower axes.

As the primordial diffuse intergalactic gas cools from the earliest epoch to the present, it is expected that all the primordial hydrogen and helium cool as in an adiabatic expansion and yet we know that the intergalactic gas is very highly ionised at the present day. The gas must have been ionised and the process of ionisation was more or less completed by a redshift of about 6. Well before this epoch, however, when the first galaxies began to form, the gas was still largely in the form of neutral hydrogen and helium, without any 'pollution' by heavy elements such as carbon, nitrogen and oxygen which began to be created in the very first generations of stars in galaxies. To determine the chemical evolution of the intergalactic gas, we need to be able to measure the chemical abundances and properties of galaxies at these much earlier epochs. In terms of the sketch shown in Figure 1, we need to probe beyond the epochs when the bulk of star formation in galaxies must have taken place – these processes seriously pollute the pristine intergalactic gas.

The Hubble Space Telescope did a wonderful job in taking images of very distant galaxies, the most distant objects being indicated in Figure 1. But the redshifts were determined by broad-band multicolour photometry. The huge advantage of the JWST is that it can probe to much fainter magnitudes than the HST and, most importantly, it has on board a powerful infrared spectrograph which enables the spectra, and chemical abundances, of these incredibly faint galaxies to the measured.



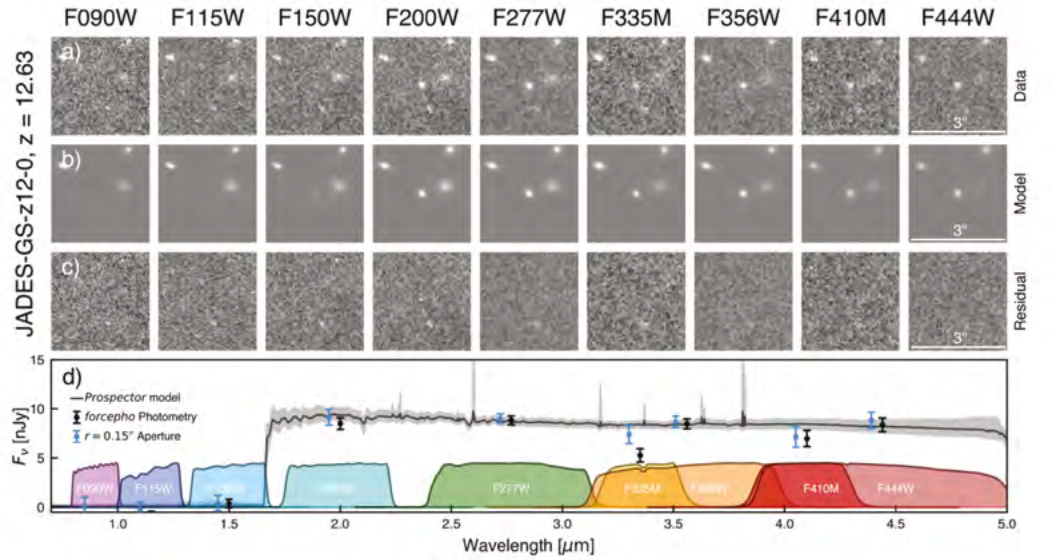


FIG.1 (OPPOSITE).
A schematic diagram showing the evolution of the formation of structures in the Universe from the Big Bang to the present day.

FIG.2 (A,B,C,D) (LEFT) The results of broad band imaging of the very faint galaxy JADES-GS-z12-0 at a redshift z = 12.63. (a) shows the galaxy in the centre of each frame which only appears at wavelengths longer than 2 μm. (b) shows modelling of the target galaxies and (c) the difference between the observations and the modelling. (d) shows the spectrum of the galaxy by modelling the infrared broad-band colours to the spectrum of an early star forming galaxy

Amazingly, galaxies with apparent magnitudes as faint as *m*(AB) = 29 can be observed in the infrared waveband spectroscopically. The first results of this programme are just about to be published[1].

An example of the power of multiband photometry is shown for the galaxy JADES-GS-z12-0 at redshift z = 12.63 in Figure 2. The large international team present the results of the detailed analysis of four galaxies with spectroscopic redshifts 13.20, 12.63, 11.58 and 10.32[2].

To paraphrase the words of the authors of the paper, the stellar masses M^* are in the range $\log_{10} M^* \approx 7.8 - 8.9$, measured in solar units M_{Sun}, up to about 100 times smaller than typical galaxies today and the stellar ages are in the range 16 − 71 Myr. Their star formation rates are in the range of about 1 − 2 M_{Sun} per year. These properties are consistent with expectations for galaxy formation in standard Λ-cold dark matter cosmologies at these redshifts. These galaxies have median star formation rates comparable to the present Milky Way despite them being more than a hundred times less massive. These systems have sustained a star formation rate more than ten times that of the Small Magellanic Cloud, a present-day galaxy of comparable stellar mass. The stellar and gas-phase metallicities are shown to be consistent with being less than a tenth of the solar value, and the visual dust attenuation in these galaxies is less than 0.3 mag, but with a large uncertainty. The integrated yield of prior Type II supernovae is enough to enrich these galaxies with metals, provided at least ≈10% of ejected metals remain and that the SFH has been sustained longer than 10 Myrs.

Using the two galaxies with the highest redshifts, a lower limit to the comoving cosmic star formation rate density for the preceding 30 Myr can be found, as well as the local ionisation volumes about the galaxies. The observed galaxies could only ionise their local intergalactic media. These simple estimates indicate that the earliest forming galaxies identified in the JADES imaging and verified through JADES spectroscopy are among the very first agents of cosmic reionisation, and will contribute to the eventual phase change from a neutral to ionised intergalactic medium at a later cosmic time.

SANDRO TACCHELLA AND ROBERTO MAIOLINO.

1. Robertson, B. E., Tacchella, S., Johnson, B. D. and 33 other authors (2023). *Discovery and properties of the earliest galaxies with confirmed distances,* submitted to *Nature.*
2. Curtis-Lake, E., Carniani, S. ;Cameron, A. and 54 other authors. *Spectroscopic confirmation of four metal-poor galaxies at z = 10.3-13.2*. https://ui.adsabs.harvard.edu/abs/2022arXiv221204568C/abstract

Roberto Maiolino awarded a second consecutive prestigious Advanced Grant from the European Research Council (ERC)

Many congratulations to Roberto on the award of a second consecutive ERC Advanced Grant, worth more than two million pounds, which will be used to pursue his research project 'RISEandFALL'.[1]

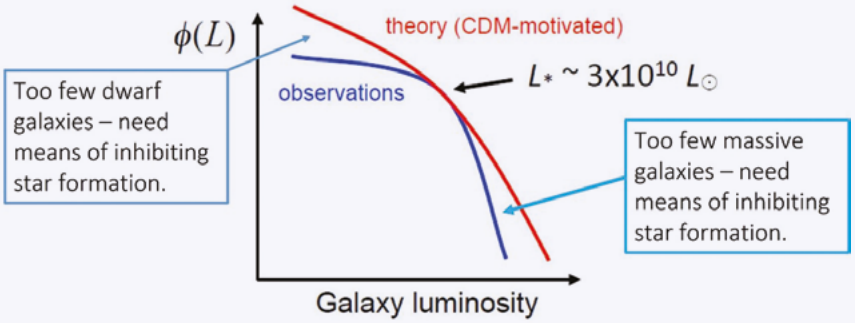


FIG. 1. Illustrating the problems of accounting for the discrepancies between the observed luminosity function of galaxies according to the standard ΛCDM model and the observations. The models predict too many intrinsically luminous and faint galaxies. There must be means of inhibiting star formation for both massive and dwarf galaxies.

This project is divided in two parts. The first part, 'RISE', is aimed at investigating the nature and properties of galaxies during their infancy, as well as their black hole seeds. The first results of this programme are described in the accompanying article with Sandro Tacchella.

The second part (the 'FALL') will explore the physical processes driving subsequent galaxy evolution and transformation with cosmic epoch, with a focus on understanding of the mechanisms responsible for the suppression of star formation. This has turned out to be a tricky non-linear phenomenon involving feedback mechanisms with a vast and complex range of astrophysical processes, many of which are poorly understood (Figure 1).

These goals will be achieved primarily using data coming from cutting edge astronomical facilities, including the James Webb Space Telescope. The project will also use data from MOONS, the next generation multi-object near-infrared spectrograph for the Very Large Telescope, which will deliver unique information for hundreds of thousands distant galaxies. The Cavendish is making major contributions to the development phase of the MOONS project. Data will also be obtained from the Atacama Large Millimetre Telescope (ALMA), the largest telescope operating in the (sub-)millimetre band.

As Roberto has remarked,

'This prestigious grant will support our project which is now entering an exciting new stage. It will certainly give us the resources to greatly foster the efforts into our cutting-edge research activities.'

We wish Roberto and his colleagues the best of wishes for this ambitious programme.

1. As UK institutes are unable to sign ERC grant agreements prior to formal association of the UK to the programme, this project will be funded, for the same amount, by UKRI under its Horizon Europe Guarantee scheme.

Ray Dolby Centre – Almost there!

The site continues to progress towards completion. This is now particularly noticeable as the external works are completing around the West Hub and along all the elevations on the RDC.

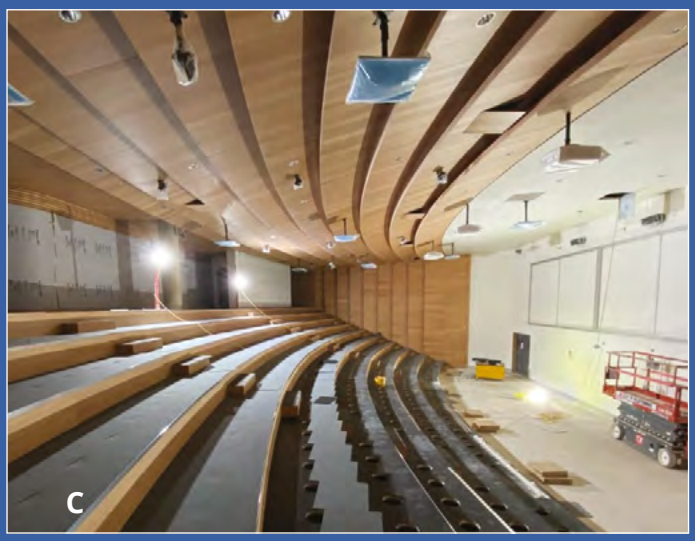
JJ Thomson avenue upgrade works are now finished and the landscaping around the building has started. The perimeter is now partially paved and planting with almost 30,000 plants, including 103 trees, is about halfway through.

The facades (A) are nearing completion as the teams are focusing on the future main entrance of the building, a plaza which rises from the central JJ Thomson gardens to give access to the public wing at level 1. The effect of the full height glazing between the polished concrete fins can now start to be appreciated within the building.

The striking copper cladded lecture theatres (B/C) welcome visitors as they enter the public wing. The upper levels of the building, which are predominantly offices and meeting rooms, are now progressively being finished and inspected. The internal courtyards are complete providing natural light into the offices.

The research facilities (D) have also progressed well, and lab equipment is being installed and connected. About half of the 2,400 m^2 of cleanrooms is completed, the next stage of the works being to clean the rooms ready for the ventilation and air-conditioning systems.

The Testing and Commissioning of the building's multiple Mechanical and Electrical systems is also progressing. The ground source heat pumps are fully operational and supply the heat load for the whole building. Chillers have been commissioned and testing has started on many systems with lighting control and fire alarms now active in parts of the RDC.



Images © Paul Raftery courtesy of Bouygues UK

Celebrating 7 years of the Maxwell Centre

As we are about to celebrate the 7th anniversary of the Maxwell Centre's launch on the 7th of April 2016, AGA IWASIEWICZ-WABNIG, Maxwell Centre Director of Partnership Development, is delighted to share a few highlights of the programme and partnerships we foster.

Mark Welland assumed Directorship of the Maxwell Centre in 2019, taking over from Richard Friend, the Founding Director. We set a new strategy for the Centre, with explicit focus on Zero Carbon, and Science-Technology-Medicine areas. To deliver our strategy we operate in close partnerships with the Cambridge Zero[1] initiative, headquartered at the Maxwell Centre, and we are a founding partner in the Connect: Health Tech[2] community and the associated online platform.

The Maxwell Centre acts as a catalyst, convener and a hub where strategic and serendipitous conversations lead to new research projects and collaborations. We serve Departments across the Schools of Physical Science and Technology, and have strong links to the School of Clinical Medicine as well. Since 2016, we have enabled interaction between several hundreds of companies and Cambridge researchers – through events, hot-desking, equipment sharing and collocation in offices and labs, and through unexpected conversations over a cup of coffee (we call those "Maxwell moments").

Although due to pandemic restrictions we were not able to celebrate our 5th anniversary in 2021 in person, we celebrated with an award of £0.75M through the Research England World Class Labs scheme. This allowed us to add two Flexi Labs, purchase new shared equipment (FTIR/UV-Vis-NIR spectroscopy suite and a wire bonder), boost our sample preparation capabilities and upgrade the XPS and XRD machines with new modules.

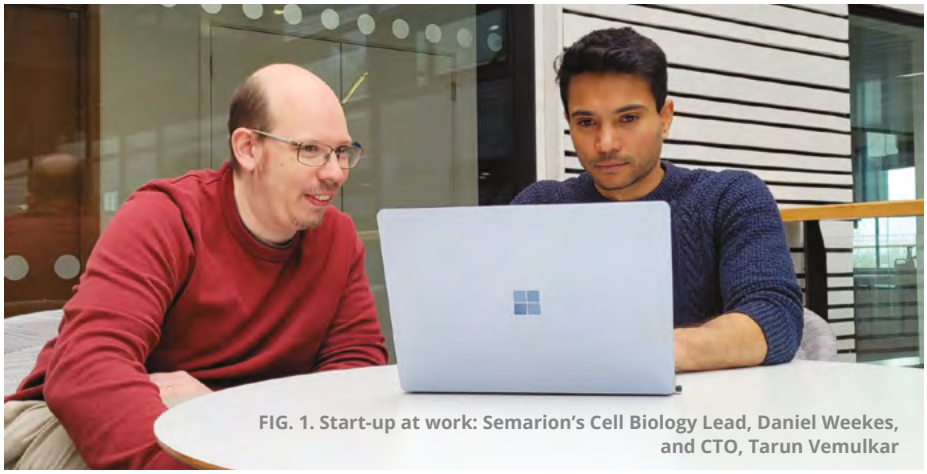


FIG. 1. Start-up at work: Semarion's Cell Biology Lead, Daniel Weekes, and CTO, Tarun Vemulkar

We have also added hybrid meeting capabilities to all of our meeting and seminar rooms, and launched a Cambridge Zero Demonstrators Laboratory making it digitally accessible to remove geographic barriers to collaboration.

We are working with a large number of companies at any given time, our longest standing partnership being with the National Physical Laboratory (NPL). This was the first external partner on site, starting with one person hot-desking part-time, and today a team of researchers from the NPL Data Science is hosted across two offices at the Maxwell Centre, and working on medical data curation and metrology.

We are especially well positioned to support local start-ups while they develop their technologies and grow. This arrangement is usually time-bound, since most of our start-ups rapidly grow beyond the amount of space we are able to offer them at the Centre. Several start-ups have significant links with Cavendish academics and are furthering technologies stemming from Cambridge research, well on the way to significant impact. Tuomas Knowles and Sarah Teichmann are co-founders of TransitionBio, a start-up that combines expertise of Cambridge and Harvard in microfluidics, cell imaging and machine learning to revolutionise condensate drug discovery. During TransitionBio's Maxwell Centre residence period, the development of their technology platform was significantly furthered and the company secured a $50M series A investment. They are now operating across two own sites, in Cambridge UK, and in Cambridge MA. The very newest industrial partner is Illumion, a start-up revolutionising measurement of energy storage in operating batteries through application of charge photometry. The technology was developed in the research groups of Akshay Rao and Clare Grey, and the company is setting up their office and lab at the Maxwell this month.

FIG. 2 (INSET). Artificial leaves: photosynthesis-based system for synthetic fuel production being assembled at the Cambridge Zero Demonstrator Laboratory at the Maxwell Centre. The prototype was tested at the rooftop of the Maxwell Centre compound ahead of competing in the final of the EU "Fuel from the Sun Prize" in Italy last summer.

We are also currently hosting the Semarion team, who are a great example of how the Maxwell Centre ecosystem helps companies with their research and development journeys. Semarion innovates across disciplines to interface microchip industry materials and techniques with cell biology to tackle bottlenecks in drug discovery. The co-founders, Tarun Vemulkar (CTO) and Jeroen Verheyen (CEO) started collaborating through the NanoDTC doctoral training centre programme, while Tarun completed his PhD at the Cavendish. They proceeded to work as postdocs with Russell Cowburn, and benefited from attending our impulse for tech innovators[3] practitioner-led entrepreneurship training programme. They are back at the Maxwell Centre now, having secured £2.14M seed funding to commercialise their cell assaying platform. Tarun said:

'We spun Semarion out of the Cavendish, and it's great to still be a part of the community as a seed-stage company. We retain close ties to Russell Cowburn's lab and work out of the Physics of Medicine communal facilities, both of which have enabled us to drive our technology and application development from the proof-of-concept stage to nearly ready for commercial deployment. It can be a challenge to accommodate the operational needs of both a semiconductor fabrication unit and a cell biology suite in a small company and it's a balance we've been able to strike perfectly by being embedded in the Cavendish, with the Maxwell Centre as a hub that ties our multidisciplinary team together.'

Interdisciplinary collaboration indeed thrives here – we host academics from Physics, Chemistry, Materials Science, Chemical Engineering and Oncology, as well as facilitators from several University strategic initiatives, including the Energy Interdisciplinary Research Centre, Cambridge Global Challenges, Precision Medicine and Quantum. We are set up to facilitate industrial users access to high-end shared equipment, including that of the Cambridge spoke of the Henry Royce Institute[4] for Advanced Materials Research.

In November 2022 we resumed our interdisciplinary Annual Research Showcase, and added an Annual Technology Showcase for emerging technologies in the sustainability space. We help Cambridge postdocs with preparation for meaningful engagement with industry through termly Putting Your Research Into Context training workshops delivered in partnership with iTeams and Cambridge Enterprise. Late last year, in collaboration with the Henry Royce Institute and Cambridge Zero, the Maxwell Centre launched the UK Chapter of the World Materials Forum, which brings together academia, industry and entrepreneurs around the vision of using materials smarter, longer and less. At the inaugural meeting of the UK Chapter we discussed decarbonisation of bulk materials production, in particular steel and glass, stationary batteries for storage performance, and energy efficient electronics.

We are delighted to report that we are back in full strength and looking forward to many more impactful collaborations at the interface of academia and industry. Feel free to get in touch![5]

1. www.zero.cam.ac.uk
2. https://connect.cam.ac.uk/health-tech
3. www.maxwell.cam.ac.uk/programmes/impulse
4. www.maxwell.cam.ac.uk/programmes/henry-royce-institute
5. www.maxwell.cam.ac.uk/maxwell-community/liaison-team

Ain Bailey - Composer

We are delighted to welcome Ain Bailey as the second Cavendish-Girton College Arts-Science Fellow to the Laboratory. Ain will be in residence in Cambridge from January-September 2023, exchanging ideas with physicists at the Cavendish Laboratory and with Fellows across multiple disciplines at Girton College. Ain and your editor had a sparkling conversation about her work and objectives.

Ain (pronounced I-een) is a life-long Londoner with Jamaican ancestry She loved music from an early age, buying her first record at the age of 12. She attended art school in 1990 and in parallel enjoyed a career as a DJ. It was during the latter activities that a colleague suggested she should learn how to create DJ mixes/make music in order to get better gigs. She followed this advice and became smitten with the potential of music technology. She was entranced by the sounds created by the BBC Sound Effects Library gifted to her on a music production course. She began ploughing her own furrow as what might be called a 'sound artist' but now she prefers to describe herself simply as a composer.

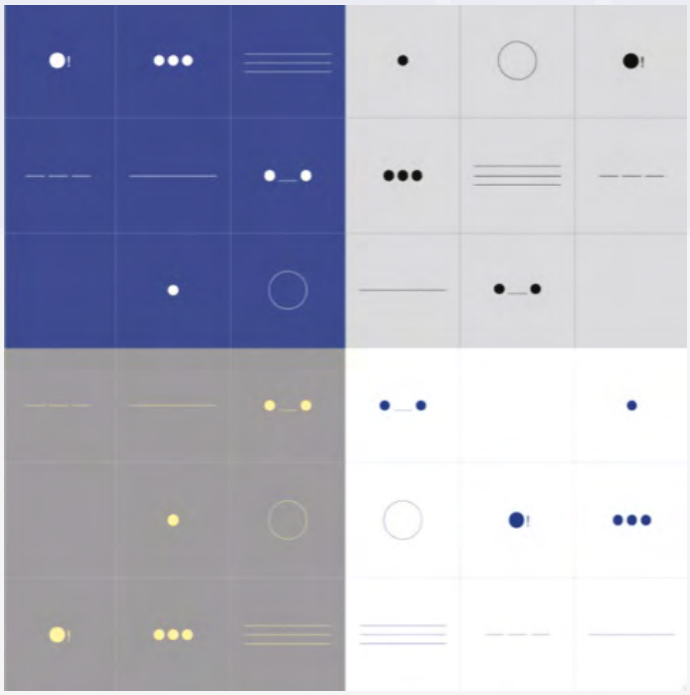
An early success was working with a choreographer in Cologne, Stephanie Thiersch, which resulted in her composition 'Audition', which, like many of her works, can be heard on her web-site at **https://soundcloud.com/ain_bailey**. She went back to college for a year which she found very stimulating. Then, to develop her compositional technique further, she did a part-time Masters degree at Goldsmith's College where they had excellent multichannel facilities.

Since then, Ain has worked on a very wide range of projects which are listed on her website. To quote from the announcement of her appointment to the Fellowship,

'Ain's practice explores sonic autobiographies and the constellation of sounds that form individual and community identities. Her compositions encompass field recordings and found sounds and are often inspired by reflections on silence and absence, feminist activism and architectural acoustics, particularly of urban spaces. She has developed numerous collaborations with performance, sonic and visual artists, creating multi-channel and mixed media installations and soundtracks for moving image, live performance and dance.'

These activities culminated in the first solo exhibition of her work in 2019 at the Cubitt Gallery, London.

Set against this remarkable background, we delved into interview mode, your editor coming from a rather different perspective and enthusiasm for 'classical' modern music – the communality of values was enlightening.



ABOVE: *The Pitch Sisters Live!* (2013). Score by Ain Bailey. Graphic Design by Laura Varzgalyte.

How would you describe your compositions?

I am a minimalist, strongly influenced by the compositions of Steve Reich. I like to describe my compositions as 'generative music'. My music is all composed on a computer, creating new textures, rhythms and loops. There is a lot of repetition, but it is always shifting. I never really know what it will sound like or where it will all end up. I use lots of samples and carry out many experiments, building up a tapestry often using banks of sound. The process of composition is very labour-intensive and often panic-inducing when I have to meet deadlines. People do not come away from performances of my works humming 'tunes' – it is a different sort of acoustic experience.

The word 'minimalism' provides a bridge between your compositions and those of composers such as Steve Reich, Philip Glass and John Adams. As I listened to the tracks of your compositions, there were resonances with major works of these 'classical' composers.

Yes, I am a great fan of Steve Reich whose remarkable piece 'Different trains' was influential. Like so many minimalist pieces, the music works by exploiting tiny shifts and changes. The listener has to enjoy the subtlety of how these small changes of emphasis play off each other to remarkable effect.

In one of your pieces, I could hear resonances with pieces such as Philip Glass's *Einstein on the Beach* where the two narrators speak apparently randomly over one another. Was this a conscious allusion?

Not really, since it is not a piece I am familiar with. But, I love the slowly evolving changes of pitch and rhythm. One of my great enthusiasms is Jazz – it is my favourite type of music. One remarkable example of the synthesis of Philip Glass's minimalism and Jazz is the very beautiful jazz trio performance of Glass's Piano Etude no. 16 by the Aaron Diehl trio.

At this point we listened to this wonderful performance by the Trio.
youtube.com/watch?v=DkG4sEgmVoU

You have only been here a few days, but do you have a plan about what you would like to achieve over the next 8 months or so?

The idea of the Arts-Science programme is to explore the links between physics and my creative work – to bring an artist's perception to the influences I hope to absorb. I want to talk to a lot of physicists in the Laboratory to get an intuitive impression of their work. It is unrealistic to expect me to understand the details of what excites them, but I hope to become absorbed in the culture.

I was very impressed when I attended Evensong at Girton College by the wonderful choir – it was a terrific sonic experience. It would be wonderful if I could find a way of incorporating that type of experience into my work. I would also love to work with an orchestra, rather than just composing on the computer. I see enormous potential for new ideas in composition.

I have a strong belief that many of the most important advances in physics come about through breaking the rules both in experiments and in theory in response to apparently intractable problems. Do you find analogous processes at work in your own compositions?

Yes, I find the same thing happening in my compositions. I often do not know how a work will turn out through this mysterious process of creativity – but it seems to work.

Thank you so much for this most enjoyable and enlightening conversation – I am very much looking forward to the outcomes of your absorption in the very different realms of physics and sound composition.

Explore Ain's work using the QR codes SoundCloud (left) and YouTube (right).

Maxwell's Viscometer Rejuvenated

One of the crown-jewels of our collection of scientific instruments is James Clerk Maxwell's viscometer. It has been on display for many years but was in a rather poor state of repair and some of the glass discs of the torsion balance were broken. With a view to moving this splendid piece of apparatus to the atrium of the Ray Dolby Centre in roughly a year's time, the instrument has been splendidly refurbished and brought back to something close to its former glory.

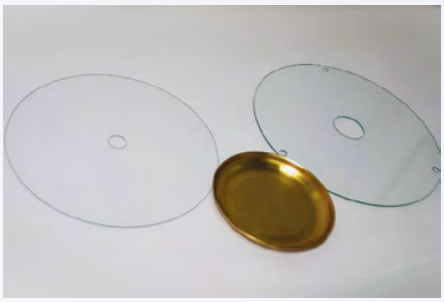
Historical Background

The two great laws of thermodynamics were formulated by Rudolf Clausius and William Thomson (Lord Kelvin) in 1850-51. Clausius set about interpreting the laws in terms of the kinetic theory of gases in which the atoms or molecules were represented by spheres which collide with each other and with the walls of the containing vessel, resulting in the pressure of the gas. Clausius worked entirely with the mean speeds of the particles and recovered the perfect gas law $pV = Nm\overline{u^2}$, where $\overline{u^2}$ is the mean squared velocity of the particles. The velocity distribution was worked out by Maxwell in a few lines in his great papers of 1860 entitled *Illustrations of the dynamical theory of gases*. According to Maxwell's theory, the viscosity of gases should be independent of their pressure but depend upon temperature as $T^{1/2}$.

At this time, Maxwell was Professor of Natural Philosophy at King's College London. To test the kinetic theory, he had this splendid viscometer built by Mr. Becker, of Messrs. Elliott Brothers in the Strand in the early 1860s. Maxwell and his wife carried out the experiments in their London home.

The method used was to measure the rate of decay of the torsional oscillations of glass discs. Maxwell used 3 suspended discs oscillating between 4 larger fixed discs, thus simplifying the mathematical analysis. (Figure 2).

The apparatus consisted of a 4 ft long suspension tube above a glass enclosure containing the plates (Figure 1). The enclosure could be evacuated, or filled with different types of gas, and the pressure was read using a barometer fixed to the suspension tube. A thermometer was placed on the upper, fixed glass plate. The temperature within the apparatus was varied by enclosing the glass enclosure in a tin vessel through which cold water, hot water, or steam flowed. The oscillations of the plates were observed by reflecting light from a mirror attached to the suspension wire onto a scale 6 ft away. A small magnet is attached to the bottom of the suspension wire below the plates which set the pendulum in motion when a strong magnet was brought up to the apparatus.



Maxwell's experiments confirmed the prediction that the coefficient of viscosity is independent of the pressure, but is proportional to the absolute temperature, rather than the square root of the temperature. Maxwell calculated that, if the intermolecular force were an inverse fifth law with distance, the viscosity would be proportional to temperature. Significantly, Maxwell had replaced collisions between particles by repulsive interactions between the fields of the particles.

The Refurbishment

Sean Geraghty, an expert instrument maker and member of the Cavendish workshop team, carried out a wonderful restoration job, replacing the broken glass discs, cleaning up the tarnished brass parts, making a new brass 'bowl' in which pumice stones in nitric acid were placed to remove any residual water vapour. A strong neodymium magnet was inserted at the bottom of the torsion balance so that the torsional oscillations could be excited by a strong external magnetic field. Not only has the restoration been successful, but the viscometer now works as intended by Maxwell.

Our initial experiments show that the torsion pendulum operates as it was in Maxwell's time and we intend repeating his experiments to measure the viscosity of gases.

Photography by Chris Brock.

FIG.1 (LEFT). Sean Geraghty (right) and Malcolm Longair (left) with the refurbished Maxwell viscometer.

Fig. 2 (RIGHT). Showing the four fixed and three moving discs of the refurbished torsion pendulum of the refurbished apparatus inside the sealed enclosure.

FIG. 3 (TOP, LEFT TO RIGHT). (a) Examples of the new glass discs and the brass bowl for the pumice stones. (b) Showing the arrangement for projecting a light beam onto a small mirror attached to the torsion wire. (c) The bronze collars which ensured the accurate separation of the moving discs.

Isaac Physics

NICKI HUMPHREY-BAKER describes the wealth of opportunities for young people and their school teachers through our ISAAC Physics and many outreach programmes. Do come and join us.

STEMSMART

Isaac Physics continues to support sixth form mentoring and support through the STEM SMART programme[1]. The second cohort of STEM SMART students made a superb start in January 2023. Of 1179 students who signed up to receive assignments as part of this programme, 1011 have been actively contributing. In the first 10 weeks, they have done over **330,000** questions on the Isaac Physics website, in addition to their school work, to develop their understanding of their studies. They have also been attending weekly subject tutorials and fortnightly mentoring sessions with a Cambridge undergraduate. A total of 949 students have attended tutorials, the average student having benefitted from 10 hours of tutorials in the first 10 weeks of the programme.

January also saw us working with the STEM SMART students who joined last year. Over 160 students took part in tutorials or supervisions supporting their school studies. Of these, 153 have signed up to receive assignments and between them they completed over 20 000 questions, over and above their school commitments. While a good proportion of these students applied to Cambridge and received offers, the goal of the 17-month programme is to increase attainment for all participating students and allow more of them to secure offers at top universities. In January 2024 we will find out how they fare. The students and their teachers told us how much the experience has boosted their confidence and increased their school grades.

New Isaac Materials

Isaac Physics will launch new materials for Years 7 and 8 (11-13 year olds) in September 2023. The team has created 2 more experiments: one on distance-time graphs and another on buoyancy. All our experiments help young students develop their practical skills. They become more confident with processing data and sketching graphs. On 28th June 2023, Isaac Physics will host 180 of this year group at the Cavendish. They will perform an experiment on forces and elasticity by stretching sweets and problem solving sessions using the new materials. Ingrid Murray, our Teacher Support Manager, is launching new Continued Professional Development (CPD) materials for teachers of this age range, spreading the word about these new resources. This follows from very successful topic-based CPD that she has been delivering since September[2]. It always makes the team's day when teachers and students tell us of the success of the courses. Here is a quote from a teacher on one of Ingrid's course:

'I want to thank the Isaac Physics team for all the resources and development. Isaac physic has transformed outcomes for my students and reduced my workload! What's not to like?'

Outreach

This year, we developed a primary school programme, initially for Years 5 and 6, (9–11 year olds), based on Jacob Butler's Master's Thesis. Our aims are to give the students the tools to be strong scientists and ensure that they see a realistic potential future in science. This eases the transition to secondary school science, countering the drop off of students' enthusiasm for scientific subjects when they start secondary school.

We have consulted closely with local primary school teachers to learn what they value most. The enthusiasm with which they have engaged with us has been energising. Teachers have requested experiments to make the lessons more engaging, and also stretch the keen students. This programme will include materials for specific topics, such as forces, electricity and waves. We have created a set of experiments studying moments and pulleys, a topic teachers wanted us to tackle first. All the experiments will use objects that can be found cheaply or that a school may already own. For example, Steve Martin devised an experiment on moments using a metre ruler hanging from a thin rod at the 50 cm mark (Fig.1). Pupils hang masses using uncurled paper clips hooked onto the ruler. They are able to investigate the principles governing turning moments and equilibrium.

All the new materials encourage students to be inquisitive, conduct their own investigations and communicate their findings, already aims of the school curriculum. However, primary education teachers, who are often not science graduates, tend to guide students to experiments with which they feel comfortable or for which the resources are available. Our plan is to support teachers to grow their confidence in physics and to foster a network of science leaders in local primary and secondary schools. We will test our new materials with students and teachers alike through various events.

FIG.1

Since September 2022 we have re-introduced all our in-person events. The **Cambridge Physics Experience** continues. We hosted 30 Year 9 (13 year old) students in October to learn about building bridges and choosing the right subject combination for GCSE. In February, we hosted 60 Year 12 students (penultimate school year) to investigate pendula and circular motion and to find out about Cambridge admissions. In March, it was the turn of GCSE students (14-16 year olds) who were introduced to optics and built a refracting telescope. In April, we will host Years 7 and 8 students (11-13 year olds) on a Mars Rover Day. They will build a rover that can withstand landing on Mars and tackle the terrain. This year, a new element will be the incorporation of a 30-minute Isaac Physics session for this age range. You can find more about the Cambridge Physics Experience and dates for 2023-2024 at https://outreach.phy.cam.ac.uk/programme/CPE.

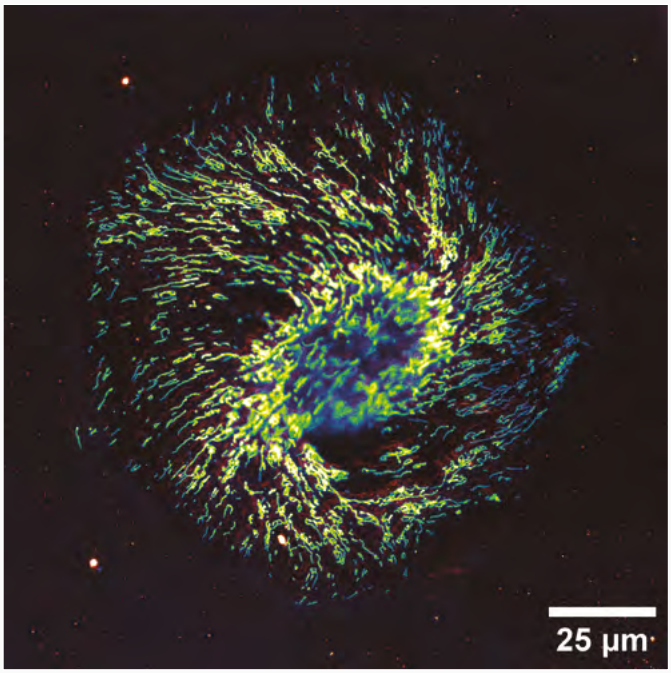
The **Cambridge Physics Centre lectures** series which runs from October to March has just concluded. This year, the topics have included dark energy and dark matter, quantum materials, aeronautics, superconductors and fusion power[3]. These free lectures are open to the public, thanks to funding from the Institute of Physics. Details of the 2023–24 lecture series will be made available in due course.

In March 2023, we opened the Department to the public as part of the Cambridge Festival. The department hosted talks by local science educators including Dave and Rosie Ansell of Sciansell, Diana Fusco on microbial evolution and a live recording of the ***People Doing Science*** podcast with Athene Donald. We also hosted a 3-minute wonder competition for early career researchers. Congratulations to Cavendish students Katie-Lou White who came first and Arthur Morris who came second. In the first year teaching lab visitors could travel from *Adventures in the NanoWorld* to the a*stronomic* in a planetarium setup for the day. In the second year lab, undergraduates and postgraduates demonstrated intriguing physics phenomena. The children were encouraged to build paper cranes, bridges and design the best sycamore seeds. The largest paper crane stood about 150 cm off the edge of the table.

We are now planning our largest outreach event, the **39th year of *Physics at Work***, in September. We invite exhibitors to come and speak about their work to 15-17 year olds (GCSE students) to showcase where a degree in Physics can take them. The more exhibitors we have, the more school groups we can host. If you would like to find out more head to https://outreach.phy.cam.ac.uk/programme/physicsatwork. The dates this year will be 19th-20th September 2023.

1. www.undergraduate.study.cam.ac.uk/stem-smart.
2. https://isaacphysics.org/events/23_electricity_topic_cpd.
3. The recordings can be found at https://outreach.phy.cam.ac.uk/programme/cpc.

Winners of the Cavendish Photography Competition 2022



Images and videos capturing multiple physics research themes are among the prize-winning entries in the Department's 2022 Photography Competition. The winners of the Department's first annual photography competition were judged anonymously on 3 criteria of scientific relevance, uniqueness and visual appeal. The panel of judges for this year's Competition included Andy Parker, Mete Atatüre, Suchitra Sebastian, Paul Rimmer and Harry Cliff. More details of the winning entries and the animations can be found at:

www.phy.cam.ac.uk/news/winners-cavendish-photography-competition-2022-unveiled

Head of Department Cash Prize

Awarded to Postdoctoral researcher **NICOLAS GAURIOT** for two entries.

True Colors

Germanium Selenide (GeSe) observed through a polarised light microscope.

See video at: **https://youtu.be/aKKshj9tXaE**

Atomically thin bird of paradise (TOP LEFT)

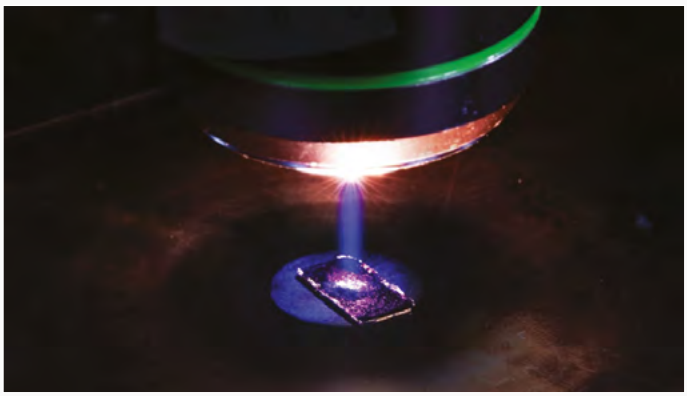
This is a micrograph of a sample of Germanium Selenide (GeSe) 125 micrometres wide.

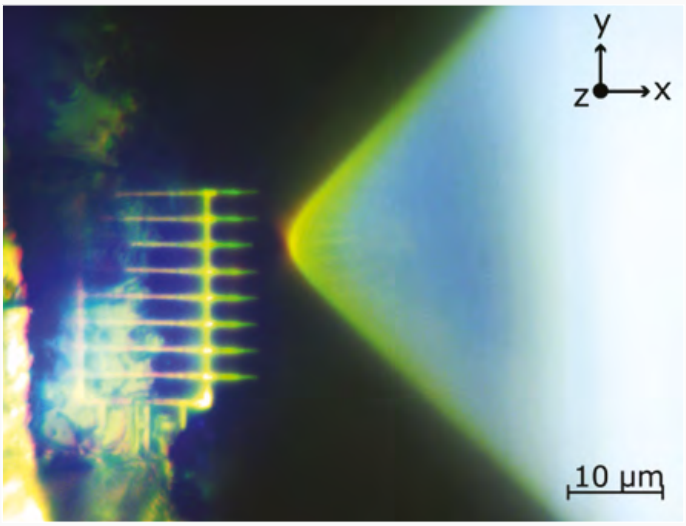
First Prize

Awarded to Postdoctoral researcher **JACK HART**.

Nanodiamond uptake in cancer cells (BOTTOM LEFT)

Nanodiamonds containing nitrogen-vacancy defects are next-generation quantum sensors that can provide fascinating insight into biological processes with unprecedented spatial resolution, probing length scales 500 times smaller than human hairs.





Second Prize

Two second prizes awarded to PhD candidates **AOIFE GREGG** and **DOMINIC ANSTEY.**

Aoife: *Microscale actuators from carbon nanotube and hydrogel composites*

Jellyfish-like structures composed of carbon nanotube forests (black) and hydrogel (translucent) are viewed in a chamber of water.

See video at **https://youtu.be/Q6FIKL2FO6E**

Dominic: *REACHing the First Stars (TOP LEFT)*

The Radio Experiment for the Analysis of Cosmic Hydrogen (REACH) is attempting to detect the traces of the first stars in the presence of powerful radio emissions from our Galaxy.

Third Prize

Three third prize awarded to Postdoctoral researcher **ERIC S.A. GÖRLITZER**, member of staff **STEVE HAWS** and PhD candidate **RA (RYAN) PARKER**.

Eric: *Nanophotonic tools to watch behaviour of individual atoms, molecules, quantum dots and solid-state emitters (BOTTOM LEFT)*

We use microscopic characterization in combination with plasmonic nanophotonic architectures that embed components under study between gold nanoparticles.

Steve: *Pulse Laser Deposition (TOP RIGHT)*

Our researchers in Li-Ion battery materials use advanced pulsed laser deposition to achieve anodes, cathodes and solid electrolyte thin films as model battery materials for understanding how batteries performs at the atomic to micron length scales.

Ryan: *Lensed Fibre coupling to a diamond nanophotonic quantum waveguide chiplet (BOTTOM LEFT)*

Other Top Entries
Other top entries were of PhD candidates **DÁVID PUSKÁS** (Astrophysics) and **TOBY MITCHELL** (Quantum Optics).

Harold Aspden Professorship of Fundamental Physics

Many congratulations to **JEREMY BAUMBERG,** Director of the Nanophotonics Centre, on his appointment to the Harold Aspden Professorship of Fundamental Physics. This new professorship is named after Harold Aspden (Trinity 1950), IBM's Director of Patent Operations in Europe and a dedicated scientist who passed away in 2011. After his death, his wife Wendy made provision in her will for the establishment of this new professorship. Aspden was a prolific and dedicated scientist, author of many books, publications and research papers. An archive of his documents is now hosted at the Cavendish Laboratory and the University Library.

'We are delighted by the appointment of Jeremy Baumberg to the Aspden Chair', said Andy Parker, Head of the Cavendish.' As an outstanding scientist, he will no doubt carve a new path towards blue sky scientific innovation, fulfilling Wendy Aspden's vision for the Harold Aspden Professorship of Fundamental Physics.'

For more details of this appointment, see **www.phy.cam.ac.uk/news/professor-jeremy-j-baumberg-appointed-harold-aspden-professor-fundamental-physics**

We are delighted to welcome the following colleagues to the academic staff

MATT KENZIE, appointed to an Associate Professorship in Data Intensive Science, based in the Cavendish High Energy Physics Group, will take up this post on 24th April 2023.

ELOY DE LERA ACEDO, Associate Professor in Experimental Astrophysics and Head of the Radio Cosmology Group in the Astrophysics Group is already in post.

SARAH WILLIAMS Assistant Professor in the High Energy Physics Group, jointly with Murray Edwards College, took up her position from 1st Feb 2023.

ERC Starting Grant to Diana Fusco

DIANA FUSCO has been awarded a prestigious European Research Council starting grant to support her research group to develop mathematical methods and experimental validations to predict phage-bacteria co-evolution, a key step to be able to engineer and control microbial ecologies. The grants, worth about €1.5 million, are awarded to early-career researchers, for their promising research projects. Diana is already a well-recognised interdisciplinary researcher and will use this grant to launch her own project – EvoPhage. Her current research on understanding how phage- bacteria systems evolve is critical to design microbial communities with specific functions - both for agricultural and medical applications.

ERC Consolidator Grants to Cavendish Researchers

ELOY DE LERA ACEDO (see above) has been awarded a grant for REACH_21: Probing the Cosmic Dawn and Epoch of Re-ionization with the REACH experiment. Eloy described the aims and status of the REACH programme in his article *Cambridge researchers contribute to Human Capital Development in Africa through Radio Astronomy* in CavMag26.

AKSHAY RAO has been awarded a grant for SPICE: Spin-Exchange and Energy Transfer at Hybrid Molecular/Lanthanide Nanoparticle Interfaces to Control Triplet Excitons. Akshay stated, 'Our project, SPICE, will explore the physics and chemistry of a new class of hybrid materials, organic molecules connected to lanthanide doped nanoparticles. if we succeed, we may create transformative applications in areas ranging from optoelectronics, data communication, photocatalysis, optogenetics and 3D bio-printing.'

Ray Dolby Centre Migration

Work has started on the Ray Dolby Centre migration programme, which will see large numbers of laboratories and offices located in our current buildings move across the road to the new Ray Dolby Centre in 2024. Move Champions been identified in every laboratory and professional services to support their teams' move to the new Centre at each stage of this complex process.

Cambridge, ETH Zurich, Harvard, and Chicago found the 'Origins Federation'

Joining forces with chemist and fellow Nobel Laureate, **JACK SZOSTAK** and astronomer, **DIMITAR SASSELOV**, **DIDIER QUELOZ** has announced the founding of a new '**Origins Federation**'. This international alliance brings together the expertise of researchers working at 'Origins of Life' centres and initiatives at the University of Cambridge, ETH Zurich, Harvard University, and the University of Chicago.

The team will explore the chemical and physical processes of living organisms and environmental conditions hospitable to supporting life on other planets. "The Origins Federation," Queloz commented, "builds upon a long-standing collegial relationship strengthened through a shared collaboration in a recently completed project with the Simons Foundation."

More details of the importance of the federation and the views of the participants shown above can be found at: **phy.cam.ac.uk/news/humanitys-quest-discover-origins-life-universe**

ABOVE, left to right:
Emily Mitchell (Zoology), Didier Queloz (Physics), Kate Adamala (Protobiology, Minnesota) and Carl Zimmer (New York Times columnist).

Catherine Clifton's 40 years in the Department

Many Congratulations indeed to **CATHERINE CLIFTON** On completing 40 years of service to the Cavendish Laboratory. Over the years, day in day out, come rain or shine, she has worked in the Reception, welcoming thousands of staff and visitors to the Department and witnessing more changes than anyone else. To celebrate this achievement, she kindly provided her reminiscences of this remarkable feat of endurance. It can be found at:

www.phy.cam.ac.uk/blog/lifetime-physics

LEFT: Catherine with her niece Laura who came to work for her and with Keith Papworth, our photographer. RIGHT: Andrea Leeming, Catherine and Gloria Oglesby, a long-time reception team, reunited for Keith Matthews's retirement party in October 2015.

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**

If you wish to support the graduate student programme, please go to: **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**

If you would like your gift to be applied to some other specific aspect of the Development Programme, please contact Andy Parker or Malcolm Longair. The Development portfolio is described in CavMag 18 and can be viewed online at: **www.phy.cam.ac.uk/alumni/files/Cavmag18Aug2017online.pdf**

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** 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 either Malcolm Longair (**msl1000@cam.ac.uk**) or Samantha Stokes (**departmental.administrator@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 either Malcolm Longair (**msl1000@cam.ac.uk**) or Andy Parker (**hod@phy. cam.ac.uk**), who will be very pleased to talk to you confidentially.

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