In 2013, the number of staff working on site was 912, more than double the number who moved to West Cambridge in 1974. This figure comprises:

- **81** University officers
- **157** visitors and emeritus staff
- **157** research fellows and postdoctoral workers
- **114** assistant and support staff
- **405** graduate students, most of whom are studying for a PhD.

The numbers of registered undergraduate students for the three-four year courses are typically:

- **1st year, Part IA** – 420. Students study three experimental subjects and mathematics in the first year.
- **2nd year, Part IB – A** 205. Physics A provides a grounding in quantum mechanics, solid-state physics, waves and optics and experimental physics.
- **2nd year, Part IB – B** 190. Physics B includes electromagnetism, dynamics and thermodynamics. Most physics students take both A and B courses.
- **3rd year, Part II** – 140.
- **4th year, Part III** – 110. This figure includes 12 students taking the Master of Advanced Studies (MASt) degree in Physics.

A total of about 860 undergraduates were taught during the 2011–12 academic year.

The annual research grant expenditure was £22M of which 70% was funded by the UK Research Councils.
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It is only five years since the last edition of the Cavendish Brochure was published and yet, looking at it today, it reads like a tale from a different world and a different epoch. The pace of change in all areas of the physical sciences has been dramatic with many new areas, which were only a gleam in the eye, now being parts of the core of the Cavendish’s research activities.

At the same time, despite the well-rehearsed problems of funding and the introduction of student fees, the Cavendish has continued to expand the scope of its activities in research and teaching. There are now well over 900 persons in the Laboratory, comprising academic staff, post-doctoral scientists, support staff and graduate students. In addition, teaching is provided for about 860 undergraduates through the four years of the physics course. It remains a real challenge to maintain freshness and originality with such large numbers of persons on site, but everyone has risen to the challenge with enthusiasm and all aspects of the programme are in a vibrant state of good health.

It is impossible to describe everything that is going on in the Laboratory and so we have adopted a slightly different approach in this edition of the brochure. We need to include factual information about the Laboratory, but at the core of the brochure has to be the physics and the frontier research challenges which are facing our colleagues. So, we have adopted the approach of describing the ‘top-level’ activities of our research groups in the various ‘Universes’ – for convenience, we divide the research activities into the Extreme, Biological, Quantum and Materials Universes. Recent highlights of the cutting edge research being carried out in each ‘Universe’ appear regularly in CavMag, our Alumni magazine. We emphasise that these are but the tip of the iceberg of the excellent science being carried out in the Laboratory. For many more details of all the research being carried out in the Laboratory, reference should be made to the web-sites of the individual research groups. Their web-addresses are given on the summary pages and we strongly urge readers to follow up their interests on these pages.

In addition to the research and teaching programmes, which remain the heart of our activities, we draw special attention to the other aspects of our work which play a prominent role in the life of the Laboratory – these include our interactions with industry, our outreach programmes to young people and our plans for redevelopment of the Laboratory.

We hope you will enjoy this snapshot of the Cavendish. We will greatly value your feedback and comments about this endeavour.
Much of our research and teaching has been driven by the desire to understand physics at its most basic level. These topics include many of the ‘big questions’ in physics:

- the formation of the Universe as we know it, from life and exoplanets to the earliest phases of the Big Bang;
- new types of fundamental interactions and symmetries in particle physics;
- quantum communication and computing;
- strongly-correlated electron systems;
- ultra-low temperature physics and new states of matter;
- nanoscience;
- the physics of new materials and polymers.

But equally challenging are researches in other cognate disciplines where physics can make innovative and paradigm-changing contributions. These include:

- the application of physics to the biological, biomedical and life sciences.
- Most recently these have been joined by a major initiative in the physics of sustainability, emphasising the role that physics plays in addressing the major problems of the global sustainability of our planet.

All these research areas attract many of the world’s brightest students who relish the opportunity to tackle some of the toughest intellectual and experimental challenges in the whole of science. Collaborations are essential in the pursuit of cutting-edge science. Current collaborative partners at Cambridge include the Departments of Chemistry, of Material Sciences and Metallurgy, the Institute of Astronomy, the Department of Applied Mathematics and Theoretical Physics and the Schools of Biological Sciences, Clinical Medicine, and Technology. Companies such as Toshiba, Hitachi and AWE work closely with us. A number of staff have been outstandingly successful in exploiting new areas of research for the benefit of industry and society.
Physicists are by nature very versatile and able to apply their skills in many ways which might seem at a remove from the traditional role of physics. Our aim is to foster the natural abilities of all students, at the same time remembering our responsibilities to society at large.

If we are required to justify what we do, we adhere to the following principles in our pursuit of knowledge:

- Practical application of physics research and teaching for the benefit of society
- Involving society in the sciences and developing its understanding of the nature and value of science
- The intellectual underpinning of physics and all cognate sciences
- The development of individuals with the ability to relate phenomena to mathematical structures in a non-trivial way
- Physics for its own sake – insights into the nature of our physical universe from the smallest to the largest scales.

It is only partly in jest that our philosophy is ‘Physics is what Physicists do’. This extensive approach has underpinned the success of the thirty Nobel Prize winners who have worked for considerable periods in the Laboratory, and whose names are associated with discoveries such as the electron, the neutron, the structure of DNA and pulsars.

To maintain this tradition of world-leading research and teaching, we need state-of-the art facilities and equipment. To this end, the Cavendish is now well on its way in carrying out a long term programme of reconstruction of the entire laboratory complex. The first fruits of this development programme are already apparent with the construction of the Physics of Medicine Building, the Kavli Institute for Cosmology and the Battcock Centre for Experimental Astrophysics as well as the advanced plans for the next phase, the Maxwell Centre which will bring together our researchers and our colleagues in other departments with industry. Our vision is described in the Development Section of this brochure.
Most of our graduates pursue successful careers in a wide range of professions including industry, teaching and the City where they can exploit their physics-based training. In 2009, we carried out a survey of alumni destinations which provided a panoramic picture of the final career destinations of our students. By selecting former undergraduate and graduate students who matriculated between 1960 and 1995, we obtain a snapshot of how our students are contributing to society at large in their final career destinations.

The left histogram, which is for students who are employed in the UK, illustrates how many of the brightest graduates in physics in the UK are making major contributions not only in the academic world, but in many diverse aspects of industry, commerce, finance, healthcare, welfare and so on. Only about 25% of our student output remains within the academic sector in their final career destinations.

Another interesting set of statistics concerns the number of former students who find employment in other UK universities. As an example of this diffusion of our students across the UK Universities, the right histogram shows the number of Physics and Astronomy Professors who were included in the 2008 Research Assessment Exercise as active research scientists and who were either undergraduate or graduate students in the Cavendish. It is apparent that the Cavendish plays a major role in educating future leaders in the academic, industrial, commercial, financial and governmental arenas.

Above:
Private Sector – Industry: Business [70], Transport [4], IT [57], Engineering [21], Natural Resources [28]
State-sector: HE [67], School [32], R&D [31], Government [26], Health/Welfare [26]
Private Sector – Services: Law [14], Finance [57], Consultancy [19], Art/Entertainment [5], Media [3], Religion [5], Other [8]
David Harding, Chairman and Head of Research of Winton Capital Management, has pledged to donate £20 million to the Cavendish Laboratory to set up and fund the Winton Programme for the Physics of Sustainability. His gift, the largest donation to the Laboratory since its creation in 1874, has created a new programme in the Physics of Sustainability, applying physics to meet the growing demand on our natural resources. The inaugural celebrations took place in March 2011 and since then the programme has developed very rapidly and successfully.

The vision is well encapsulated in the words of Peter Littlewood, Head of the Cavendish from 2005 to 2011, opposite.

“In 2100, the sources of energy on this planet will be either solar or fusion, and the preferred means to transport and use that energy will be electrical. The ‘magic’ technologies needed to deliver this new age and make them available to societies worldwide are: photovoltaics, electrical storage, refrigeration and lighting.

These technologies are particularly important for use in the tropical, developing world. There are no basic physical principles preventing breakthroughs in all these areas. Today, solid state lighting is the closest to the appropriate performance. The discovery of new materials and the development of new concepts in physics are needed to bring this vision to fruition and to make the resulting technologies available to the worldwide community.”


BOTTOM: NETWORKING DURING THE FIRST WINTON SYMPOSIUM ON ENERGY EFFICIENCY HELD ON 1ST OCTOBER 2012
Construction began in the summer of 2012 of the Cavendish Laboratory’s Battcock Centre for Experimental Astrophysics, bringing all astronomers, astrophysics and cosmologists from the Cavendish Laboratory, Institute of Astronomy and the Department of Applied Mathematics and Theoretical Physics together on a single site for the first time. This is the second phase of the consolidation of Cambridge Astrophysics, and the next phase of the Cavendish’s redevelopment plan. This development has been realised through the generosity of Cavendish Alumnus Humphrey Battcock, Managing Partner of Advent International, and of the Wolfson Foundation. We are most grateful to Humphrey and the Wolfson Foundation for their major gifts which have been matched by the University to enable the new Centre for Experimental Astrophysics to be completed by September 2013.

Humphrey has been a very strong and enthusiastic supporter of our development initiatives. In particular, he was host of a breakfast gathering at the Royal Society in 2010 for Alumni with an interest in supporting our redevelopment efforts – out of that event, the Winton Programme for the Physics of Sustainability was created. The University has agreed that the new Centre for Experimental Astrophysics should be named in his honour. The Wolfson Foundation’s gift continues its generous long-term term support of astronomy in Cambridge. The Cavendish Astrophysics group, led by Paul Alexander, is expected to move into the new building in September 2013.
The map illustrates the diversity of physics research being carried out in the Cavendish. There are many overlapping and cognate themes associated with the four universes – the extreme, biological, quantum and materials universes. The cross-fertilisation between them results in a diversity of approach and synergies for the analysis of physics problems. Theoretical and computational studies complement many of the experimental activities. The significance of each icon can be found on the research group web pages or in CAVMAG.
The Cavendish Astrophysics Group carries out a wide range of research programmes centred on four major areas each linked to experimental and instrumental programmes. The areas and the associated facilities are:

- **The Formation of Stars and Planets**
  - The Atacama Large Millimetre Array (ALMA)
  - James Clerk Maxwell Telescope (JCMT)

- **Observational Cosmology of the Microwave Background Radiation**
  - The Arcminute Microkelvin Imager (AMI)
  - The ESA Planck Surveyor Satellite

- **The Formation and Evolution of Galaxies**
  - The Low Frequency Array (LOFAR)
  - The Square Kilometre Array (SKA)

- **High Resolution Imaging of Stellar Systems and Active Galactic Nuclei**
  - The Magdalena Ridge Observatory (MRO)

These activities are supported by theoretical studies into fundamental physics applications in Relativity and Cosmology and modelling and simulation of astrophysical phenomena. With the arrival of Roberto Maiolino as Professor of Experimental Astrophysics and Didier Queloz as Professor of Physics, the instrumentation programme will expand into new projects in the IR, mm and submm wavebands.

WWW.MRAO.CAM.AC.UK

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The High Energy Physics Group's research is based upon experiments at high energy particle accelerators, with group members making up part of international collaborations working on experiments at CERN, Geneva, at Fermilab, Chicago, and on R&D activities for a future Linear Collider. The group is also interested in a range of theoretical problems with a phenomenological emphasis.

The major projects of the HEP Group at the Cavendish are:

- **ATLAS**: a general purpose detector for the LHC at CERN.
- **The Large Hadron Collider beauty experiment (LHCb)**: CP violation and b-quark physics at the LHC.
- **The Main Injector Neutrino Oscillation Search (MINOS)** at Fermilab
- **Research and Development for Future Collider Experiments**
- **Cavendish HEP Theory Group**

WWW.HEP.PHY.CAM.AC.UK

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The Extreme Universe involves the physics of the very large and the very small – the physics of the universe and particle physics. As our understanding of the nature of our universe has matured, it is now apparent that many of the key cosmological and astrophysical problems are closely related to the issues and concerns of high energy particle physics. The discovery of the Higgs boson demonstrates that scalar fields are present in the universe and fields of this nature are needed to account for the inflationary expansion of the early universe.

Biological and Soft Systems Sector
The 21st Century promises a major expansion at the interface of physics with the biological sciences and nanotechnology. These areas fall outside the conventional boundaries of the scientific disciplines of Chemistry, Physics and Biology, requiring a collaborative, multidisciplinary approach. The Biological and Soft Systems Sector (BSS) is pursuing such multidisciplinary research. Using techniques and inspirations from classical polymer physics, soft matter physics and the physics of condensed matter, we build on this foundation with exciting progress in protein folding, biomaterials, cell biophysics and nanoscience, using theoretical, computational, and experimental techniques. Much of our research takes place within the Centre for the Physics of Medicine with key strengths in:

- Properties of soft matter
- Polymers at surfaces and interfaces
- Protein aggregation and folding
- Cellular biophysics
- Modelling of biological systems
- Medical imaging and biophotonics
- Nanoscience
- Environmental Scanning Electron Microscopy (ESEM)

WWW.BSS.PHY.CAM.AC.UK

Physics of Medicine
From the structure of DNA to the development of magnetic resonance imaging, many major advances in biology and medicine have come about by collaboration between physical scientists and biologists. The Cambridge Center for the Physics of Medicine (CCPoM) is a major new expansion of research activity in these areas in the University. With a core hub in the Physics of Medicine (PoM) building and a focus on biomedical research, it aims to nucleate interactions between different disciplines as well as technology development at the interface of the physical, life and clinical sciences. A major theme of the project is to foster new methods and concepts to understand the organization and function of cells and their assembly into tissues and organs.

In addition to its function as a hub, CCPoM aims to identify talented scientists with multidisciplinary skills and interests at the early stages of their careers. PoM will support applications for independent career fellowships and provide space and research infrastructure.

WWW.POM.CAM.AC.UK
Atomic, Mesoscopic and Optical Physics

The research of the Atomic, Mesoscopic and Optical Physics Group (AMOP) is centred on the development of understanding of quantum aspects of condensed matter, from atomic Bose-Einstein condensates to semiconductor quantum dots. The group has a high turnover of projects and experiments, in response to the rapid advances in these areas. The group has four subgroups, each led by a different group member:

- **Quantum gases and collective phenomena**: superfluidity, quantum magnetism, two-dimensional systems, non-equilibrium phenomena.
- **Quantum optics and cold atoms**: quantum gases, optical lattices, single atoms, cavity QED.
- **Quantum optics and mesoscopic systems**: quantum dot spins, cavity QED, plasmonics and diamond colour centres.
- **Quantum optoelectronics**: Quantum dot spins, polymer semiconductors, coherence in semiconductors.

WWW-AMOP.PHY.CAM.AC.UK

Microelectronics

Members of the Microelectronics Group (ME) investigate electron spin physics in nanoscale electronic devices. Ultra-sensitive electrical measurement techniques, both at low-frequency and microwave frequencies, are applied for sample characterisation. The group aims to explore both classical and quantum effects in spintronics that are relevant for future technologies.

There is close collaboration with the Hitachi Cambridge Laboratory (HCL), established in 1989 as an ‘embedded Laboratory’ within the Cavendish. The aim is to create new concepts for advanced electronic/optoelectronic devices. The HCL specialises in advanced measurement and characterisation techniques, while the ME Group specialises in nanofabrication techniques. The main collaborative research topics include:

- PLEDM®
- Single Electron Devices and Nanoelectronics
- Quantum Information Processing
- Nanospintronics
- Spin transport in carbon-based, organic semiconductors

WWW.ME.PHY.CAM.AC.UK

Nanophotonics

In Nanophotonics, new materials are constructed in which atoms are arranged in sophisticated ways on the nanometre-scale. The NanoPhotonics Group (NP) is one of the most recent groups in the Cavendish and is part of the EPSRC-funded UK NanoPhotonics Portfolio in Cambridge. Research conducted at the Laboratory includes:

- Nano-plasmonics
- Polymer photonic crystals
- Semiconductor Microcavities
- MetaMaterials
- Nano - Self Assembly

Assembling nano-chunks of matter into sophisticated structures creates nano-materials with emergent properties not found in their constituents, but is a major technological challenge. One of our goals is moving from expensive fabrication of devices to elegant nano-assembly in which materials ‘build themselves’.

This convergence of NanoScience/NanoTechnology with Photonics is highly interdisciplinary across
Quantum Matter
In the Quantum Matter Group (QM) matter is studied under extreme conditions of very low temperatures, high magnetic fields and high pressures, using advanced experimental techniques. The goal of this research is to understand new forms of magnetism and superconductivity and to find electrically conducting materials with new physical properties not described within the standard models of solid state physics.

Work focuses on two major topics:

(i) the nature of quantum order in itinerant-electron systems on the border of magnetism at low temperatures;
(ii) the physics of novel superconducting materials, such as the high-Tc superconductors, graphite intercalates and the ruthenates.

Research interests include: anisotropic superconductivity, development of new cryogenic equipment, electronic structure of correlated electron materials, exotic states of matter, high-Tc materials, hydrostatic pressure, novel superconductors and quantum ferroelectrics.

Theory of Condensed Matter
The Theory of Condensed Matter Group (TCM) carries out world-leading research under three general headings:

- collective quantum phenomena,
- first principles quantum mechanical methods
- Soft matter

Our research interests constantly evolve to address new theoretical challenges, some arising from experiments performed in the Cavendish and others from elsewhere. For instance, Payne and his colleagues have developed ONETEP, a quantum mechanical code that offers state of the art accuracy, the cost scaling only linearly with system size. This allows quantum mechanical simulations of biological systems. The group has an outstanding record for training young researchers, twenty eight members of the group having taken up permanent academic appointments within the last nine years and fourteen within the last five.

Semiconductor Physics
The Semiconductor Physics Group (SP) uses semiconductor devices to investigate phenomena in fundamental physics. These investigations often revolve around the observation of effects which can only be explained by the laws of quantum mechanics and often require the control of small numbers of quantum particles such as electrons and photons. The aim is to develop semiconductor devices where quantum effects dominate the device operation, an area of work which has many future applications in science, technology and medicine, including quantum information processing, sensing and imaging technologies.

To achieve these aims the group has developed a range of sophisticated technologies for the fabrication of devices of the highest quality, much of the group’s research relying on the technique of molecular beam epitaxy (MBE). Recent work has seen the start of a number of projects based on carbon electronics. These rely on using either graphene, a single layer of carbon atoms with very unusual properties, or carbon nanotubes, a single layer of carbon atoms rolled up into a tube structure.

The group also works in collaboration with a number of other researchers at the Cavendish, Material Science and Engineering as well as with many other universities and industrial research laboratories such as Toshiba, TeraView and the National Physical Laboratory (NPL).

Examples of the research undertaken in the group are:

- Single and entangled photon sources
- Coupled electron-hole gases
- Terahertz technology
- Quantum computing using surface acoustic waves
- Carbon electronics
- Gate defined quantum dots

Detector Physics
The Detector Physics Group (DP) operates a major facility for investigating, manufacturing and testing a new generation of superconducting detectors and sensors for astrophysics and the applied sciences. Much of the work relates to large-format superconducting cameras and receivers for millimetre-wave, submillimetre-wave and far-infrared wavelengths. The Group runs one of the most advanced fabrication facilities worldwide for superconducting microcircuits, and explores the limits of quantum detection and sensing. Topics include:

- Heat flow and thermal fluctuation noise in low-dimensional structures at 100mK
- Non-equilibrium superconductivity through above-gap and sub-gap photon and phonon excitation
- Partially coherent optics and electromagnetism
- Detector materials science, mesoscopic device processing, and quantum measurement techniques
- Transition Edge Sensors, Kinetic Inductance Detectors, >1THz SIS mixers, SQUIDs, and quantum Q bits,
- Energy Absorption Interferometry for measuring coherent phenomena in energy absorbing structures

The Group works with many international agencies, and under an ESA contract is currently developing 200-20 micron ultra-low-noise imaging arrays for the Japanese cooled-aperture space telescope SPICA.

WWW.PHY.CAM.AC.UK/RESEARCH/DP
Optoelectronics

Members of the Optoelectronics Group (OE) carry out fundamental physics studies of different aspects of organic semiconductor materials. There is a particular focus upon the physics of semiconducting conjugated polymers which are long-chain organic molecules made from conjugated units such as benzene. They are inherently quantum mechanical objects with nanometer sized dimensions.

In the late 1980’s, the group discovered that these conjugated polymers behave in many respects like inorganic semiconductors and can be used in a number of semiconducting devices such as field-effect transistors, light-emitting diodes (LEDs) and solar cells. These pioneering discoveries were important milestones for the field of organic electronics, which has now developed into a large international research field with significant academic and industrial activities. The current main applications of the group’s research interests are:

- LEDs
- Solar cells
- Transistors

WWW.OE.PHY.CAM.AC.UK

Structure and Dynamics

The Structure and Dynamics Group (SD) investigates structure-property relationships in optoelectronic and energy-related materials. Armed with this knowledge, we can ‘structurally engineer’ new materials to suit a given device application.

We are primarily interested in materials which have potential use for dye-sensitized solar cells, optical telecommunications, nuclear waste storage and nano-electronic insulation. We employ a wide variety of experimental and computational techniques to realise this goal:

- Diffraction and spectroscopy
- Optoelectronics measurements
- Sample fabrication and device testing
- Non-linear optical devices are fabricated by embedding them in a polymer
- Computational techniques are seminal in predicting or rationalising our experimental work

WWW.SD.PHY.CAM.AC.UK

Surface, Microstructure and Fracture

The areas of study in the Surface, Microstructure and Fracture (SMF) Group are broadly divided into surface phenomena and dynamic material processes. The group has two main focus areas:

Fracture and Shock Physics and Surface Physics.

- The Fracture and Shock Physics group has an international reputation in the areas of material fracture, shock physics, the study of energetic materials and has pioneered the use of high-speed diagnostics.
- In the area of surface physics, we carry out fundamental research into surface structure and processes. We specialise in the experimental technique of Helium Atom Scattering (HAS), which we complement with more traditional surface techniques. Some of our most exciting work includes the development of new instrumentation.
- Our current high-profile projects include using helium-3 spin-echo techniques to study dynamics on atomic length and timescales and the development of helium atom microscopy to provide an imaging technique with a uniquely delicate helium atom probe.

WWW.SMF.PHY.CAM.AC.UK

THE MATERIALS UNIVERSE

THE MATERIAL UNIVERSE IS CONCERNED WITH THE DISCOVERY OF NEW MATERIALS WHICH ARE OF SCIENTIFIC, INDUSTRIAL AND SOCIAL IMPORTANCE. THE WINTON PROGRAMME FOR THE PHYSICS OF SUSTAINABILITY IS A PRIME EXAMPLE OF THE SOCIETAL IMPORTANCE OF THESE RESEARCHES. THE DISTINCTION BETWEEN THE QUANTUM UNIVERSE AND THE MATERIALS UNIVERSE AT ONE END OF SPECTRUM, AND BETWEEN THE BIOLOGICAL UNIVERSE AND THE MATERIALS UNIVERSE AT THE OTHER END IS BLURRED AND OVERLAPPING. THE ACTIVITIES OF THE FOLLOWING GROUPS ARE DESCRIBED UNDER THIS HEADING: OPTOELECTRONICS (OE); STRUCTURE AND DYNAMICS (SD); SURFACE, MICROSTRUCTURE AND FRACTURE (SMF); THIN FILM MAGNETISM (TFM); SCIENTIFIC COMPUTING (SC).
Thin Film Magnetism
The Thin Film Magnetism Group (TFM) is at the forefront of ultrathin magnetic film and magnetic nanostructure research. Major research areas include magnetic mesostructures and spin transport.

We investigate novel magnetic properties and spin-polarized electron transport phenomena in molecular beam epitaxy (MBE)-grown magnetic film structures, including ferromagnet-semiconductor hybrid structures. In particular we are exploring the fundamental electron spin-dependent transport processes which underpin the emerging field of spintronics and are pioneers in the development of nanomagnetism for biomedical applications.

The group is well equipped to characterise and fabricate nanomagnetic structures. We can fabricate magnetic materials using an ultra-high vacuum (UHV) multiple technique chamber, electrochemical deposition, MBE, and so on. We also have characterisation facilities such as SQUID, low-temperature MOKE, spin detector chamber, and other tools.

Scientific Computing
The niche of the Scientific Computing Group (SC) is the implementation of contemporary, cutting-edge research from physical sciences (including applied mathematics, numerical analysis and fundamental physics) and contemporary high-performance computing (HPC) methodologies, in technology, engineering and applied science applications.

Our methodologies include:
- high-resolution, shock-capturing Riemann problem-based numerical schemes,
- mesh generation and moving boundaries using Cartesian cut-cell and ghost-fluid approaches,
- hierarchical, structured adaptive mesh refinement,
- parallel computing using MPI and algorithm/code implementations on graphical processing units (GPGPUs).

Research is funded mainly by industrial projects which include companies such as ORICA Mining Services, Schlumberger Cambridge Research, Boeing Research and Technology, Jaguar Land Rover, AWE Aldermaston and BAE Systems. The projects include a wide range of topics in pure and applied physics including the determination of equations of state for hydrocodes by means of ab-initio atomic-level modelling, atmospheric dispersion of pollutants, anti-icing of aircraft, heavy oil recovery, coupled reactive two-phase flow and elastoplastic material algorithms, advanced vehicle simulation and many others of importance for industry.

The Group also supports a Masters (MPhil) degree on Scientific Computing and an advanced training programme which includes short courses and summer schools at a national and international level, such as the EPSRC Autumn Academy on High Performance Computing and the NCAS (National Centre for Atmospheric Science) Climate Modelling Summer School.

WWW.TFM.PHY.CAM.AC.UK
WWW.SCI.PHY.CAM.AC.UK
Training future generations of physical scientists continues to be a central pillar of the Cavendish’s programme. The Laboratory attracts large numbers of the brightest young scientists from the UK and overseas at both undergraduate and graduate levels. Ability at problem solving and finding original and imaginative solutions in experimental and theoretical physics are key skills which are fostered at all stages in their training.

Undergraduate Teaching
The basic course has a three- or four-year structure, over 80% of the students opting for the four-year course. Our objective is to teach and train undergraduates in the complete spectrum of experimental and theoretical physics at the highest level and to ensure that they are exposed to the many ways in which physics can bring new insights and advances in cognate fields of research.

Physics at undergraduate level is offered through the Natural Sciences Tripos in conjunction with other physical and biological sciences, and allows specialisation to occur as the students progress through the Tripos. The undergraduate course is highly regarded and exceptionally comprehensive, ranging from the purest theoretical research to new interdisciplinary subjects such as the physics of the life sciences. Physics students are able to develop their enthusiasms and ingenuity through the challenges provided by the course. In the later years of the course, students can gain examination credit in non-traditional physics areas such as entrepreneurship and education. Each year, typically, over 100 students graduate from the four-year course.

A recent innovation is the ‘Master of Advanced Study (MASt)’ degree in Physics, allowing students from outside Cambridge to study the fourth year of the undergraduate degree course for a standalone Masters.

Graduate Training
The Laboratory offers graduates from all over the world the opportunity to study with world-class researchers across, effectively, the complete spectrum of physics, from studies of the very early universe, to the physics of superglue and chocolate. Research is organised flexibly within the research groups, some administratively linked into larger sectors. However, the direction of research is determined by the initiative of the individual research workers. Students interact closely with the academic staff members and a large group of post-doctoral workers and research fellows in an intellectually stimulating environment. About 70-80 postgraduate students join the Laboratory each year, resulting in a cohort of about 400 students within the Laboratory at any one time. The courses lead to a PhD after 3-4 years or an MPhil after one year.

A complete description of the undergraduate courses is given at
WWW.PHY.CAM.AC.UK/TEACHING/COURSES.PHP

Full details concerning admission as an undergraduate or graduate student can be found at
WWW.PHY.CAM.AC.UK/ADMISSIONS
Advanced technological capabilities have always been the key to the success of Cavendish’s research programme. Excellence in experimental research demands corresponding support facilities and the Cavendish has been fortunate to employ assistant technical staff of the very highest order throughout its history. For example, without the skill and expertise of Ebeneezer Everett, J.J. Thomson would not have made the discovery of the electron in 1897.

Today, the same level of attainment and dedication characterises the work of the assistant staff in the mechanical workshops that have been dramatically enhanced over recent years in response to the increasingly complex requirements of research. The main workshop has been extensively refurbished and new offices provided. Additional capacity in Computer Aided Design has been provided and six new CNC mills and lathes have been procured while at the same time staff have undergone extensive training in their use. These developments have been essential with the establishment of new activities which have increased the demands for high-tolerance work.

A further innovation has been the provision of a new Graduate Student Workshop under the leadership of Nigel Palfrey. The training of postgraduate students in workshop practice is seen as a key element of their programme. Three new lathes, along with four mills and associated tooling have been installed in part of the former Mott workshop to provide a facility that postgraduate students can use to make items of equipment. In addition, and perhaps more importantly, they are trained in the basics of mechanical instrument design and manufacture. The feedback has been overwhelmingly positive: one student wrote ‘Walking back to the office was like going along the hall of fame as the different researchers admired our work! We all enjoyed ourselves and are happy to have learnt all these new skills.’ Alongside the practical course, similar provision is being made to provide training in basic design skills using AutoCAD. With a clear grounding in workshop practice they can appreciate the potential for innovation, the skilled support that is available to them and the need to work collaboratively towards an effective solution to their project.

As experienced staff have retired, it has proved a challenge to recruit people with all the attributes needed to support such an extensive research programme. The Laboratory has been extremely fortunate in its recent appointments in the workshops and the future is looking very promising. The staff continue to develop the long Cavendish tradition of close involvement and interaction between technician and academic in the design and delivery of new items. The Department has led the way in the University in developing an Apprenticeship Training Programme for those seeking to follow a career in mechanical engineering.
The top priority of our strategic plan for Physics is

- Practical application of physics research and teaching for the benefit of society.

This means many things, but of central importance are our interactions and collaborations with the industrial sector. As significant as any of these is the large percentage of our graduates who find employment in the industrial, commercial and public sector (see page 8). But of more immediate importance is collaborative research with industry in fostering the transfer of discoveries in physics into the new technologies and techniques needed by industry. The Laboratory has a long list of more than 100 industrial collaborators, ranging from consultancies and research grants to full-scale embedded laboratories. Particularly notable are the long-standing and fruitful partnerships with Hitachi through the Hitachi Cambridge Laboratory contiguous with the Microelectronics Group, Toshiba’s ongoing support of major projects in the Semiconductor Physics Group and AWE’s long-term commitment in the areas of materials physics.

Equally important are the spin-off companies which have been created by members of the Laboratory who have been keen to exploit the fruits of their researches. These include companies such as Cambridge Display Technologies, Plastic Logic, Teraview and Accelrys.

But this is only the beginning. In our vision of the future development of the Laboratory, there will be strong industrial collaborations involving all the Groups in the Laboratory and laboratory space will be created within each group for our industrial collaborators. An example of this vision is our plan for the new Maxwell Centre which will foster collaborations between the Winton programme in the Physics of Sustainability, which spans many groups in the Department and our industrial partners. The Centre will also house new and emerging projects with Jaguar Land Rover, Boeing, Samsung and Microsoft, many of which are directly associated with our Theory of Condensed Matter and Scientific Computing Groups. This approach is readily adapted to all the activities which will be pursued in other areas which will occupy the building such as the Biological and Soft Systems Sector and the Physics of Medicine.

Cavendish Industrial Engagement Forum

As an example of how the Laboratory is proactively seeking further industrial involvement, the Cavendish stages a series of engagement days with companies, as part of the Laboratory’s initiative to develop closer contacts with industry.

In partnership with the University’s technology transfer group, Cambridge Enterprise, the first Cavendish Industry Engagement Forum was held with BP. The primary purpose was to give Cavendish post-doctoral researchers and PhD students from the Biological and Soft Systems, Astrophysics, High Energy Physics, Thin Film Magnetism, Theory of Condensed Matter, and Surfaces, Microstructure and Fracture Groups experience of considering industry-related research problems through structured discussions over a day. BP put forward four themes in areas crucial to their business, and participants were divided into groups to look more closely at possible ways of tackling these.

Feedback from the delegates was, overwhelmingly, that they had learnt a good deal about BP’s activities, had gained a broader perspective on the needs of industry, and had greater realisation that a career outside of academia could be just as rewarding as pure academic research. Outcomes at the end of the day were three research topics which are being discussed and developed further with BP. Subsequent Fora have been held with AWE and Unilever.

“Today was something of an experiment for all of us. There was a terrific level of energy throughout the day and I think it was engaging for all those who participated. Out of the four themes, three great innovative ideas were generated and these will be progressed further over the next few weeks. The forum was a real success. It is a format we will use again.”

Andy Leonard
Vice-President
BP Cambridge
The Cavendish Laboratory is arguably the most famous physics laboratory in the world. Physics is a living and dynamic discipline which continues to expand in intellectual depth and breadth, both in its own right and as an underpinning discipline for the physical and, now, biological and life sciences.

This brochure illustrates how different today’s programme is from the traditional view of physics. Particularly significant are the many cross-linkages with other departments, notably the physics of biology, medicine and the life sciences. These ground-breaking developments require new investment in infrastructure. Resources such as high performance computing and clean rooms, and facilities for handling biological materials, have become an integral part of today’s laboratory. Collaborative working with other departments requires greater flexibility of laboratory resources. The teaching programme has also evolved in content, style and method, reflecting the changing needs of students coming to Cambridge and the changing demands of the world in which they will work upon graduation. In parallel with these changes, physics needs to become more engaged with society, raising public awareness of the discipline, particularly amongst young people. As discussed on page 22, enhancing our interactions with industry is a central plank of our future strategy.

The University has recognised that it is essential to rebuild the Laboratory to match the new requirements of the research and teaching programmes. Specifically:

- The present buildings, constructed in 1974, are no longer appropriate for the current programme nor, in light of new interdisciplinary collaborations and new investigative techniques, for the future direction of research at the Cavendish.
- The provision of state-of-the-art laboratories, offices and supporting infrastructure, including scientific computing, with all the advantages of modern design, will enable the Cavendish to maintain and enhance its contribution to physics at the highest international level.
- The reconstruction of the Laboratory will complement the University’s ambitious plans for a major contemporary science complex on the West Cambridge site.

The benefits for physics and physics-related research will be immense if we continue to attract the very best staff and collaborators at the highest international level. Through imaginative planning, the University will gain a modern vehicle for interdisciplinary research housed in state-of-the-art laboratories. The first phases of redevelopment have begun with the construction of the Physics of Medicine Building, the creation of a Kavli Institute of Cosmology and now the Battcock Centre for Experimental Astrophysics. There are ambitious plans to continue the programme of redevelopment through a phased reconstruction of the Laboratory, the next initiative being the Maxwell Centre which will focus upon collaboration with industry.

There are many opportunities for investing in these important and exciting developments for physics and science in Cambridge, which will greatly enhance our ability to contribute to science and society.

If you would like to learn more about our Development plans, please visit:

WWW.PHY.CAM.AC.UK/CAVENDISH/DEVELOPMENT

where you will find a description of the many areas in which philanthropic gifts can make an enormous contribution to the work of the Department.
Implementing the Vision

Administration
The only way of appreciating the complexity of running the Cavendish is to think of it as a business with a staff of about 1000 persons and a turnover of over £30M per year. While the Central Administration of the University sets the rules, all responsibility for the proper management, governance and administration of the Department lies with the Head of Department who in turn is dependent upon the support of senior staff and, particularly, of the Administration Section which is responsible for all aspects of finances, human resources, health and safety and all the other functions required of a medium-sized business.

Since 1948, the Department has operated on a devolved basis, based upon a research group structure. Each research group has its own culture and strategy matched to the cutting edge of contemporary science in that area. A critical component of the administrative structure is therefore the team of research group administrators, based within the groups, who carry our many of the routine yet vital administrative tasks. This is all in line with the Department’s policy of keeping support resources as close to researchers as possible. The group administrators therefore face two ways: towards the staff in their group and towards central administration of the Department.

The Departmental Secretaries are members of the Senior Management Group and are thus involved not just in decision making about the present but also in strategic policy-making across the Department, feeding into developments at the School of the Physical Sciences.

Looking after our staff
The overwhelming focus of Administration Section’s work is on people and their career progression. We give graduate students the best advice we can, but we also encourage them to look broadly at the many outstanding career opportunities outside academic life in industry, the city, government and so on where the majority of our graduates in fact find permanent employment (see the Section on Training, page 8). We also have a very experienced core of support staff for whom we make provision for career development. For all our staff, a major dimension of the Laboratory’s work is aimed at providing the training and development opportunities for their next career stage.

The Department’s Juno Champion status and its Athena Swan Silver Award have given all our activities a clear focus, as the Laboratory seeks to improve the working environment and career opportunities for all. This activity is led by the Department’s Personnel Committee, with representativies from all staff groups. Academic life imposes as severe pressures as any other career on home life and other activities. The Personnel Committee has recently published a leaflet ‘Families at the Cavendish’ highlighting the broad range of provision which the University makes for those with caring responsibilities. This runs alongside the activities of the Cavendish Social Committee which organises events such as the summer barbecue for staff and families.

IOP
Institute of Physics

Juno Champion

PROJECT JUNO RECOGNISES AND REWARDS THE PROGRESS THAT PHYSICS DEPARTMENTS ARE MAKING TO ADDRESS THE UNDER-REPRESENTATION OF WOMEN AT ALL LEVELS IN UNIVERSITY PHYSICS. THE DEPARTMENT’S JUNO CHAMPION STATUS IS THE HIGHEST LEVEL OF ATTAINMENT WITHIN THE SCHEME.

Athena Swan
Silver Award

THE ATHENA SWAN CHARTER RECOGNISES AND CELEBARTES GOOD EMPLOYMENT PRACTICE FOR WOMEN WORKING IN SCIENCE, ENGINEERING AND TECHNOLOGY (SET) IN HIGHER EDUCATION AND RESEARCH. THE DEPARTMENT HAS BEEN AWARD AN ATHENA SWAN SILVER AWARD IN RECOGNITION OF ITS ACHIEVEMENTS IN IMPROVING THE WORKING LIFE AND EMPLOYMENT PRACTICES FOR EVERYONE, ESPECIALLY WOMEN.

MEMBERS OF THE ASSISTANT STAFF IN 2010, INCLUDING ADMINISTRATIVE, WORKSHOP AND SUPPORT PERSONNEL
Educational Outreach to young people is an essential part of the work of the Laboratory. The Educational Outreach Office has the prime objective of stimulating interest and widening participation in physics amongst 11-19 year olds.

Physics at Work
The flagship event organised by the Cavendish is the annual Physics at Work exhibition, which provides an opportunity for secondary school pupils to view the many uses of physics in everyday life. Nearly 2500 young people visit the Laboratory over a three-day period. During their half-day visit each group explores a number of exhibits which demonstrate the breadth of the Laboratory’s research programme, the applications of physics in everyday life and the career opportunities available for physicists in industry. The proof of the event’s success is evident from its longevity (28 years and counting!) which is mirrored in the large number of schools returning each year: bookings are often full within a fortnight of opening. Teachers comment that as a result of attending this event, ‘Pupils now see physics as a vocational choice as well as an academic one’ and ‘Even the students with no interest in Physics come away with a positive image of the subject’.

Working with schools
Helping to educate school physicists is regarded as an important responsibility at the Cavendish. Afternoon workshops for school pupils are examples of activities which benefit and inspire both young people and their teachers. The development of these links is crucial in order to enhance school-level appreciation of physics and provide vital physics resources for schools. As part of the University’s increased responsibility to encourage applicants from areas of society under-represented at Cambridge, the Laboratory has recently extended its programme of workshops to address this specific goal. The sessions are arranged in collaboration with the Colleges through the University’s local area link scheme.

Our students, both undergraduate and postgraduate, are often involved in these workshops. There are further opportunities for them to engage with school pupils through taking the Part II (third year) Physics Education module for which they receive examination credit. This module involves half a day per week for a term in schools where they work on the planning, delivery and evaluation of a lesson as part of the school’s curriculum. More informally students also engage with local schools through programmes such as Stimulus. It is always exciting to see some of these students, typically 1/3 of each year’s physics education cohort, move on to teacher training and then into schools as teachers - they even bring their pupils back to Physics at Work.

Senior Physics Challenge
To address the problem of the nationwide decline of physics student numbers, the Cavendish has created a major ‘schools physics development programme’ and ‘university access initiative’ called the Senior Physics Challenge. A number of the most able school and college pupils, with aptitude in mathematics and an incipient passion for physics, are tending not to opt to study physics at university. Their misconceptions about physics at university level arise from the loss of much mathematically-based problem solving from the school curriculum. The activities and materials produced for this programme dispel some of the myths about the real nature of studying physics at university. This event, now in its 7th year, takes place over four days at the beginning of each July. Pupils are selected by ability and by recommendation from their school. They sample University life by being fully immersed in the Cambridge environment, they stay in Colleges and come to the Cavendish for lectures, examples classes and experimental sessions.

This programme has been extended in recent years to include a ‘Physics Teachers’ Residential’, where some of the same material is shared with teachers for them to take back to their schools, thus extending the reach of programme quite significantly.

Sutton Trust Summer School in Physics
The Sutton Trust has supported Summer Schools in Physics for many years now. Physics is one of a number of one-week courses run under the scheme which gives selected year 12 students the opportunity to experience what it is like to study physics as an undergraduate at Cambridge. As with the Senior Physics Challenge, pupils experience a full week of lectures, practical and examples classes as well as supervisions in the subjects they study during
the week. In addition, they live in the colleges and experience all aspects of student life in Cambridge. Twenty students are selected from underprivileged parts of the community and from non-academic backgrounds. We have found that they are outstanding and most of them go on to be accepted at Universities, many of them coming to Cambridge.

**High Energy Physics Masterclass**
The High Energy Physics Group regularly hosts one-day events to highlight some of the latest developments in Particle Physics research. These events are primarily intended for those students taking modules which include particle physics at A or AS level, but are also open to any physics student or teacher interested in studying or teaching the subject. The days are a mixture of short talks by research physicists and practical sessions.

**The General Public**
Every year during the University’s hugely popular Science, Engineering and Technology Festival, the Laboratory is inundated by young people and the general public, who carry out hands-on experiments, attend lectures and construct science toys. This is in addition to the many public engagement activities carried out by staff around the country and through the media, such as Athene Donald’s blog.

Details of the many activities promoted through the Outreach programme can be found on our Outreach Website at:

WWW-OUTREACH.PHY.CAM.AC.UK
**Up until 1874**
There was no organised course of study in experimental physics in Cambridge. The outstanding experimental contributions of Isaac Newton, Thomas Young and George Stokes were carried out in their colleges.

**1871**
The Chancellor of the University, William Cavendish, Seventh Duke of Devonshire, provided £6,300 to meet the costs of building and equipping a physics laboratory, on condition that the Colleges funded a Professorship of Experimental Physics. James Clerk Maxwell appointed the first Cavendish professor.

**1874**
Maxwell's legacy was the design and equipping of the new Laboratory which opened in this year.

**1875–1923**
James Dewar elected Jacksonian Professor of Natural Philosophy.

**1879**
Maxwell was succeeded by John William Strutt, Lord Rayleigh, (Nobel 1904) who was responsible for setting up a systematic course of instruction in experimental physics, as well as Rayleigh scattering, Rayleigh criterion, Rayleigh-Jeans law, Rayleigh-Taylor instability, etc.

**1881**

**1884**
Joseph John (JJ) Thomson succeeded Rayleigh as Cavendish Professor.

**1895**
The University allowed students from outside Cambridge to study to the degree of BA (research). Among the first generation of physics graduate students were Ernest Rutherford from New Zealand and John Townsend from Dublin.

**1896**
William Pye, superintendent of the Cavendish workshop, founded the W.G. Pye & Co. Ltd. as a part-time business making scientific instruments. From the 1920s the company became makers of domestic radio and television, television transmitting equipment and electrical products.

**1897**
The discovery of the electron by JJ Thomson (Nobel 1906).

**1898**
Rutherford’s discovery of the distinction between $\alpha$ and $\beta$ rays in radioactive decays.

**1895–1913**

**1900**
Rutherford’s elucidation of nuclear disintegration chains (Nobel 1908 Chemistry).

**1901**
Owen Richardson (Nobel 1928) discovers the law of thermionic emission.

**1911**
Charles Barkla (Nobel 1917) discovers the K and L series in X-ray line spectra.

**1912–13**
William and Lawrence Bragg (Nobel 1915) discover Bragg’s law of X-ray diffraction.

**1915**
Geoffrey (G.I.) Taylor wins the Adams Prize for ‘Turbulent Motion in Fluids’, a subject he pioneered over the succeeding decades.

**1919**
JJ Thomson succeeded by Rutherford as Cavendish Professor. The discovery of artificial nuclear transformations induced by $\alpha$–particles by Rutherford.

**1920**
Francis Aston (Nobel 1922 Chemistry) discovers the isotopes of the chemical elements.

**1924**
Edward Appleton (Nobel 1947) determines the height and properties of the ionosphere. Jacksonian Professor of Natural Philosophy (1936-1939).

**1925**
Patrick Blackett (Nobel 1948) photographs nuclear transformations induced by $\alpha$–particles with the Wilson Cloud Chamber.

**1927**
George Thomson (Nobel 1937) demonstrates electron diffraction.

**1930**
Eryl Wynn-Williams invents the Scale of Two Counter.

**1932**
James Chadwick (Nobel 1935) discovers the neutron.

**1932**
John Cockcroft (Nobel 1951) and Ernest Walton (Nobel 1951) carry out the first controlled nuclear disintegrations induced by accelerated high energy particles. Demonstrated for the first time that $E = mc^2$ experimentally. Cockcroft Jacksonian Professor of Natural Philosophy (1939–1946).
1933 Opening of the Mond Laboratory for low temperature physics led by Piotr Kapitsa (Nobel 1978).

1930s Norman de Bruyne invents glues for use in aircraft structures, including the Mosquito, and founds the Cambridge Aeroplane Construction Co. His Aero Research Company was taken over by the Swiss Ciba-Geigy company in 1948.

1934 First X-ray images of a protein by John Bernal.

1934 Geoffrey Taylor and Egon Orowan independently realise that the plastic deformation of ductile materials can be explained by the theory of dislocations.

1936 Herbert Austin, the car manufacturer, donates £250,000 to build the Austin Wing of the Laboratory. Building completed in 1940 for war work and handed back to the University in 1945.

1937 Kapitsa, having returned to the USSR, and Jack Allen and Don Misener in the Mond Laboratory discover superfluidity in liquid helium.

1938 Lawrence Bragg succeeds Rutherford as Cavendish Professor. The development of X-ray diffraction for the study of the structure of biomolecules and of deformed metals.

1939 Philip Bowden and David Tabor develop the theory of friction, emphasising the importance of surface roughness for bodies in contact. Tabor invents the term tribology.

1945 Dorothy Hodgkin (Nobel 1964, Chemistry), former graduate student of Bernal, determines the structure of penicillin at Oxford University.

1945 onwards Development of radio astronomy and the implementation of aperture synthesis techniques led by Martin Ryle (Nobel 1974).

1946 Ellis Cosslett sets up the electron microscopy group.

1947–1972 Otto Frisch elected Jacksonian Professor of Natural Philosophy.

1948 Formation of the Group organisation of the Laboratory by Bragg with separate groups in nuclear (Frisch), radio (Jack Ratcliffe), low temperature (David Shoenberg), crystallography (Will Taylor), metal (Egon Orowan) and mathematical physics.

1949 onwards Norman Ramsey (Nobel 1987) at Harvard invents the separated oscillatory fields method leading to its use in the hydrogen maser and other atomic clocks.

1950 Meteorological Section (Thomas Wormell) and Napier Shaw Library transferred from the Observatories to the Cavendish.

1953 The determination of the double-helix structure of the DNA molecule by Francis Crick and James Watson (both Nobel 1962, Physiology or Medicine).

1953–7 Jefrey Courtney-Pratt invents image converter high speed photography and the use of image detection techniques in high speed photography.

1954 Bragg succeeded as Cavendish Professor by Nevill Mott (Nobel 1977). Pioneering studies in condensed matter physics, including his work on amorphous semiconductors.

1954 Mott brought John Ziman with him from Bristol to form the Solid State Theory Group, later to become the Theory of Condensed Matter Group.

1956 W.H. (Joe) Vinen and Henry Hall make the experimental discovery of the quantisation of vortex motion in superfluid helium.

1956 onwards Allan Cormack (Nobel 1979) at University of Cape Town begins investigations of X-ray computer tomography leading to practical CT scanners.

1956 Peter Hirsch and colleagues develop diffraction contrast transmission electron microscopy to study crystal defects following on from Bragg’s X-ray microbeam diffraction project.

1956 James Menter makes the first direct observations of crystal lattices by transmission electron microscopy and the first observation of an edge dislocation within such a lattice.

1957 Pippard’s experimental determination of the Fermi surface of copper.

1957 Opening of the Mullard Radio Astronomy Observatory at Lord’s Bridge.
1957 onwards
Bowden heads the Physics and Chemistry of Solids Group, transferred from Physical Chemistry to the Cavendish: research on solid explosives, friction and lubrication with Tabor, Abe Yoffe and John Field.

1958
John Kendrew determines the structure of myoglobin by high-resolution X-ray crystallography.

1959
Max Perutz determines the structure of haemoglobin by high-resolution X-ray crystallography.

1962
Spin-off of the MRC Laboratory of Molecular Biology as a separate department on the Addenbrooks site. Since then, 9 Nobel Prizes, shared by 13 scientists, for key discoveries made in Cambridge: Perutz (Nobel 1962, Chemistry), Kendrew (Nobel 1962, Chemistry), Hodgkin (Nobel 1964, Chemistry), Aaron Klug (Nobel 1982, Chemistry).

1962
Brian Josephson (Nobel 1973) predicts the existence of a supercurrent penetrating through a tunnel barrier, the Josephson effect.

1964
Frisch builds the first version of SWEEPNIK. In 1969, the perfected machine was sold commercially by the spin-out company Laser Scan Limited.

1965 onwards
Mott (Nobel 1977) investigates the properties of amorphous semiconductors. Phil Anderson (Nobel 1977) investigates the electronic structure of magnetic and disordered systems.

1965
First radio images made with the Cambridge One-mile Telescope, the first fully steerable earth-rotation aperture synthesis radio telescope.

1968
Discovery of neutron stars as the parent bodies of pulsars by Jocelyn Bell-Burnell and Anthony Hewish (Nobel 1974).

1971
Pippard appointed successor to Mott as Cavendish Professor. He was Head of Department (1971–1979).

1972–1990
Alan Cook appointed Jacksonian Professor. 1979–1984 Head of Department.

1972
Inauguration of the Ryle 5-km radio telescope and its first radio images.

1973
Tabor and Jacob Brachlachivi measure the van der Waals forces between surfaces with the surface force apparatus (SFA) down to separations of 1.5nm.

1974
Move of Cavendish Laboratory to West Cambridge.

1974
Foundation of Energy Research Group by Richard Eden.

1975
Sam Edwards and Anderson on the theory of spin glasses.

1978
Edwards and Masao Doi on the reptation motion of polymers.

1978
Invention of phaseless aperture synthesis by John Baldwin and Peter Warner.

1980
Archie Howie, Mick Brown and colleagues develop the high angle dark field imaging method in Scanning Transmission Electron Microscopy.

1983
Haroon Ahmed moves from Engineering to the Cavendish to found the Microelectronics Research Centre.

1983
High Energy Physics group participates in the UA2 experiment at CERN which measured precisely the masses of the W and Z bosons.

1984–1995

1984
Formation of Semiconductor Physics Group under Michael Pepper, one of three authors of the 1980 paper that won the Nobel Prize for the quantum Hall effect for Klaus von Klitzing.

1985 to date
Mike Payne author of the first principles total energy pseudo-potential code CASTEP. In 1994, code commercially developed and marketed by Accelrys.

1987
Optoelectronics (OE), Polymer and Colloids (P&C) and parts of the IRC in superconductivity created as separate groups originating from the PCS Group.

1988
Richard Friend’s Optoelectronics research group the first to demonstrate the use of semiconducting polymers in the operation of field-effect transistors.

1988
Quantisation of conductance in 1D semiconductor structures discovered by the Semiconductor Physics Group.

1989–1997
Howie: Head of Department.

1989
Opening of the IRC in Superconductivity Building.

1989
The Hitachi Cambridge Laboratory established as an embedded laboratory within the Cavendish.

1990 The first semiconducting polymer light-emitting diodes by the Optoelectrics Group.


1991 Foundation of Toshiba Cambridge Research Centre, now known as the Cambridge Research Laboratory (CRL) of Toshiba Research Europe.

1993 Invention of a probe for the measurement of single electrons in a quantum dot by the Semiconductor Physics Group.

1995–present Friend elected Cavendish Professor.

1995 The first efficient semiconducting polymer photovoltaic diodes and optically-pumped lasers in the following year by the Optoelectrics Group.

1996 Baldwin and COAST - the first long-baseline optical aperture synthesis interferometer obtains high-resolution images of the surfaces of stars other than our Sun.

1997 Ondrej Krivanek’s construction of the first aberration-corrected scanning transmission electron microscope (STEM).

1998 Athene Donald appointed first female Professor of the Physical Sciences in Cambridge.

1998 Gil Lonzarich demonstrates the similarity of the phase diagrams for heavy fermions in CeIn₃, superconductors near the boundary of magnetism.

1998 Athene Donald begins development of Environmental Scanning Electron Microscopes for the study of wet biological and medical samples.

2000 The first directly-printed polymer transistor circuits by Henning Sirringhaus.

2000 Discovery of superconductivity in the ferromagnet UGe₂ under applied pressure by the Low Temperature Physics Group.

2000 Development of ONETEP computational codes for very large molecular simulations by Payne and colleagues.

2000–2004 Precise measurements of the angular power-spectrum of the Cosmic Microwave Background Radiation with the Very Small Array by Astrophysics Group.

2001 Pepper becomes Scientific Director of the spin-out company TeraView to exploit advances in Terahertz technology.

2002 Biological Physics developed as a new theoretical and experimental initiative.


2004 Surface Physics Group: ³He Spin-Echo Spectroscopy opens up the study of surface dynamics.


2006 Demonstration of a triggered source of pairs of entangled photons by the Semiconductor Physics Group and Toshiba.


2008 David Mackay’s ‘Sustainable Energy – Without the Hot Air’.

2008 Opening of Physics of Medicine Building.

2008 High Energy Physics Group’s silicon detector system installed in the LHC at CERN.


2010 Appointment of Ben Simons to the Herschel Smith Professorship of the Physics of Medicine.

2011 Inauguration of the Winton Programme for the Physics of Sustainability: Friend appointed first director.

2011 Ben Simons’ group defines the strategies for homeostatic stem-cell self-renewal in adult tissues.

2012 Use of Bose-Einstein condensation at the AMOP Group at ultra-low temperature in a standing wave optical lattice to simulate and clarify complex phenomena of condensed matter physics.

2012 High Energy Group participates in the discovery of the Higgs boson.

2013 Astrophysics Group participates in analysis of the ESA Planck satellite data in the precise determination of cosmological parameters and tests of the ΛCDM model.