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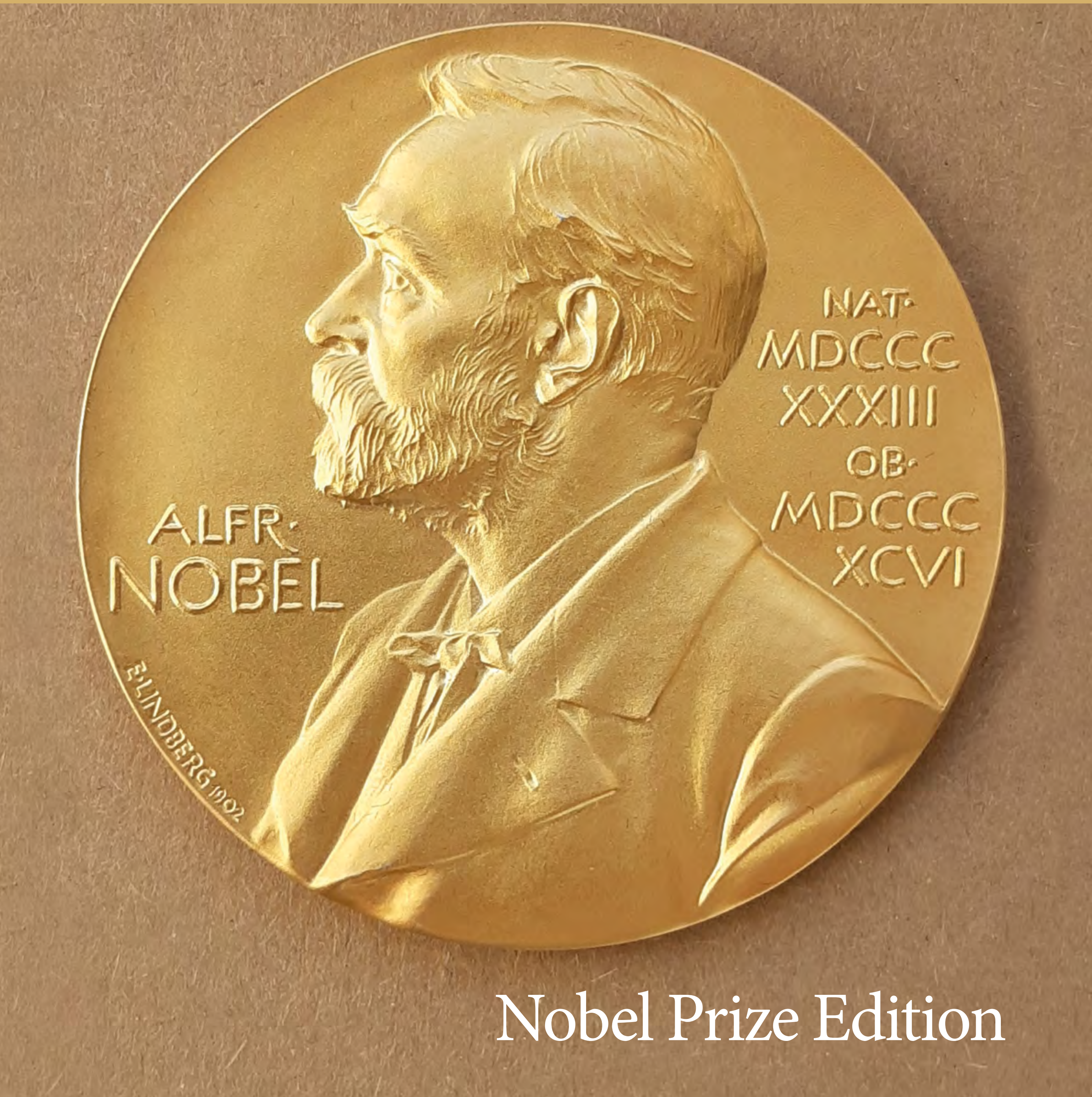
News from the Cavendish Laboratory



Nobel Prize Edition

The award of the 2019 Nobel Prize in Physics to Michel Mayor and Didier Queloz is a major cause for celebration. Their discovery of exoplanets about normal stars was a great and disruptive discovery, overturning many previous beliefs about the nature and origin of planetary systems. It has generated a huge astronomical industry, which has raised many new and important issues related to the origin of our own Solar System. As described in this celebratory issue of *CavMag*, the nature of the discovery has many lessons for the process of making breakthroughs in physics and astronomy.

Most of all, our warmest congratulations to Michel and Didier for their brilliant discovery of 1995 and the wonderful news of their Nobel Prize.

INSIDE

COVER PAGE: Photograph of Didier Queloz's Nobel Prize Medal.

Didier Queloz wins 2019 Nobel Prize in Physics

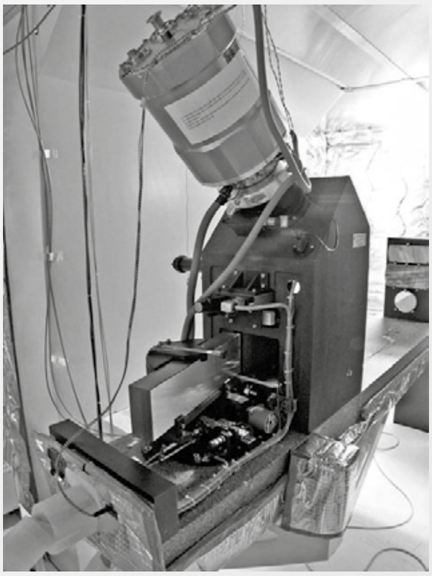
DIDIER QUELOZ has been awarded the 2019 Nobel Prize in Physics jointly with MICHEL MAYOR and JAMES PEEBLES. The full citation reads

The Nobel Prize in Physics 2019 was awarded "for contributions to our understanding of the evolution of the universe and Earth's place in the cosmos" with one half to James Peebles "for theoretical discoveries in physical cosmology", the other half jointly to Michel Mayor and Didier Queloz "for the discovery of an exoplanet orbiting a solar-type star".

WHAT MICHEL MAYOR AND DIDIER QUELOZ DID

The discovery of planets about nearby stars has been a cherished ambition of astronomers for centuries, but it proved to be a very considerable challenge. The first detection of a Jupiter-mass planet orbiting a normal star was made by Michel Mayor and Didier Queloz of the University of Geneva in 1995 (Fig. 1). Their success can be attributed to the development of very stable optical spectrographs with very high spectral resolution.

To appreciate the nature of the challenge, the Sun orbits the centre of mass of the Solar System at a typical speed of about 13 m s^{-1}. To have any hope of being able to detect the presence of Jupiter mass planets in planetary systems such as our own, the spectrograph would have to be able to resolve radial velocities of a few m s^{-1}.



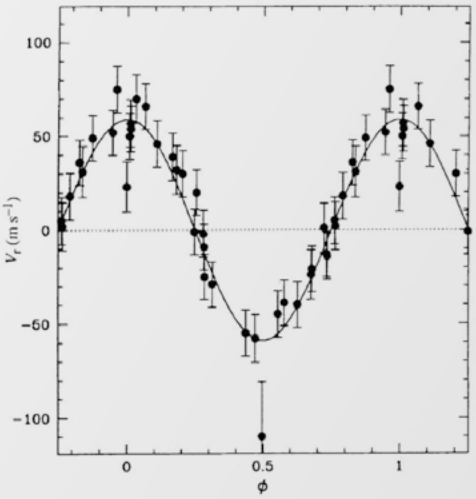


FIG. 1 (opposite). Michel Mayor (left) and Didier Queloz (right) in 1995 at the time of the discovery of an exoplanet orbiting the star 51 Peg. FIG. 2a, above-left. The 1.93 m reflecting telescope of the Haute-Provence Observatory, France. Fig.2.b, above-centre. The ELODIE fibre-fed echelle spectrograph without its thermal shield in the strictly thermally controlled instrument room. FIG. 3, above-right. The discovery record of the sinusoidal variation of the centre of mass of the star 51 Peg and its planetary companion (Mayor and Queloz 1995).

The observations were made with the fibre-fed echelle spectrograph ELODIE mounted on the 1.93 m reflector of the Haute-Provence Observatory, France (Fig.2 (a) and (b)). This instrument, developed by André Baranne of the Marseille Observatory, enabled measurements of radial velocities with an accuracy of about 13 m s^{-1} for stars up to 9 magnitudes to be made in an exposure time of less than 30 min.

The discovery record (Fig. 3) of the sinusoidal variation of the radial velocity of the nearby star 51 Peg shows that the amplitude of the motion of this solar-type star is very much greater than would be expected of a planetary system such as our own. Furthermore, the period of the planet about the star is only 4.231 days. The mass of the planet turned out to be at least 0.46 Jupiter masses and its semi-major axis only 0.052 AU, the astronomical unit AU meaning the mean radius of the Earth's orbit about the Sun. This discovery stimulated a huge effort to discover further examples of planets about nearby stars and it has been extraordinarily successful. The ELOIDE instrument itself discovered more than 20 other exoplanets. Now, the number of known exoplanets exceeds 4,000.

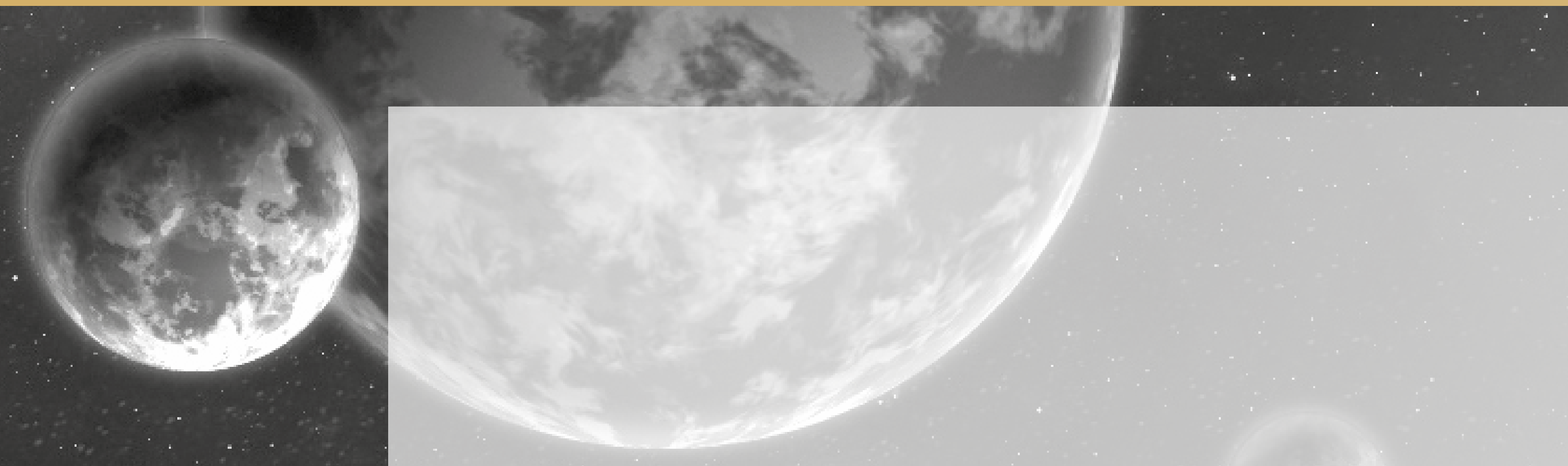
These discoveries resulted in two major surprises, which have forced a major rethink of the theory of the formation of planetary systems. The first was the large fraction of Jupiter-like companions at orbital radii about 100 times closer to the parent star than in our Solar System. For example, more than half of these gaseous giant planets orbit within 1 AU of the host star and a significant fraction within 0.1 AU.

The second great surprise was the fact that the orbits of many of the Jupiter-sized planets are highly elliptical. This poses problems for the standard picture of planet formation in which planets are formed by accretion in a proto-planetary disc. In this picture, dissipative processes rapidly circularise the planetary orbit. Therefore, the elliptical orbits must have come about through some other process.

The study of extrasolar planets is a major growth area of modern astrophysics and has opened the way to the study of bio-astrophysics and the possibility of determining by observation whether or not conditions exist in other planetary systems in which life could have formed.

We were delighted when Didier Queloz accepted a Professorship of Physics in the Cavendish Laboratory in 2013, as well becoming a fellow of Trinity College.

Since then, he has built up an extraordinary powerful interdepartmental collaboration in all aspects of the study of exoplanets.



Background to the discovery of exoplanets

When I was a small boy, it was claimed that the wobbles reported in the position of the nearby star, Barnard's star, were evidence for a planetary companion. The observations, spanning the years 1940 to 1968 and using 3036 plates, were analysed by Peter van de Kamp who modelled the wobbles by assuming that a planet with 1.7 times the mass of Jupiter and period 25 years was orbiting the star. His fit to the data are shown in Figure 1. The observations could not, however, be reproduced and the apparent motion was shown to be due to instrumental problems.

The first definite detection of extrasolar planets, or exoplanets, came from a quite unexpected direction, the observation of systematic variations in the radial velocity of the radio pulsar PSR 1257+12 by Alex Wolszczan and Dale Frail in 1992. The reason for their success was the very high precision with which radial velocities of pulsars can be determined by very precise timing of the arrival times of the radio pulses. In fact, they found evidence for three planets, two with masses roughly that of the Earth and one about 50 times less. This was a wholly unexpected discovery since it was assumed that when a neutron star, the parent body of a radio pulsar, forms, any planets orbiting the pre-supernova star would not remain in bound orbits. A favoured view is that these planets formed from an accretion disc about the neutron star after the progenitor supernova exploded. In any case, the mere existence of this system showed that planets can be formed in a wide variety of different astronomical environments.

But this was not what the astronomers hoped to find – they wanted planets orbiting normal stars, ideally similar to our own Solar System. As discussed in the preceding article, they were discovered by Michel Mayor and Didier Queloz thanks to the development of a very stable spectrograph with very high spectral resolution. The effects searched for were so small that very special precautions were needed to ensure the necessary vibrational and temperature stability were obained. But other key factors were involved.

They had to obtain dedicated observing time so that regular observations of very high quality could be made over prolonged periods. The choice of the 1.93 m telescope at the Haut-Provence Observatory was a good one since observing time was more readily obtainable as compared with that on one of the large 4–8 metre telescopes. This contrasted with their competitors in California who attacked the problem with the 10-metre Keck telescopes on which time was very much more difficult to obtain.

A third point was that to obtain the necessary precision in the radial velocities, cross-correlation techniques for the accurate measurement of radial velocities, developed by Roger Griffin at the Cambridge Observatories

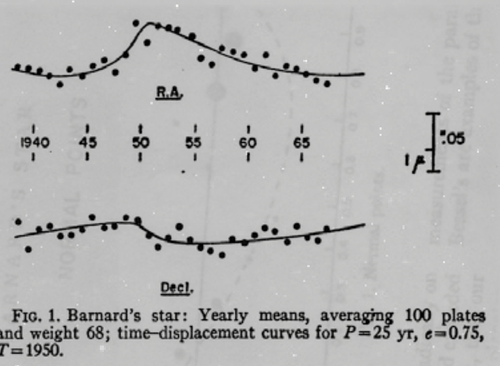


FIG 1. The apparent motion of the position of Barnard's star over 30 years from 1938 to 1968 in right ascension and declination according to van de Kamp. The positional data are averaged over each year.

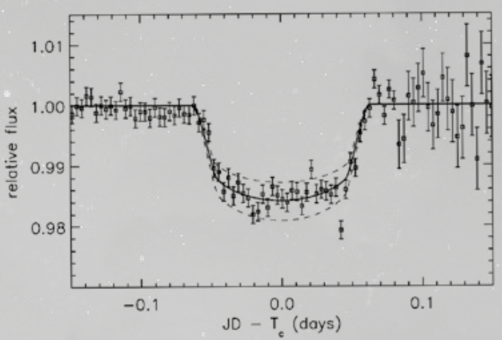


FIG. 2. The tiny dip in the total intensity of the star HD 209458 due to the passage of an exoplanet in front of the stellar disc (Charbonneau et al 2000, Ap.J., 529, L45-L48.

FIG. 3. Didier and members of his research team on the morning of the announcement of the award of the 2019 Nobel Prize in Physics.

and used by him in his remarkable career-long determination of accurate masses of stars in binary systems, were essential. These were adapted by Michel and Didier in order to achieve the accuracies needed to attain reliable velocity precision of order 10 m s^{-1}.

The moral of the story is that many different aspects of the observational programme need to be right and working simultaneously to have a chance of a major breakthrough – state of the art instrumentation, the availability of telescope time, innovative data reduction techniques and luck. Then, what precautions do you have to take to ensure the interpretation is correct? This is not a unique example of what it takes to make a major breakthrough in the sciences. The technology, observing/experiment time and data reduction techniques all need to be matched to the problem at hand.

The same considerations apply to a second method of discovering exoplanets about sun-like stars which was successfully employed by David Charbonneau, Michel Mayor and their colleagues in 1999 by observing the tiny dip in the light from the star when the exoplanet passes in front of it (Fig. 2). These eclipsing exoplanets have the advantage that the molecular gases in the atmosphere of the exoplanet imprint absorption lines on the star's spectrum, enabling the constituent molecules in the exoplanet atmosphere to be observed.

Didier and his team (Fig.3) are now exploiting both techniques for the discovery of exoplanets and for the determination of the properties of their atmospheres, hoping to find out whether or not these exoplanets might be habitable.

MALCOLM LONGAIR

2019 Nobel Prize Celebrations in Stockholm – a Right Royal Occasion

By our ROYAL CORRESPONDENTS

Andy Parker and your editor were honoured to be Didier Queloz's invited guests for the presentation of the 2019 Nobel Prize medals and associated celebrations. We had simply to turn up for the activities on 10 December 2019 and let it roll over us – it was quite an event.

RIGHT: Didier presents to the Nobel Museum the key of the Haute Provence Observatory 1.93 m telescope with which exoplanets were discovered.

For the prize-winners, however, this was just the highpoint of a demanding week of activities. In Sweden, Nobel Prize week is one of national celebration, culminating in the prize-giving event and subsequent Nobel Banquet which are shown live on national television. To give some impression of the effort involved, this is the specially printed programme for Didier, Michel and their guests:

Thursday 5th December
Arrive from Switzerland and met by the Secretary General of the Royal Swedish Academy of Sciences.

Friday 6th December
Informal get-together of Laureates and families at the Nobel Prize museum. Lectures about the history of the Nobel Prizes, interviews for the Nobel Prize's official digital channel, donation of an object for the museum's collection, signing a chair in the Bistro Nobel.

In the afternoon, the Laureates had a live conversation with astronauts on the international space station.

Saturday 7th December
Breakfast meeting preparation for the press conference, followed by interviews with the Laureates. Rehearsal for Nobel lectures. In the afternoon, preparation for television programme 'Nobel Minds' on 12 December. Dinner at the Royal Swedish Academy.

Sunday 8th December
Morning: Nobel lectures by the Prizewinners in Physics in the Aula Magna of Stockholm University. Lunch for Laureates in Physics and Chemistry. In the early evening, reception

at Stockholm Concert Hall, followed by the Nobel Prize Concert by the Royal Stockholm Philharmonia Orchestra conducted by Herbert Blomstedt. Buffet Dinner from 21.45 to 23.00.

Monday 9th December
In the morning, recording of 'Nobel Minds'. Afternoon, reception at the Swiss Residency, hosted by the Ambassador. Evening reception to honour all the Nobel Laureates.

Tuesday 10th December
08.30 to 09.30: Hair and Manicure appointments. Morning rehearsal of Nobel Prize Award Ceremony. Lunch with the Swiss Ambassador and Delegation. Award ceremony and Banquet (see below).

Wednesday 11th December
Afternoon: seminar at the Swedish Parliament by Michel and Didier on their research and how they discovered exoplanets. Interviews with journalists. Pre-dinner audience with the Royal Family. Banquet at the Royal Palace (formal dress).

Thursday 12th December
Morning: Official School visit to the Spånga senior high school. Lecture, then and question

and answer session. Afternoon: Individual visits to the Nobel Foundation to receive the Medals and diplomas. Official Nobel portrait. Evening: Concluding reception of the Nobel Week.

Award Ceremony and Nobel Prize Banquet

The highlight of the week was undoubtedly the formal Award Ceremony and Nobel Prize Banquet on 10th December. The dress was 'formal attire, i.e. white tie and tails for men/long evening gown for women, or national dress'. At 3.30 pm, the cortège of official Volvo cars, one for each Laureate, departed for the Stockholm Concert Hall where the awards were to be made. The ceremony took place from 4.30 to 5.45 pm. We were all seated in the hall packed with invited guests. Andy, Stephen Toope, Vice-Chancellor of Cambridge University, and I had splendid seats in the centre of the front row of the Balcony.

The Award Ceremony ran like clockwork. The Royal Party, guests of the Nobel Foundation, consisted of Their Majesties The King and Queen of Sweden, The Crown Princess, Prince Daniel, Prince Carl Philip, Princess Sofia and Princess Madeleine. The same pattern was followed for each group of Laureates in Physics, Chemistry, Physiology or Medicine, 2108 Literature Award, 2019 Literature Award, and Economic Sciences. Speeches celebrating each group were followed by the presentation of the medals to the individual Laureates. Between each group light classical music pieces, many by Scandinavian composers, were performed as well as a rousing fanfare for each Laureate.

ABOVE: (left) Michel displays his signature on the base of a chair in the Bistro Nobel.
(right) Didier rehearsing his receipt of the Nobel Prize.
BELOW: Jim Peebles, Michel Mayor and Didier Queloz in lighted-hearted mood at the morning rehearsal.

ABOVE: The view from the front of the balcony with the Royal Party on the front right of the stage and the Laureates seated in the front row on the left. The Royal Stockholm Philharmonic Orchestra played from the balcony.

BELOW: Your Royal Correspondents, Andy Parker (right) and Malcolm Longair (left).

Jim, Michel and Didier then stood up in turn, walked forward and were presented with their medals by King Carl XVI Gustaf.

Following the ceremony, we were all transported to the Stockholm City Town Hall for the Nobel Banquet. This was a banquet for 1,500 people, all in formal dress. The Royal Family led the procession of distinguished guests. Beginning at 7.30 pm, the Banquet was meticulously orchestrated with regular intervals during which various 'Acts' of a Divertisement were performed by distinguished performers. The various interludes celebrated the Swedish ballad tradition spanning the four seasons, representing the eternal cycle of life, death and regeneration. Among the interludes were short speeches by speakers for the prize recipients, Jim Peebles doing the honours for the Physics Prize. During one of the interludes, students from the Swedish universities and colleges, bearing the standards of their student unions, paid homage to the Laureates.

The table service was immaculately organised, a highlight being the procession for the dessert course, in which the waiters and waitresses processed down the ramp of honour with silver platters adorned with large lit candles, the platters being held high with one hand, the other hand being firmly behind the back - nothing untoward happened! This part of the evening concluded at 11.30 pm and was followed by a move to the upper Golden Hall where there was dancing. A midnight snack was provided at 00.15 am and the dancing concluded at 2.00 am. For the really hardy, there were continuing celebrations provided by the 'Students' Nobel Night Cap' from 02.00 to 05.00 am.

Reflections

This was a truly remarkable day. The abiding memory was the celebration of the very best of science, the humanities and social sciences interpreted broadly. The events were Sweden's national celebration of outstanding contributions to culture in its broadest sense and on the world scale, led by the members of the Royal family. The seriousness with which these events were taken was clear from the wide broadcast and public involvement in this week of events. Whatever one may think of such prizes, the promotion of the very best of science and culture is strongly to be welcomed. In these uncertain times, it is reassuring that at least one country puts the full resources of Nobel's legacy to the promotion of the very best values of society.

The laudation for Michel and Didier was as follows:

'The sun, moon and the brightly shining planets in our solar system, as well as the stars that are visible with the naked eye, have been known to humanity since prehistoric times. But are there planets that orbit stars similar to our own sun? Is our solar system unique, or are there other planetary systems? Until quite recently, in a historical perspective, these questions remained unanswered. The reason is simple; planets orbiting other stars cannot be directly observed since the light they emit is too faint. Instead we must look for the slight rocking motion a star makes if a planet, for example one the size of Jupiter, is rotating around it. Michel Mayor and Didier Queloz built an instrument – a spectrograph – that can measure such movement by utilising the Doppler effect. Many people are aware of how the Doppler effect influences sound. We hear a high-pitched sound from an emergency vehicle that is approaching us, but a lower-pitched sound as it moves away from us.

In October 1995, Mayor and Queloz announced the discovery of a Jupiter-like planet orbiting the star 51 Pegasi in the constellation known as Pegasus, about 50 light years away from Earth. It moves around its star at very high speed; a Pegasi year takes just over four days, compared to Earth's one year and Jupiter's twelve years. Other astronomers were quickly able to confirm this discovery, and since then the new field of "exoplanets" has literally exploded. Today more than 4,000 exoplanets within a few thousand light years of earth have been observed, enabling researchers to draw the conclusion that in our own Milky Way galaxy alone, there are perhaps 100 billion planetary systems. Technological development is progressing rapidly, and the question of whether there is life elsewhere in the Universe than in our own solar system will engage a new generation of astronomers.'

Didier receives his Nobel Prize from King Carl XVI Gustaf of Sweden.

The Gianna Angelopoulos Programme for Science, Technology and Innovation

The Gianna Angelopoulos Programme for Science, Technology and Innovation (GAPSTI) is a major UK-Greece collaboration programme centred on the intersection of academic research and the needs of industry and society. The initial focus of the Programme is in the fields of Computational Multiphysics, Energy Materials and Devices, and Bioengineering.

ABOVE LEFT: Gianna Angelopoulos RIGHT: Nikos Nikiforakis

GAPSTI is a five-year training and research programme based at the Cavendish, supported by a donation from Gianna Angelopoulos-Daskalaki, a Greek businesswoman, parliamentarian and President of the 2004 Athens Olympics. Mrs Angelopoulos has been recently appointed by the Prime Minister of Greece to deliver the 'Greece 2021' Programme, which celebrates the 200th anniversary of the independence of the Greek state. GAPSTI reflects Mrs Angelopoulos's commitment to education, entrepreneurship and economic growth, and in particular her desire to support early-career scientists in receiving excellent training as well as opportunities to flourish.

The programme, based in Cavendish Laboratory, is not intended simply to fund a range of research activities and studentships; it is designed to feed directly into the research-business cluster, which has placed Cambridge high on the international innovation map in recent decades. The aim is to conduct research directed by business needs, which in turn encourages businesses to invest in more research, and to foster innovation at a global level by enabling international collaboration between academia, industry and public organisations. It will therefore be an internationally unique ecosystem of training, research and entrepreneurial activity.

Nikos Nikiforakis, an academic with key expertise in the relevant fields and considerable experience in running similar large-scale programmes, has been appointed Programme Director.

Launch events

The GAPSTI programme was launched in March 2019 in Cambridge by Professor Stephen Toope, Vice Chancellor of the University, in the presence of the Ambassador of Greece, Mr Caramitsos-Tziras. A diverse group of international academics, industrialists and Greek media representatives attended the event.

A second launch event was held in October 2019 at the residence of the British Ambassador in Athens. This was attended by HM Ambassador to Greece, Ms Kate Smith CMG, the pro-Vice Chancellor for Institutional and International Relations, Eilis Ferran, the Head of the Department of Physics, Andy Parker, as well as Greek academics, industrialists and government officials.

Activities and achievements

Over the course of five years, GAPSTI will fund four academic positions, two support staff and 15 PhD studentships in the fields of energy materials and devices, computational multiphysics and bioengineering.

Two of the academic posts are already in place: Dr Hrvoje Jasak is the new Lecturer in Scientific Computing (Department of Physics), and Dr Bartomeu Monserrat has been appointed Lecturer is Computational Materials Science (Department of Material Science and Metallurgy). The third position, a joint appointment between the Departments of Engineering and Physics in Medical Therapeutics, is in the process of being filled at the time of writing. The lectureships were initially designed to be five-year posts. However, following successful negotiations with the relevant departments, they have now been converted into tenured University positions.

The programme also supports a series of initiatives aiming to establish strong links with Greek academic institutions and industry and to facilitate a two-way exchange of people and ideas, as part of its *Impact for Greece* (IfG) element.

In its first year, IfG provided 16 studentships for Greek post-graduate students to take part in the High Performance Computing Summer School in Cambridge, and funding for five Greek small/medium enterprises to take part in the SME Growth Programme run by the Cambridge Judge Business School.

The programme has also contributed to collaborative work between the Institute of Astronomy, University of Cambridge, and the Foundation for Research and Technology – Hellas (FORTH) in Crete, Greece, on Data Science projects. These are related to the projects *Gaia*, a flagship mission of the European Space Agency (ESA) which has undertaken the largest complete census ever made of the positions and motions of stars in the Galaxy, and *PASIPHAE*, a survey of stellar optical polarizations. GAPSTI is offering funding for a PhD studentship, leveraging another one from FORTH, as well as providing funding for exchange visits for the two students, who will be co-supervised by staff at Cambridge and FORTH.

A fruitful future

Looking ahead, GAPSTI's current engagement with industry is well underway to meet the remit of the Programme to accelerate significantly the conversion of blue-skies research into disruptive technology for the benefit of industry, the economy and the society at large.

The University is very grateful to Gianna Angelopoulos for her vision and financial support of this imaginative and important initiative. We wish everyone well in making a great success of this outstanding opportunity for mutually beneficial international research.

For more information on the Programme, visit **www.gianna.phy.cam.ac.uk or contact gianna-admin@phy.cam.ac.uk**

ABOVE, CLOCKWISE FROM TOP-LEFT:

The Cambridge contingent and some of the scholars at the Programme launch at the residence of the British Ambassador in Athens.

The participants of the High Performance Computing Academy at the Centre for Mathematical Sciences, University of Cambridge.

The participants of the SME Strategic Growth Programme at the Judge Business School.

Ultracold Turbulence

NIR NAVON and ZORAN HADZIBABIC describe a remarkable new approach to the study of turbulence using an atomic Bose-Einstein condensate.

Turbulence is a ubiquitous phenomenon in nature, and has fascinated scientists for centuries, at least since the time of Leonardo da Vinci. This regime of fluid flow, characterized by spatio-temporal chaos, is encountered in contexts as diverse as biology, physics and engineering. Moreover, it is of fundamental interest to mathematicians, and analogous phenomena have also been observed in finance. Turbulent air flows limit our ability to forecast weather with critical impact on climate-change science, turbulent friction is crucial in the design of re-entry heat shields for space vehicles, and dimples favour turbulence to boost the flight distance of golf balls. In spite of its interdisciplinary importance, many basic aspects of turbulence remain elusive, and Richard Feynman famously dubbed it the 'most important unsolved problem of classical physics.' For instance, it is well established that a key universal feature of turbulence is the transfer of energy across different length scales, the so-called *turbulent cascade*, but the mechanisms responsible for this transfer are still under active investigation.

We study ultracold quantum gases - puffs of atoms a million times thinner than air that are cooled to less than a millionth of a degree above absolute zero temperature; at such temperatures they form a Bose-Einstein condensate (BEC), an exotic state of matter in which the atoms lose their individuality and behave like a single giant matter wave. What do these quantum gases have to do with turbulence? Since they were first produced in 1995, confirming Einstein's prediction of 1925, it has been shown that they display phenomena such as superfluid hydrodynamics and quantum vortices, which are closely related to turbulence. More generally, they are a popular platform for highly controllable studies of complex many-particle phenomena, in essence because the atomic physicists know their atoms well and can relatively easily manipulate them using lasers and magnetic fields. A major hurdle, however, for devising turbulence experiments with clear answers was that the atoms were traditionally trapped in the focus of lasers beams (optical tweezers) or the minima of magnetic fields, and the atomic density in such a trapping potential was inhomogeneous. This, for example, makes it hard to observe the turbulent cascade through different length scales, which is naturally revealed in Fourier, or momentum, space.

In 2013 at the Cavendish Laboratory, using holographic light-sculpting, we produced first atomic BECs in an 'optical-box' trap (see Fig.1a) [1], in which the quantum gas has uniform density; our box provides a 'flat' potential, such as often studied in undergraduate courses on quantum mechanics. This solved many problems in the field of ultracold atoms in general, and in particular it allowed us to observe the emergence of a matter-wave turbulent cascade in 2016 [2]. We devised a simple protocol to excite selectively the lowest-energy excitation (a long wavelength sound wave) in our uniform BEC and saw the energy propagate to smaller-wavelength, meaning higher-energy, excitations. Quantitatively, the smoking gun for a turbulent cascade was the emergence of an isotropic and scale-invariant, power-law atomic momentum distribution.

More recently, we realized that our system naturally provides us with an unusual control 'knob' for novel studies of turbulence. Our optical box has a finite depth, which is readily controlled by the trapping laser power, and the atoms whose energy exceeds this trap depth escape from the box (Fig.1b), which we can easily detect (see Fig.1c) [3]. In the context of turbulence, controlling our trap depth is akin to controlling the microscopic length scale at which the energy dissipation occurs, and counting the escaping atoms gives the particle and energy fluxes through a specific momentum-space shell. In contrast, in conventional fluids, the dissipation length scale, the so-called *Kolmogorov scale,* is set by the viscosity and cannot be easily tuned, and the measurement of the cascade fluxes has been an important outstanding problem. Our experiments allowed a direct demonstration of the counterintuitive "zeroth law of turbulence", which stipulates that as the dissipation length scale is tuned to zero, the particle flux through the cascade vanishes while the energy flux remains nonzero (see Fig.1c). The tuning of the dissipation scale also allowed us to follow in real time how the cascade front moves through momentum space in the early stages of turbulence (see Fig.1c), which was another historically important problem.

Our experiments open several further research directions. These include specific problems such as extending our methods to studies of vortex turbulence which is more closely related to turbulence in classical fluids, but also more generally understanding turbulence in the broad context of far-from-equilibrium behaviour of quantum many-body systems, which is of great relevance for the recently emerging quantum technologies. Even more generally, our work illustrates the importance of the development of new experimental platforms, which can offer a novel angle even on centuries-old problems such as turbulence.

References

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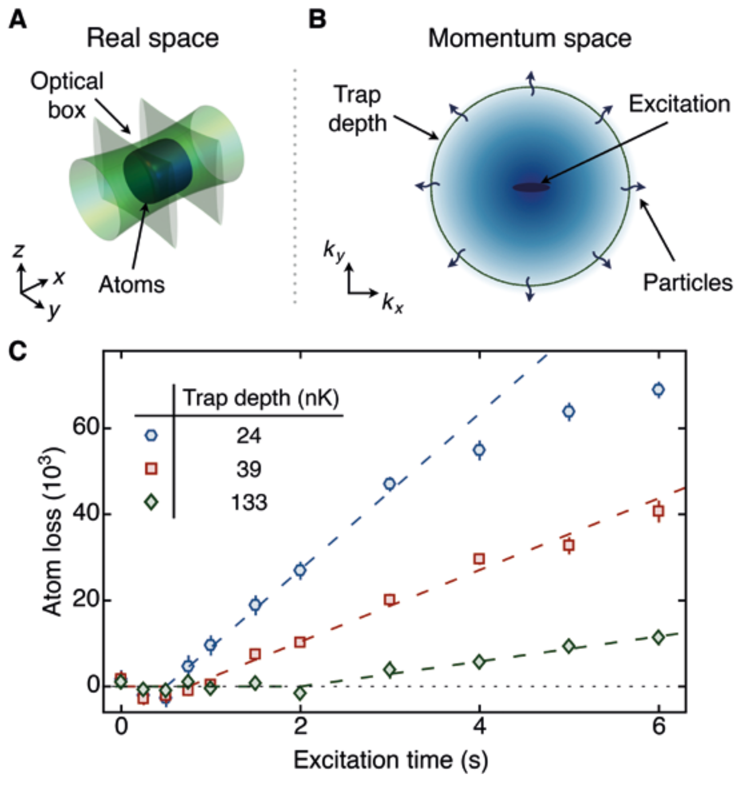
[3] N. Navon, C. Eigen, J. Zhang, R. Lopes, A.L. Gaunt, K. Fujimoto, M. Tsubota, R.P. Smith, Z. Hadzibabic, Science 366, 382 (2019)

We thank Christoph Eigen for his help in preparing the figure.

Nir Navon was elected to a Junior Research Fellow at Trinity College in 2012. In 2017, he was appointed Assistant Professor of Physics at Yale University. Zoran Hadzibabic is Professor of Physics at the Cavendish Laboratory.



(a) Sketch of our optical box in real space. The atoms (blue) are trapped in a finite-depth potential formed by laser barriers (green) in the shape of a cylindrical box. The excitation scheme is applied along the x axis. (b) Analogous sketch in momentum space. The trap depth sets the dissipation scale; when excitations propagate to that scale, dissipation occurs in the form of particle loss. (c) Atom-loss dynamics due to the turbulent cascade. Atoms lost are shown versus excitation time for different trap depths (in nK). At short times we observe no loss. This is consistent with the expectation that no losses occur before the turbulent cascade front has reached the dissipation scale. After an onset time, the loss rate is essentially constant in time. This rate is the particle cascade flux at the dissipation scale; it vanishes in the limit of infinite trap depth (i.e. vanishing dissipation scale) but in such a way that the energy flux remains constant. The trap-depth-dependent onset time gives access to the cascade front velocity in momentum space.

Renewal of the Hitachi Agreement

We are delighted to report the Renewal of the Agreement between Hitachi Ltd. and the University of Cambridge. The collaborative activity between the Hitachi Cambridge Laboratory and the Cavendish Laboratory began in 1989 to create new concept advanced electronic and optoelectronic devices.

FIG 1. The signing of the Hitachi Agreement. Those mentioned in the text are: Fourth from the left, Andy Parker; sixth from the left, David Cardwell, seventh from the left, Dr. Masakatsu Mori; eighth from the left, Dr. Norihiro Suzuki.

The collaboration has resulted in technology milestones such as the demonstration of the world's first single-electron memory device, the first single-electron logic device, measurement of the Spin-Hall effect and one of the first silicon qubit devices, the Spin-injection Hall effect, and a prototype Spin-Hall effect transistor.

A part of such works led to the development of major activity on quantum computation. Building on this 30-year partnership, the collaboration will study the basic science and cutting-edge technology needed to develop a practical quantum computer. The development of an ecosystem in this area covering activities across the University, as well as companies in the Cambridge cluster – the largest technology cluster in Europe – is a central priority for the HCL.

HCL will carry out next-generation computing research with the Cavendish Laboratory in addition to ongoing fundamental research, and the partnership will continue at the Ray Dolby Centre due to open in 2022. The new home of the Cavendish will operate as a National Facility for the UK physics community and its industrial partners. Hitachi and the University have agreed that the Ray Dolby Centre will be the ideal home for the HCL.

Andy Parker, Head of the Cavendish Laboratory said: 'HCL and the Cavendish have operated as partners for three decades, producing world-leading results and enabling great new products to be developed. We are proud that Hitachi have chosen to continue our partnership in our new facility and look forward to many more years of outstanding results.'

'Working with the Cavendish Laboratory and research partners, we have made significant advances in Si-based quantum devices over the last few years,' said Dr Masakatsu Mori, CTO of Hitachi Europe Ltd. 'The next step towards a practical quantum computer based on this technology will be to extend the research beyond the device to computer science, to include architecture and systems consideration. We are excited to be moving forward together with the University of Cambridge in this new endeavour.'

'HCL and the Department of Physics at the University of Cambridge have built a strong and successful collaboration over the past 30 years,' said David Cardwell, Pro-Vice-Chancellor for Strategy and Planning, who signed the MoU on behalf of the University. 'This new phase of the collaboration creates an important opportunity for HCL to expand and extend its network throughout the University and its many collaborators that support our joint vision for the future. The Cavendish 3 development aims to be the best research centre for physics in the world and this ambitious project represents an excellent opportunity for HCL to continue its substantial collaboration with the University of Cambridge.'

'We are proud of the relationship that has grown over the last 30 years with the University of Cambridge,' said Dr Norihiro Suzuki, Vice President and Executive Officer, and CTO of Hitachi. 'By building on this valuable partnership, the best minds in academia and industry will become part of an innovation ecosystem ensuring that the fruits of the research have true value and contribute to a better society.'

The New Cavendish - Building Progress

NEIL PIXLEY, Project Director, Bouygues UK, has kindly provided the following description of the remarkable rate of progress on the Cavendish 3 project.

Outside the site, the infrastructure upgrade works are progressing, with the drainage connection between Cavendish 2 and Cavendish 3 completed just before Christmas. Given the number of existing services at the intersection between JJ Thomson Avenue and Charles Babbage Road, this was achieved by digging a tunnel over 21m long and 5m deep (Fig. 1)!

The construction of the concrete frame of the Dolby Centre is now roughly 70% complete, with the construction of the roof (final level) starting on wing 3. Current physical and personnel resources on site include 6 tower cranes and up to 220 workers (Fig. 2) . Over 25,000 m^3 of concrete have been poured over the last 9 months.

The raft foundations are almost complete, with just a few pours left on wing 5, the public wing.

Clockwise, from top left: FIG. 1. The tunnel showing the drainage connection between Cav2 and Cav3. FIG. 2. Drone view of the site of Cav3 in February 2020. FIG. 3. The low-vibration basement ready for fit-out. FIG. 4. A mock-up of a roughly 10m cube showing the white polished concrete panels on the facades.

The wing 1 structure which houses the cryostat laboratories with their trenches and its double height columns and walls is progressing with the formwork in progress for the level 2 floor slabs. The slab for this area was poured with large areas of non-magnetic stainless steel reinforcement to ensure that the reinforcement would not be polarised by the magnets that will be used in the cryostat hall.

On wings 2 and 3, the clean rooms and deposition area are starting to take shape. The roof of wing 3 is about to start and will be the highest level of the whole structure.

The structure of the low-vibration basement is now complete and the hydraulic props have been removed, allowing the fit-out to start (Fig.3).

The site is now entering its next phase with the start of work on the envelope and internal trades. Deliveries have started for the envelope trades: the white polished concrete panels for the facades have started to arrive (Fig.4), as well as the structural steel parts and the first glazing panels.

Inside the building, the screeds have started, as well as the blockwork walls. The next trade to commence will be the Internal plumbing and drainage, starting with the rainwater pipe installation to assist in making the building watertight for other trades.

With the arrival of new trades contractors in the next few months, we anticipate that the population on site will increase to over 500 people by the end of the summer.

Abe Yoffe – Happy 100th Birthday

Abraham David Yoffe, or 'Abe' as he has always been known, was born in 1919 in Jerusalem but, when he was five, his father moved to Australia to establish a synagogue in Shepparton, in Victoria State. He went to Melbourne High School, and then to the University of Melbourne where he graduated with a Master's Degree in Chemistry in 1941.

In 1942, Abe joined the newly-founded Lubricants and Bearings Section of the Australian Council of Scientific and Industrial Research, housed in the University of Melbourne and led by Dr Frank Philip Bowden. Abe's job was to investigate the initiation and growth of explosions in nitroglycerine, and especially to understand the causes of the occasional unpredicted explosion which could completely destroy an explosives factory. Within a remarkably short period, Abe and his colleagues showed experimentally that, if bubbles as small as 0.1 mm in diameter were present in liquid nitroglycerine, its sensitivity to mechanical impact increased by about 1000 times. Since then, the role of bubbles and gaseous spaces in liquid and solid explosives has been the subject of intense investigation, with bubbles sometimes being added deliberately to industrial explosives in order to sensitize them.

In December 1944, Bowden returned to Cambridge and founded the Physics and Chemistry of Rubbing Solids (PCRS) Section in the Department of Physical Chemistry. Abe joined this new section in 1945 as Bowden's first Cambridge research student, taking advantage of a Melbourne University Travelling Scholarship which he had deferred until 1945. Abe became a member of Trinity College and obtained his Ph.D. in 1948.

After his Ph.D., with the award of a Royal Society Mackinnon Research Studentship, Abe continued to work with Bowden in the PCRS Section. In 1951 he moved to Israel for three years as a Senior Scientist at the Weizmann Institute. Abe returned to Cambridge to work with Bowden in 1955, supported by an ICI Fellowship. In 1957, the PCRS Section became part of the Cavendish Laboratory, and was re-named the Physics and Chemistry of Solids (PCS) Group; following that move, Abe was appointed Assistant Director of Research in Physics and Chemistry of Solids.

Bowden and Yoffe published two classic books based on their research into explosives - *Initiation and Growth of Explosion in Liquids and Solids* (CUP 1952, reissued in 1985) and *Fast Reactions in Solids* (Butterworths, 1958). In 1968 he was appointed to a Readership in Physics, a significant distinction as so few Readerships were awarded at that time.

Following his work on explosives, Abe's research moved into the area of solid state physics, working on the optical, electrical and luminescence properties of single crystals, amorphous solids and layered compounds. He carried out pioneering experiments on the transition metal di-chalcogenides and other low-dimensional materials. This very significant expansion of his research interests was crucial for many of the subsequent development areas within the Department, including the burgeoning area of Optoelectronics. He was Head of the PCS group from 1981 until his retirement in 1987, after which he conducted research on the physical properties of quantum dots and other low-dimensional systems. Many of Abe's students went on to have illustrious careers, including several who became Fellows of the Royal Society.

In 1949 Abe married Elizabeth Mann, a brilliant applied mathematician and daughter of Sir Frederick Wollaston Mann, Chief Justice and Lieutenant-Governor of Victoria. She died in 2014 at the age of 91. They had two sons - Gideon, and Jay who sadly died at a young age, and two daughters - Deborah and Susan. At the latest count, Abe has 13 grandchildren and 6 great-grandchildren.

Abe continues to live quietly at home in Cambridge, with the help of a live-in carer. We are delighted to send him, on behalf of everyone in the Laboratory, our warmest 100th birthday greetings.

NICHOLAS BRANSON, MUNAWAR CHAUDHRI AND JOHN COOPER

Unsung Heroes (2):

Tony Broad and the invention of the Nobel-Prize Winning X-ray Tube

Over the years, the Laboratory has been very fortunate in employing outstanding assistant and technical staff who have been crucial to its success. Another unsung hero was brought to my attention by Dr. Charles McCutchen, who carried out his doctoral research in the Laboratory in the 1950s.

His brief note to me, stimulated by the essay about Alan Blumlein in CavMag22, stated:

'Donald Anthony Gifford (Tony) Broad, communist narcoleptic from EMI's Blumlein era, believed in UFOs and telekinesis, communicated with the Czarina's adviser Rasputin, saved my principal PhD project by telling me, 'Try ammonium bifluoride', and for winning Nobel prizes with crystallography, built two water-cooled, rotating-anode X-ray generators for the Cavendish Laboratory's Medical Council Unit.'

It turned out that Georgina Ferry had posted a blog[1] about Tony Broad's death at the age of 93 in 2015. His daughter Hilary Wallace filled in more details of his employment and family history.

'(Tony) went to Technical College. He became very good at science and good with practical things too: using machines, making electrical things, woodwork; and he could mend anything. He developed narcolepsy in his teens and that affected his life from then on. He joined EMI in about 1938 with the help of his uncle who ran Harrods Music Department. His boss and scientific mentor was Otto Klemperer, cousin of Otto Klemperer the conductor.'

Georgina, who wrote an acclaimed biography of Max Perutz, describes in her blog how Tony became involved in these efforts.

He was recruited to the Laboratory by the Cavendish Professor Lawrence Bragg to build X-ray tubes for Perutz and his fellow crystallographers in the MRC Research Unit for the Study of the Molecular Structure of Biological Systems. These tubes produce X-rays by focusing a beam of electrons from a cathode to an anode, generating intense heat as well as X-rays. The heat tends to damage the anode, limiting the power of the tube. Tony made an improved tube with an anode in the form of a rotating drum that could sweep past the beam of electrons, so limiting the heat damage and making it possible to increase the tube's power. The crystals of haemoglobin and myoglobin that Perutz and his colleague John Kendrew used in their studies of protein structure were very tiny, and needed powerful X-ray sources to produce data-rich diffraction patterns. The rotating anode tube gave them a global advantage in their quest to become the first to solve protein structures at atomic resolution. For this remarkable work, which took over 20 years of effort, they were awarded the Nobel Prize in Chemistry in 1962.

Colin Robertson, who worked with Broad tubes when they were developed commercially at Elliott's in the 1960s commented:

'In my opinion the main value of Tony's work lay in the engineering design of the bearing and sealing arrangements that allowed the rotating anode drum (not a disc) to be driven and water-cooled reliably from outside the continuously evacuated enclosure of the tube itself. This resulted in a tube capable of providing much higher outputs for very long continuous periods that crystallographers needed for the advanced work they were doing.'

The increase in X-ray luminosity corresponded to a factor of 20 over the previous generation of X-ray tubes and this was crucial in enabling Perutz and Kendrew to reconstruct the molecular structures of myoglobin and haemoglobin. Tony Broad's name is mentioned in a number of Nobel Prize submissions, in books and on the internet. He also made the first small model of DNA used for demonstration at conferences by Crick and Watson. Tony made significant contributions to the design of the new MRC Laboratory for Molecular Biology (LMB), opened on the Addenbrookes site in 1962.

Tony's help in enabling Charles McCutchen to solve a technical problem in his PhD work was not an isolated example. He was always keen to make bits and pieces of equipment to enable the scientists achieve their experimental goals. Perhaps most remarkable of all was the fact that his narcolepsy meant that he typically fell asleep in his chair at least twice a day. When he was very pleased with something he had achieved, he would lose consciousness or stagger around the room trying to stay awake. Nonetheless he was working with X-ray sources, concentrated acids and machinery without anyone apparently worrying too much about safety.

Tony's story illustrates the individual brilliance and flair of many of the technical staff who have played a huge role in the scientific achievements of the Laboratory.

FIG. 1. One of the rotating anode X-ray tubes built by Tony Broad and used in the experiments carried out by Perutz and Kendrew (copright: Cavendish Laboratory, University of Cambridge).

INVITATION:
We will greatly welcome suggestions from alumni for other 'unsung heroes' from among the assistant, administrative and technical staff. This is not only essential history, but also a recognition of the key roles they have played in the work of the Laboratory.

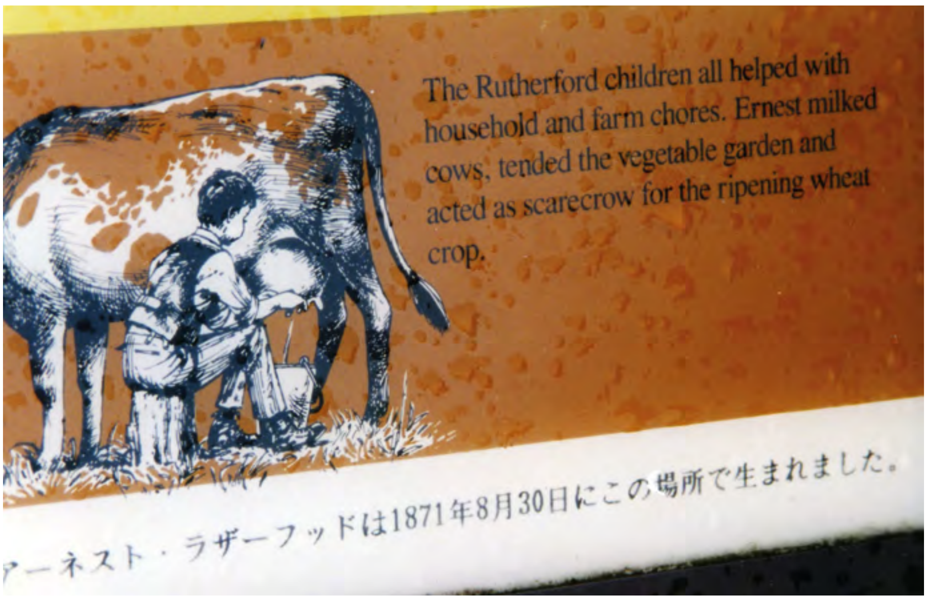
1. http://mgf.longferry.co.uk/index.php/2015/01/22/rip-tony-broad-creator-of-nobel-prizewinning-x-ray-tube

Ernest Rutherford's Birthplace

Dr. John Campbell has kindly forwarded photographs of the monument marking the location of the farmhouse where Ernest Rutherford was born at Brightwater some 20km from Nelson towards the West Coast of New Zealand. John is the author of the book *Rutherford Scientist Supreme* (1999) which provides a vivid picture of Rutherford's childhood and early manhood in New Zealand.

The house that once had stood on the site had been demolished about 1921. In 1953 an international effort was mounted to honour him, resulting Rutherford Scholarships and touring Rutherford lecturers. A bronze plaque mounted on a concrete slab on the roadside was erected to mark the birthplace but it deteriorated over the following years. In 1987, the 50th anniversary of Rutherford's death, John reported that the site was still a wasteland and a national disgrace. He then led the Rutherford Birthplace Project which raised four hundred and fifty thousand dollars to transform the site into a tranquil haven where the story of Rutherford's life and work is told through fourteen display panels and six sound stations in a garden setting. It was opened in December 1991 by Sir Mark Oliphant, one of Rutherford's most distinguished graduate students, and the Governor-General of New Zealand, Dame Cath Tizard, in the presence of all Rutherford's grandchildren.

Tree clusters in three of the corners of the memorial represent the countries which were most important in fostering Rutherford's glittering career - the totara of New Zealand, the maple of Canada and the oak of England. The front wall is of Nelson marble to showcase a local product, also reflecting his formal title of Lord Rutherford of Nelson.



Second Release of Images in the Cavendish PhotoArchive

Learning glass-blowing

The second release of historic photographs of people, equipment and events, mostly from the early history of the Cavendish Laboratory up to about 1970, is now available on line at:

https://cudl.lib.cam.ac.uk/collections/cavendish

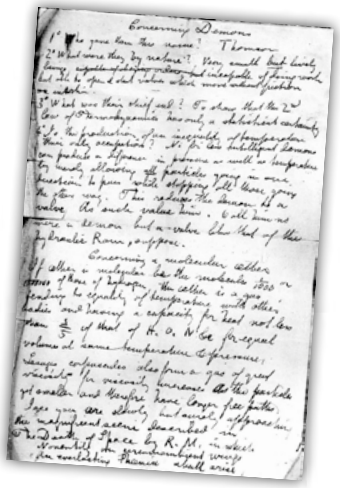
This site includes the combined first and second releases. Much of the research on the background to the images in this second release was carried out by Krzysztof Zamarski, to whom we are very grateful and who was supported by the University's Undergraduate Research Opportunities Programme (UROP).

The first and second releases include 406 images, 367 black and white and 39 in colour. The black and white images correspond to 351 P numbers because several of the P number files include more than one tab, which are labelled (a), (b) and (c).

The first release contained images of many famous pieces of equipment. In this second release, there are more images of experiments and equipment, but there are also letters and writings, more portraits of many of distinguished staff members and, in particular, many images of daily life in the Laboratory. Please pass on this information about the second release to all interested parties.

The core of the present collection is a sequence of over 1800 glass plates and film negatives compiled in the 1970s by the Laboratory Photographer at the time Keith Papworth (hence the P numbers).

In addition, there are thousands of photographs from the later period.

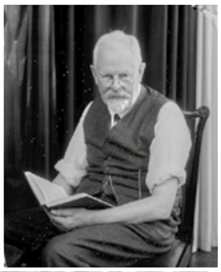
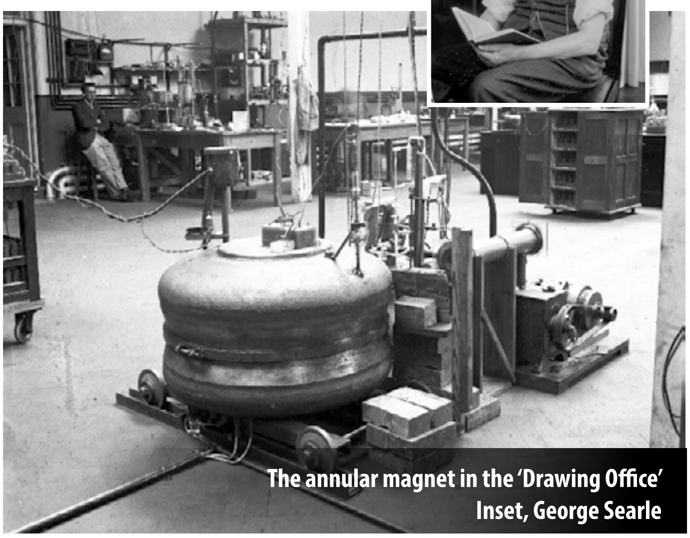

Maxwell 'Concerning Demons'

In this second release, all the black and white images have been scanned at very high resolution, thanks to the efforts of members of the Cambridge Digital Library team at the University Library. We thank them for their outstanding work.

The next major task is tracking down the negatives, positives and photographic prints of the remaining items in the Papworth catalogue. We are particularly grateful to Gloria Oglesby for her meticulous work in keeping track of the multiple sources for these materials.

For permission to use and reproduce any of these images, we follow the procedures established by the University Library's Cambridge Digital Library. Once you have selected the image of interest, please click on it to find how the material can be used and if fees are payable. These are generally charged only for material to be used for commercial purposes.

MALCOLM LONGAIR AND ISOBEL FALCONER



The annular magnet in the 'Drawing Office'
Inset, George Searle

Isaac Physics

Supporting the Next Generation of Physicists

Isaac Physics, a National project funded by the Department for Education, has been encouraging the next generation of Physicists for 7 years now. It continues to develop students' knowledge and problem solving skills in Physics through the provision of both online and printed resources and access to events and Physics specialists, irrespective of location or school, with or without their teachers' involvement. All this completely free. NICKI HUMPHRY-BAKER brings the story up to date.

Senior Physics Challenge – 29th June – 2nd July 20 – Cambridge[1]

Isaac Physics supports students through a mixture of face-to-face events and online mentoring schemes from students in Year 11 through to Year 13[2]. Students on the mentoring scheme are rewarded with a certificate in May for attempting at least 60% of the questions on the scheme. Forty of the most highly active year 12 students on the site are rewarded with an invitation to a 4-day residential course at the Cavendish, called the Senior Physics Challenge. Many of these students come from the mentoring scheme. Students experience university through lectures on Quantum Mechanics and living in a college.

Widening Participation in Cambridge

Throughout the year, Isaac Physics hosts many face-to-face events at the Cavendish in collaboration with the Cavendish Outreach Team on their Cambridge Physics Experience days and the Cambridge Admissions Office. Examples include the Physics strand of the Sutton Trust Summer School in August, a week-long residential course for students from areas of low progression to higher education. Students on the summer course learn about rotational mechanics and special relativity. They are also taken on a tour of the Mullard Radio Astronomy Observatory.

Isaac Physics Bootcamp – 28th – 30 August 20 – Cambridge[3]

Isaac Physics also runs a free 2-day residential bootcamp for students entering year 13 with backgrounds from low progression to higher education. Students may apply for a travel bursary to further reduce any barrier for attendance. The bootcamp is two days of intensive Physics problem solving to allow students to practise the Physics concepts they need to get good grades at A-level.

Dr Jessie Durk, a postdoc at Isaac Physics, analysed students' attainment and self-efficacy before and after the 2019 bootcamp. She found that for all students their self-efficacy increased by one point. Their attainment increased by an average of 10%. The increase was most pronounced for students on free school meals (FSM) whose attainment increased by 24% (8% for non-FSM students), irrespective of gender. Female students' attainment also increased by 12%, slightly higher than the average (24% of the cohort).

Isaac Physics GCSE Masterclass – 18th May 20 – IOP, London[4]

On the back of the positive outcomes of the Year 12 events, Isaac Physics is running two free half-day masterclasses for GCSE students in state-maintained schools in London. The first one is on 18th May

Students hard at work on Bootcamp

for Year 10 students and the second is on 16th September for Year 11 students. Travel bursaries and cover costs for the accompanying teachers are also available.

Teacher Symposium – 10th – 11th July 20 – Cambridge[5]

Over the years, we have also increased our support for teachers by reducing their workload through automatic marking and report generation, as well as free continuing professional development events across the country. Following last year's two free teacher symposiums in Cambridge and Manchester, we are running a residential Teacher Symposium on 10th – 11th July in Cambridge for 55 Physics teachers from across the country. The aim of this free 2-day event is to develop teachers' confidence and familiarity with the Physics resources on our site and to help them embed them in their teaching. Teachers work together to solve Physics and Maths problems and our very active teachers will be present to introduce how they went about incorporating our site into their lesson plans. The symposium is free, teachers only paying their travel costs. Teachers from state schools can apply for a travel bursary and teachers from schools in areas of low progression to higher education are eligible for cover costs as well.

Teacher Ambassadors and Embedded Schools[6]

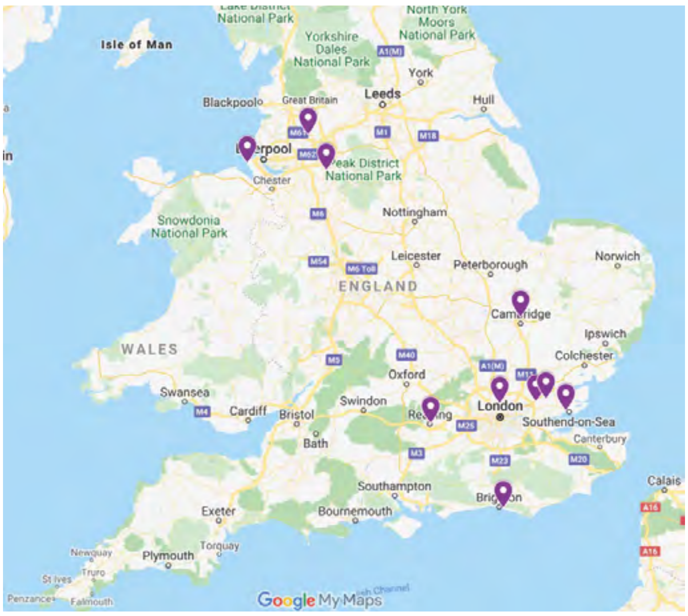
To recognise these very active users and their contribution to Isaac Physics, we introduced a new scheme called Isaac Ambassadors. We currently have 14 of them from across England and hope to welcome more. Our Ambassadors provide support for

Lisa Jardine-Wright (Director of Isaac Physics, left) with Isaac Physics Ambassadors

students and teachers in their region through CPD events and Isaac promotion activities supported by us. To become Isaac Ambassadors, teachers must be from an Isaac Embedded School. These are schools who show sustained activity on Isaac and reach a certain threshold of assignments set and questions answered throughout the year. Schools are rewarded with a certificate.

Impact

Last Spring, we ran a survey of students and teachers. We were very encouraged by the results. Teachers told us using Isaac Physics with their students saved them on average 3.8 hours per week of work. They also reported greater resilience, confidence and larger number of students considering Physics and Engineering degrees than before. Students also agreed that the site helped them become more confident in Physics and improved their grades. With such a positive response from teachers and students, we hope to continue our work of encouraging and supporting the next generation of Physicists for anther 7 years.



Map of Isaac Physics Teacher Ambassadors

Publications

All our books are full of questions for students to practise. All the questions can be found and answered on our site. They can be ordered from **www.isaacbooks.org** and cost £1, plus postage and packaging.

Mastering Essential GCSE Physics by A.C. Machacek & J. Crowter
Mastering Essential Pre-University Physics by A.C. Machacek & K.O. Dalby
Mastering Essential Pre-University Chemistry by D.I. Follows
Pre-University Mathematics for Scientists by J. Riley & M. Warner
How to Solve Physics Problems by M. Conterio

1. isaacphysics.org/pages/spc
2. isaacphysics.org/pages/mentor_menu
3. isaacphysics.org/events/28082020cambridgebootcamp
4. isaacphysics.org/events/200518_y10_gcse_bootcamp
5. isaacphysics.org/events/cpd10072020cambridge
6. isaacphysics.org/pages/isaac_embedded_schools

New appointments

We welcome the following who have joined the Laboratory in the roles indicated.

Lecturers



Dr Helena Knowles, University Lecturer, AMOP (left)
Dr Akshay Rao, Harding Lecturer, OE (centre)
Dr Chiara Ciccarelli, Harding Lecturer, ME (right)

Research Fellows

Dr Nana Wang, Marie Curie Research Fellow, OE
Dr Denis Tihon, Marie Curie Research Fellow, QS
Dr Emrys Evans, Leverhulme Trust Early Career Fellow, OE
Dr Vid Irsic, Kavli Institute Fellow, AP
Dr Nicholas Laporte, Kavli Institute Fellow, AP
Dr Robert-Jan Slager, Winton Fellow, TCM

Administrative, Technical and Support Staff

Dominic Martin, Head of Mechanical Engineering, Workshops.
Samuel Day, Finance Administrator, Mott Hub.
James Smith, Accounts Assistant, Mott Hub.
Louise Hilton, General & HR Administrator, Rutherford Hub.
James Craston, Hub General Administrator, Rutherford Hub
Samantha Selvini, EPSRC CDT Administrator, CSC.
Eileen Nugent, REF UoA Impact Coordinator, REF Office.
Mayami Abdulla, REF UoA Impact Coordinator, REF Office.
Richard Hill, Radio Telescope Technician, Battcock Centre.
Jose Pascual Ibanez Cortijo, Facilities Cleaner .
Kiala Luzala, Facilities Cleaner.

Professor Dame Athene Donald awarded a life-time achievement award for her work on gender equality

We are delighted to report that Professor Dame Athene Donald, Master of Churchill College, has been awarded the 2019 Times Higher Education Lifetime Achievement Award in recognition of her enduring and pioneering work to promote gender equality both at Cambridge and in wider academia.

Outreach Activities

The Cavendish Science Festival activities are taking place again this year, with a SciArt Soiree featuring talks from artists and scientists from 18:30 on Friday 20th March and the main Cavendish open day from 13:00 on Saturday 21st March. This features talks, the CHaOS Science Roadshow, and the School's Zone science exhibition. More details can be found at http://outreach.phy.cam.ac.uk/scifest

Our schools' events continue with a week of Cambridge Physics Experience activities from the 27th April for Y10/11 students and 11th May for Y7/8. There are many bursaries available for schools interested in attending, with more information available at **http://outreach.phy.cam.ac.uk/cpe**

This year's **Physics at Work** will take place from the 22nd to 24th September and the call for exhibitors has just gone out. If any physics-related industry or academic groups would like to exhibit, please get in touch with the Outreach Office at jbb48@cam.ac.uk. The event has an annual attendance of around 2000 students and is now in its 36th year. For more information and the exhibition archive, please visit **http://outreach.phy.cam.ac.uk/paw**

Well-being Advocates

The Department now has seven trained Well-being Advocates (see below) who will provide information, guidance and signposting on a variety of matters. These include:

- Mental or physical health concerns and any issues relating to bullying and harassment or other dignity at work concerns
- Promote University and local well-being initiatives
- Contribute to and participate in networks to facilitate greater awareness of well-being across the University.

Clare Bates
Senior HR Administrator
ceb215

Alicja Dabrowska
Research Associate
ad981

Claire Donnelly
Early Career Fellow
cd691

Andy Irvine
Senior Research Associate
aci20

Richard King
UG Laboratory Manager
rjk45

Helen Marshall
Undergraduate Administrator
hm328

John Young
Senior Research Associate
jsy1001

30 years

explore | discover | reconnect

Alumni Festival 25–27 September 2020

SAVE THE DATE

The Return of the Alumni

This is early warning that the Laboratory will be hosting a major event for all Cavendish Alumni on

Friday 25th September 2020

The event will be organized as part of the 2020 Alumni Festival. Booking for the event will be managed through the Alumni Office as part of the Alumni Festival. The whole of the Laboratory will be open from 2.00 to 6.00 pm with many opportunities to meet old friends in the research groups, lecturers, staff of the Laboratory and young physicists involved in cutting edge research.

The event will be a preview of what is to come when the new Laboratory is opened in 2022. There will be opportunities for a 'walk-around' the new Laboratory site for guests at various fixed times. All guests will have to preregister, but there will be no limit on numbers. There will be a small charge. Refreshments will be provided.

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 Gillian Weale (**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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Email: msl1000@cam.ac.uk