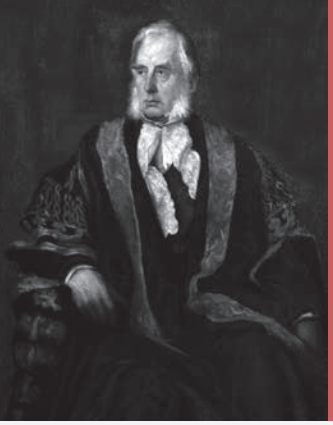
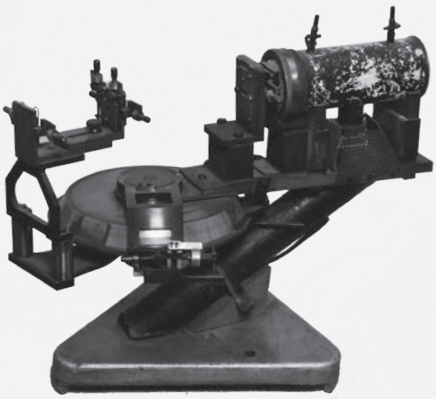


A Brief History of the Cavendish Laboratory

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	Foundation of the **Cambridge Scientific Instrument Company** by **Horace Darwin** and **Arthur Dew-Smith.**
1884	**Joseph John (JJ) Thomson** succeeded **Rayleigh** as Cavendish Professor.
1895	The University allowed students from outside Cambridge to study for 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 α and β rays in radioactive decays.
1895–1913	The invention and perfection of the Wilson Cloud chamber by **Charles (C.T.R) Wilson** (Nobel 1927). Jacksonian Professor of Natural Philosophy 1925-1935.
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 α–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 α–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.
1946 onwards	Development of radio astronomy and the implementation of **aperture synthesis** techniques led by **Martin Ryle** (Nobel 1974).

IMAGES, FROM LEFT:

W.H. BRAGG'S X-RAY SPECTROMETER SENT TO HIS SON W.L. BRAGG IN CAMBRIDGE IN 1914.

A CROOKES' RADIOMETER FROM THE 1870s.

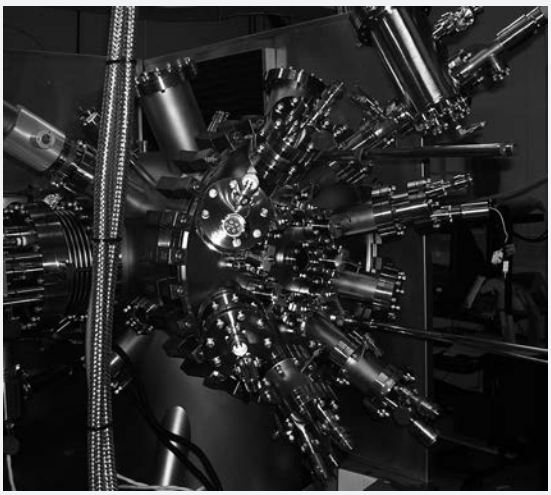
WATSON AND CRICK'S HALF-SIZED MODEL OF THE DNA MOLECULE.

WYNN-WILLIAMS' SCALE OF TWO COUNTER.

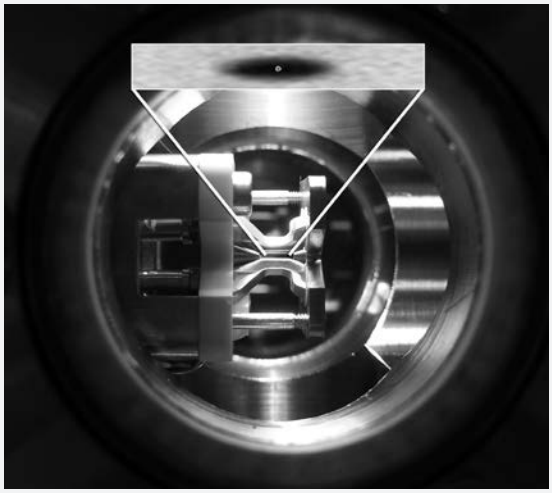
1946	**Ellis Cosslett** sets up the electron microscopy group.
1947–1972	**Otto Frisch** elected Jacksonian Professor of Natural Philosophy.
1948	Formation of the Group organisation of the Laboratory by **Bragg** with separate groups in nuclear (**Frisch**), radio (**Jack Ratcliffe**), low temperature (**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	**Brian Pippard** proposes non-local theories of electromagnetic response in normal metals and superconductors, the latter predating the theory of superconductivity of **Bardeen, Cooper** and **Schrieffer.**
1953–7	**Jeofry 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 Israelachvili** 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	**Edwards** appointed Cavendish Professor. Head of Department 1984–1989. Soft condensed matter research leads to the development of major initiatives in biological physics and the physics of medicine.
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.



1989–2000	**High Energy Physics Group** participate in analysis of LEP data from CERN confirming the standard model with high precision.
1990	The first semiconducting polymer light-emitting diodes by the **Optoelectrics Group**.
1991–2008	**Malcolm Longair,** Jacksonian Professor. Head of Department 1997–2005.
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 measurment 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 $CeIn_3$ 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 UGe_2 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**.



IMAGES, FROM LEFT:

THE FINAL PRODUCTION MODEL OF SWEEPNIK

A VECCO MOLECULAR BEAM EPITAXY SYSTEM USED PRIMARILY FOR THZ APPLICATIONS

AN ULTRAHIGH VACCUM CHAMBER IN WHICH A SINGLE ION IS TRAPPED IN THE SMALL HORIZONTAL GAP

AN ARTIST'S IMPRESSION OF THE ESA PLANCK SATELLITE IN ORBIT

2001	**Pepper** becomes Scientific Director of the spin-out company TeraView to exploit advances in Terahetz technology.
2002	**Biological Physics** developed as a new theoretical and experimental initiative.
2002	Invention of the terahertz quantum cascade laser by **Semiconductor Physics Group** and the Scuola Normale Superiore, Pisa.
2004	**Surface Physics Group:** ^{3}He Spin-Echo Spectroscopy opens up the study of surface dynamics.
2005	**Peter Littlewood** Head of Department: 2005–2010.
2006	Demonstration of a triggered source of pairs of entangled photons by the **Semiconductor Physics Group** and Toshiba.
2008	Formation of the **Optical Physics (AMOP) Group.**
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.
2008–2013	**James Stirling** Jacksonian Professor. Head of Department 2011–2013.
2009	**Jeremy Baumberg** leads the **Nanophotonics Group** and Cambridge Nano Doctoral Training Centre.
2010	Appointment of **Ben Simons** to the Hershel Smith Professorship of the Physics of Medicine.
2011	Inauguration of the **Winton Programme for the Physics of Sustainability: Friend** appointed first director.
2011	**Ben Simon's** 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.

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Cover image: Kelvin Fagan