

MALCOLM LONGAIR

MAXWELL'S ENDURING LEGACY

A SCIENTIFIC HISTORY OF
THE CAVENDISH LABORATORY



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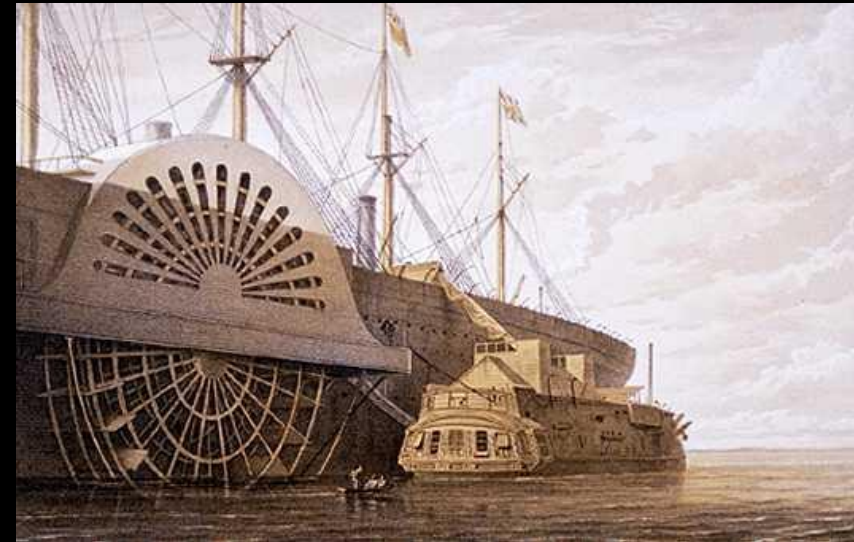
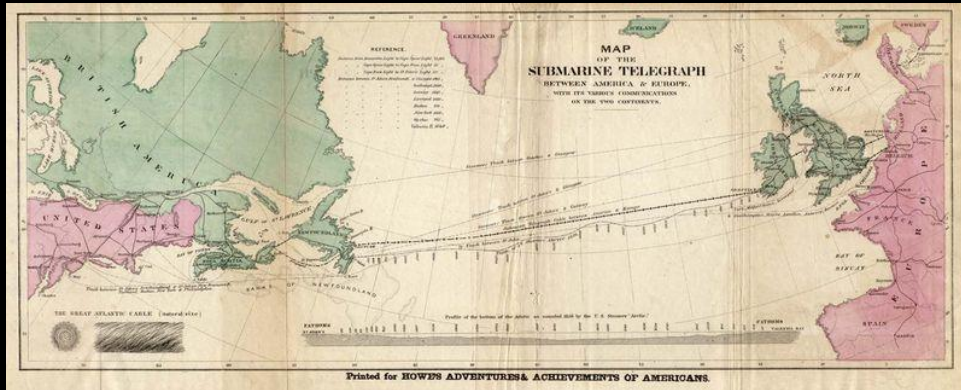
ALBERT, THE PRINCE CONSORT

Albert, the Prince Consort and Chancellor of Cambridge University, took on the role of promoting industry and science. He was convinced of the need for the reform of the University and proposed a number of reforms in 1848. The proposals were generally welcomed by members of the University, but the more conservative element was in opposition:

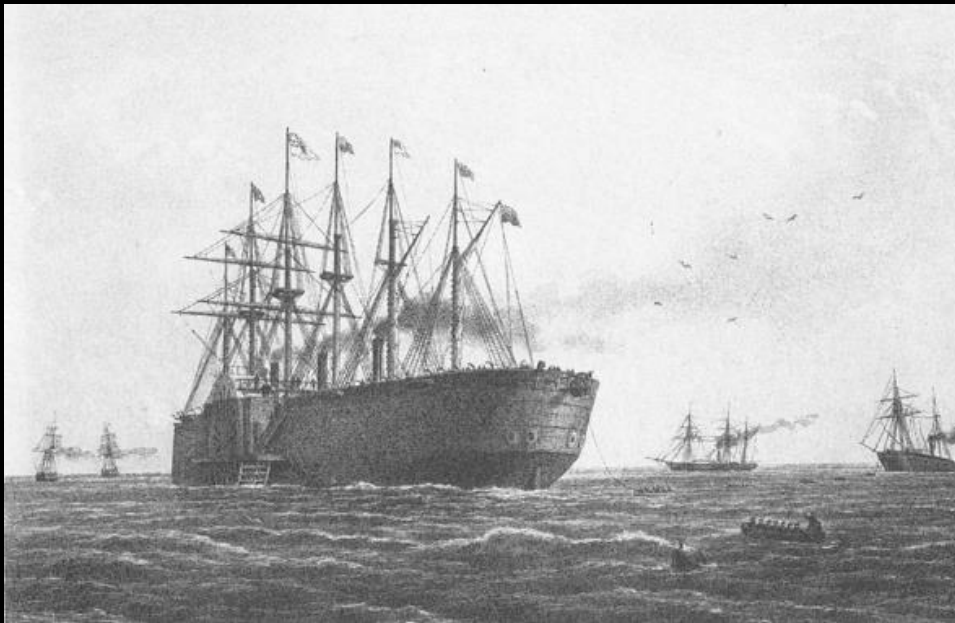
‘... mathematical knowledge is entitled to *paramount* consideration, because it is conversant with indisputable truths ... such departments of science as Chemistry are not proper subjects of academic instruction ...’ (Whewell)



THOMSON AND THE TRANSATLANTIC CABLE



The Great Eastern laying the transatlantic cable.



Thomson's analysis showed the key role physics and theoretical physics could play for the benefit of industry and commerce.

UNIVERSITY EXPERIMENTAL PHYSICS LABORATORIES

Institution	Year founded	Founder–Director
University of Glasgow	1866	William Thomson
University College, London	1866	George C. Foster
University of Edinburgh	1868	Peter Guthrie Tait
King's College, London	1868	William G. Adams
Owens College, Manchester	1870	Balfour Stewart
University of Oxford	1870	Robert B. Clifton
Royal School of Mines (later Royal School of Science)	1872	Frederick Guthrie
Royal School of Science, Dublin	1873	William Barrett
Queen's College, Belfast	1873	Joseph D. Everett
Cambridge University	1874	James Clerk Maxwell

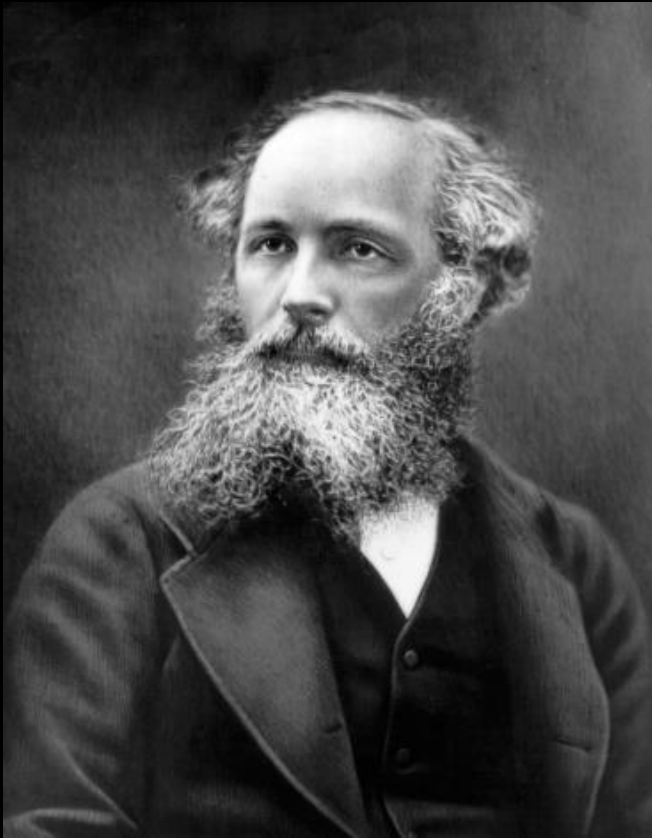
WILLIAM CAVENDISH



William Cavendish, the Seventh
Duke of Devonshire

Physics was only recognised as an academic discipline in Cambridge in the second half of the 19th Century. There was no experimental physics laboratory. In 1871, this was achieved through the generosity of the Chancellor of the University, William Cavendish, Seventh Duke of Devonshire, who provided £6,300 from his own resources to meet the costs of building and equipping a physics laboratory. To match this, the Colleges provided the funding for a Professorship of Experimental Physics.

JAMES CLERK MAXWELL



James Clerk Maxwell was elected the first Cavendish Professor in 1871.

Maxwell was responsible for the design of the Laboratory and the equipping of its laboratories.

His vision for the research and teaching programme is splendidly set out in his inaugural lecture.

MAXWELL'S INAUGURAL LECTURE

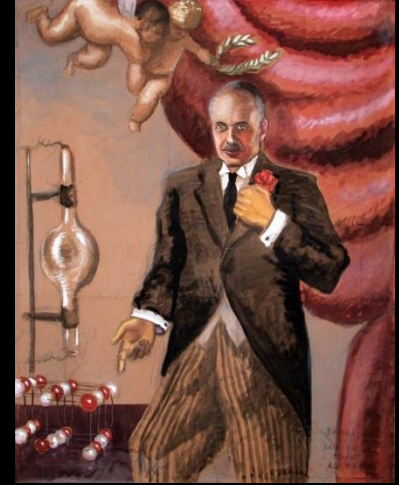
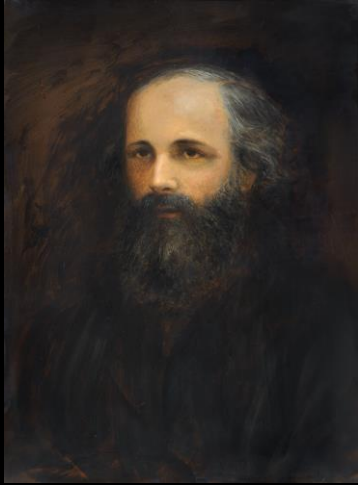
'The University of Cambridge, in accordance with that law of its evolution, by which, while maintaining the strictest continuity between the successive phases of its history, it adapts itself **with more or less promptness to the requirements of the times**, has lately instituted a course of Experimental Physics ...

The familiar apparatus of pen, ink and paper will no longer be sufficient for us, and we shall require more room than that afforded by a seat at a desk, and a wider area than that of the black board. **We owe it to our Chancellor that, whatever be the character in other respects of the experiments which we hope hereafter to conduct, the material facilities for their full development will be upon a scale which has not hitherto been surpassed.'**

MAXWELL'S INAUGURAL LECTURE

'When we shall be able to employ in scientific education, not only the trained attention of the student, and his familiarity with symbols, but the keenness of his eye, the quickness of his ear, the delicacy of his touch, and the adroitness of his fingers, we shall not only extend our influence over a class of men who are not fond of cold abstractions, but, by opening at once all the gateways of knowledge, we shall ensure the association of the doctrines of science with those elementary sensations which form the obscure background of all our conscious thoughts, and which lend a vividness and relief to ideas, which, when presented as mere abstract terms, are apt to fade entirely from the memory.'

THE CAVENDISH PROFESSORS



James Clerk Maxwell (1873-1879)

Lord Rayleigh (1879-1884)

J.J. Thomson (1884-1919)

Ernest Rutherford (1919-1937)

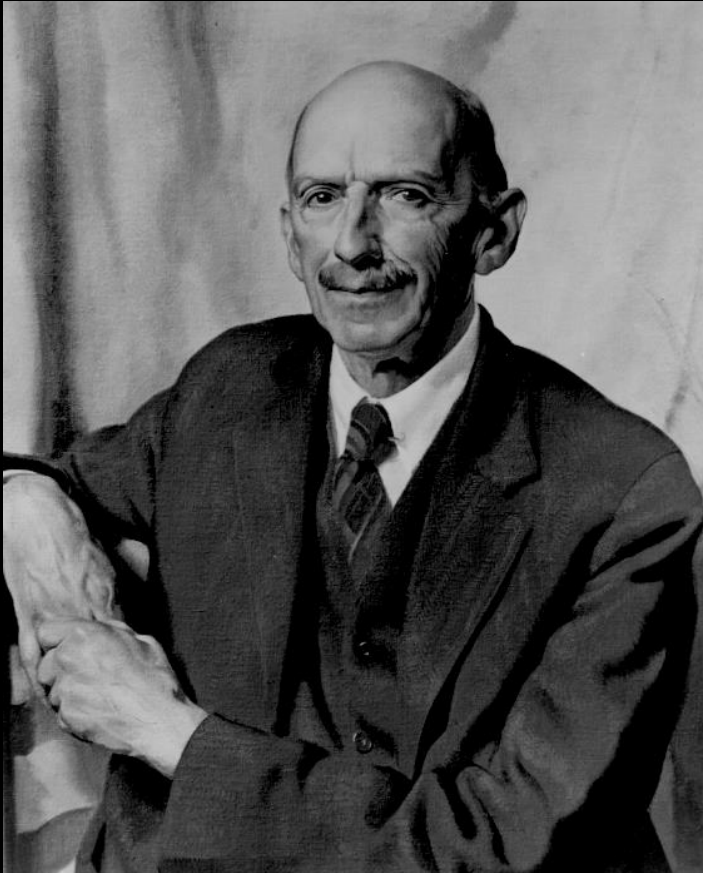
Lawrence Bragg (1938-1953)

ELECTRICAL STANDARDS



Rayleigh continued his broad range of research interests throughout his tenure of the Cavendish Chair but took the decision to continue Maxwell's programme of the **determination of electrical standards, but increasing their precision by an order of magnitude or more**, very much in the spirit of Maxwell's dictum that new science would come from improving the precision with which the laws of physics and the fundamental constants were known. The great sequence of papers involved collaborations with Schuster and Nora Sidgwick, with the assistance of Glazebrook and J.J. Thomson .

C.T.R. WILSON



C.T.R. Wilson was the inventor of the Wilson Cloud Chamber. His primary interest was in understanding the process of cloud formation from super-saturated water vapour. He was inspired in these studies by the cloud and atmospheric phenomena he noted as an observer at the meteorological observatory at the summit of Ben Nevis.

WILSON AND ATMOSPHERIC PHENOMENA



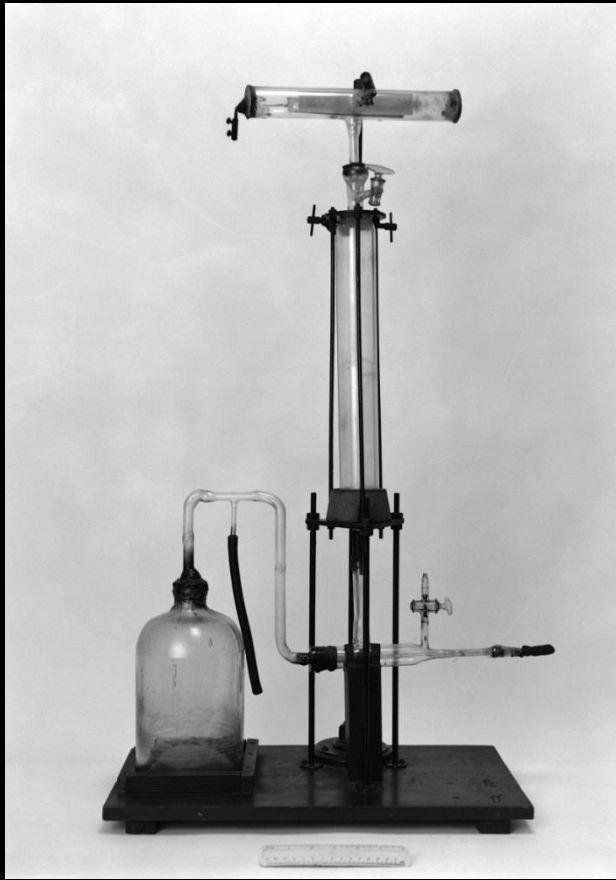
MSL on Cuillin ridge in Skye



A double Brocken spectre

While a meteorological observer, Wilson was struck by the beauty of coronas and 'glories', coloured rings surrounding shadows cast on mist and cloud, such as the **Brocken spectre**. He decided to imitate these natural phenomena in the Laboratory on his return to Cambridge. 1897.

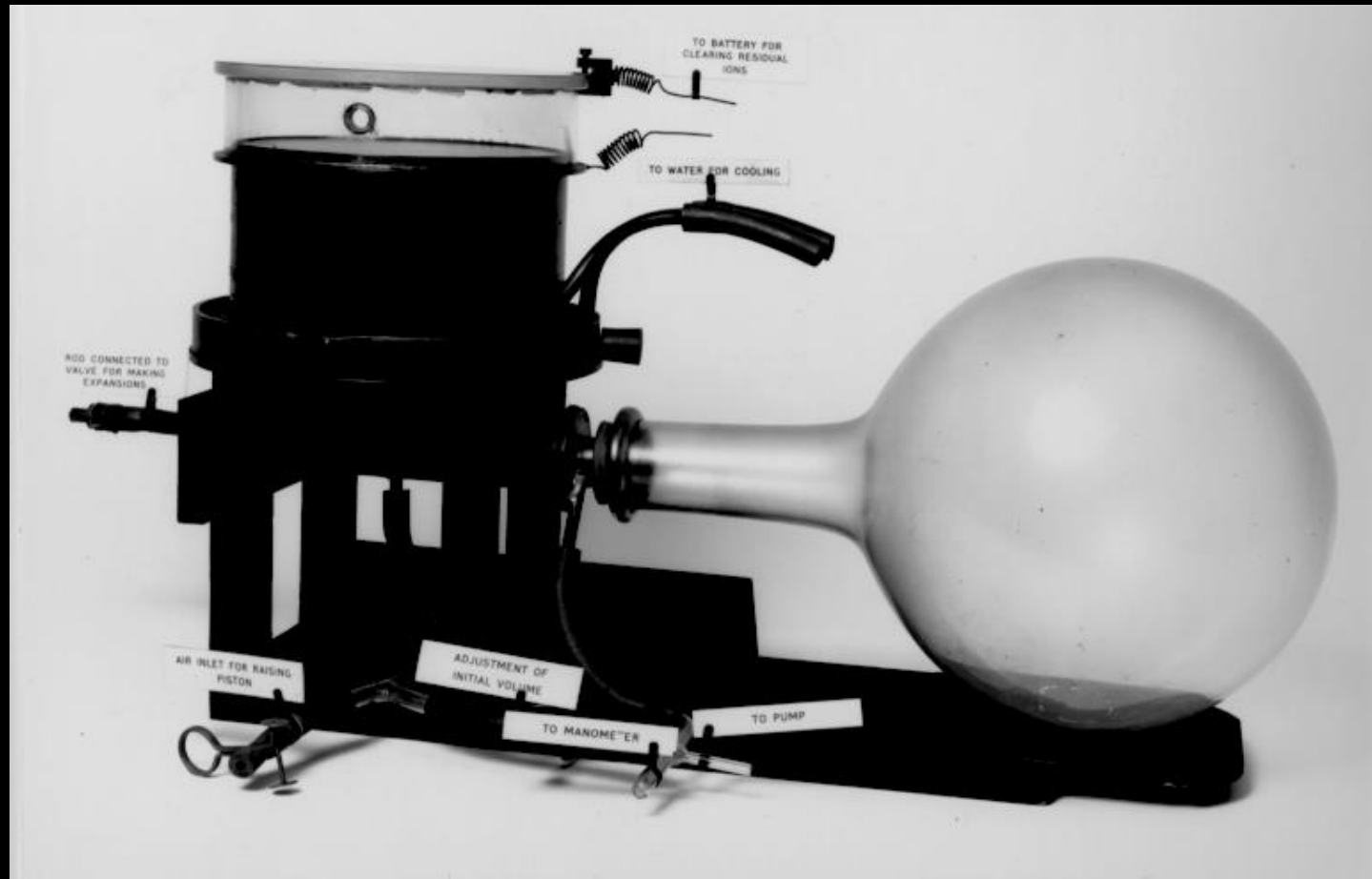
THE WILSON CLOUD CHAMBER



Wilson's 1895 cloud chamber. A later variant is on display in the museum.

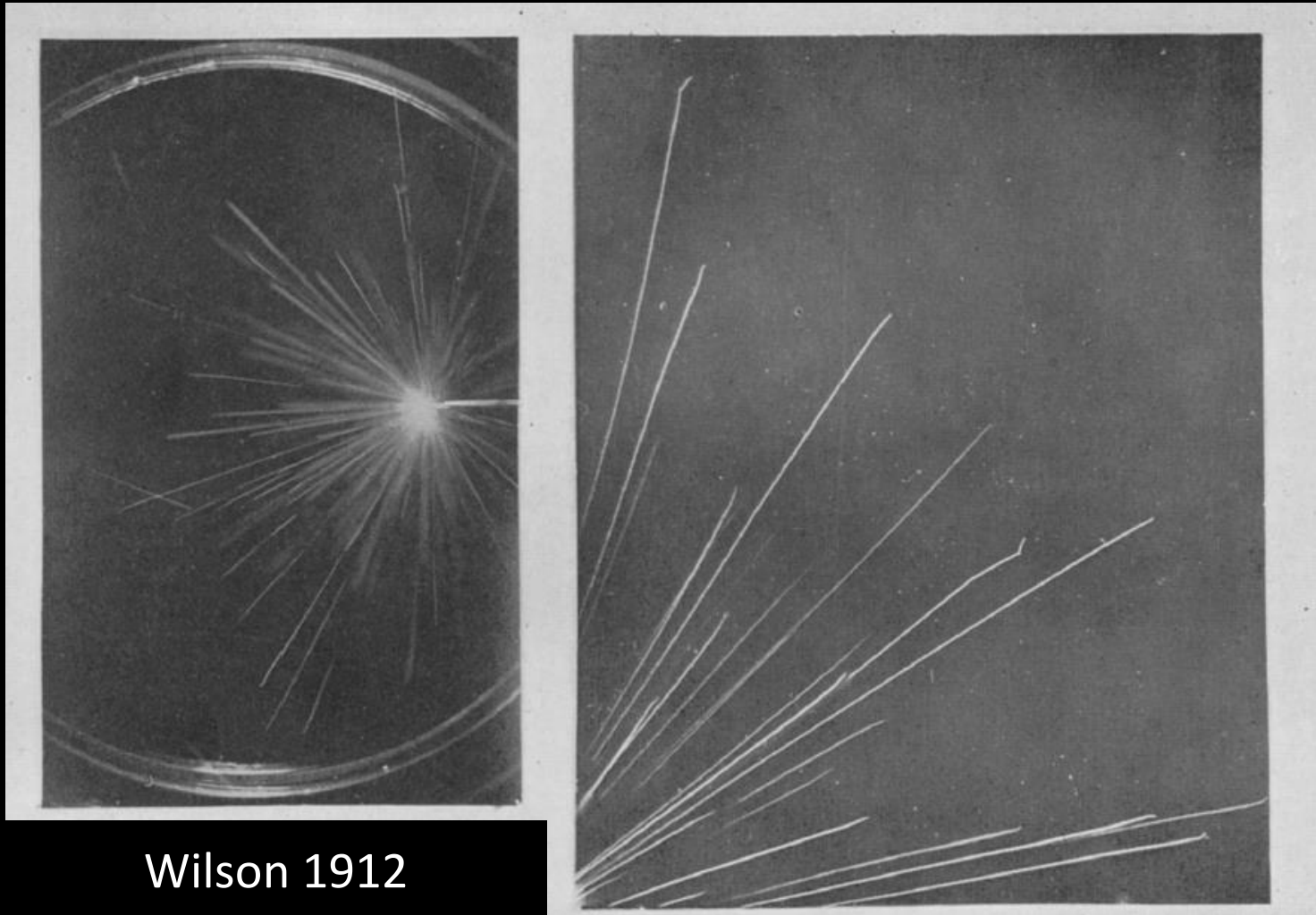
In the course of his experiments, it was realised that the paths of charged particles could be identified by the condensation tracks they produce in the supersaturated water vapour.

THE WILSON CLOUD CHAMBER



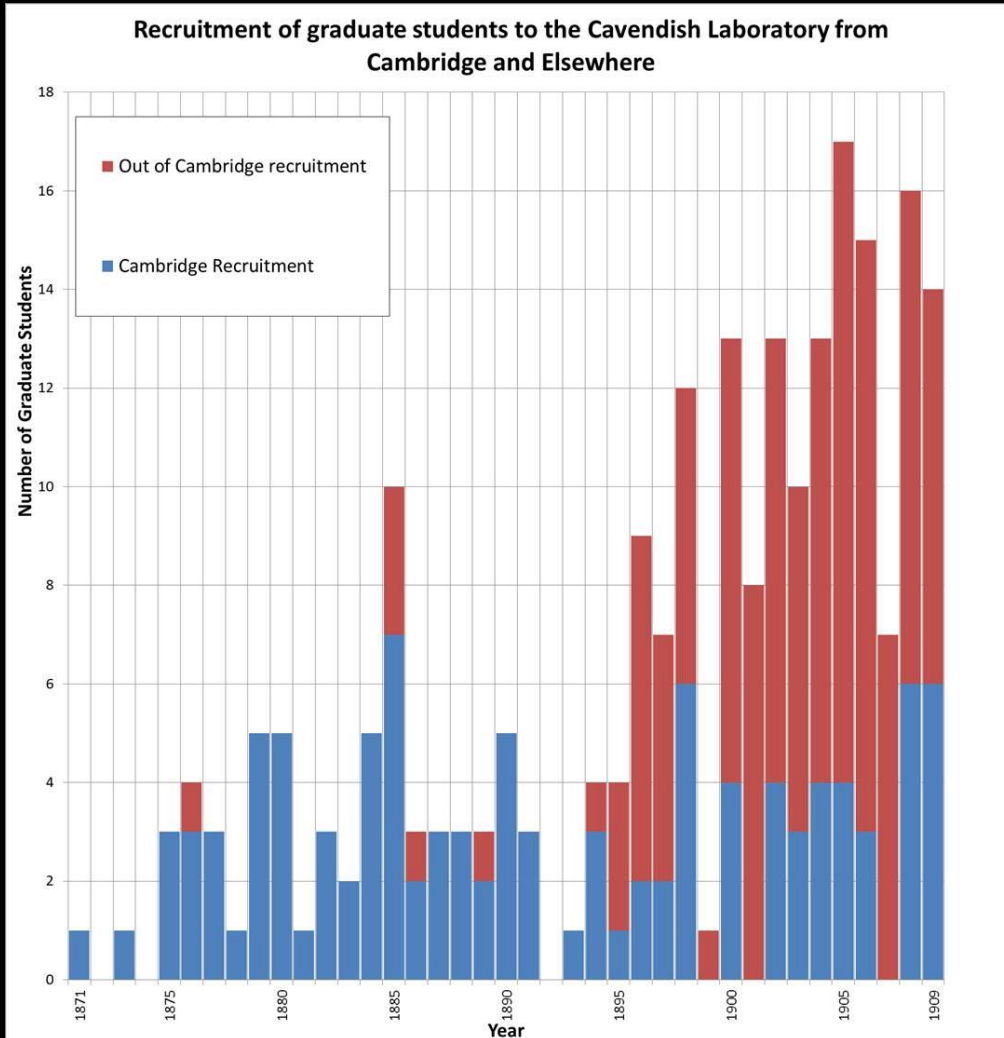
Wilson's perfected cloud chamber.

α -PARTICLES FROM RADIUM



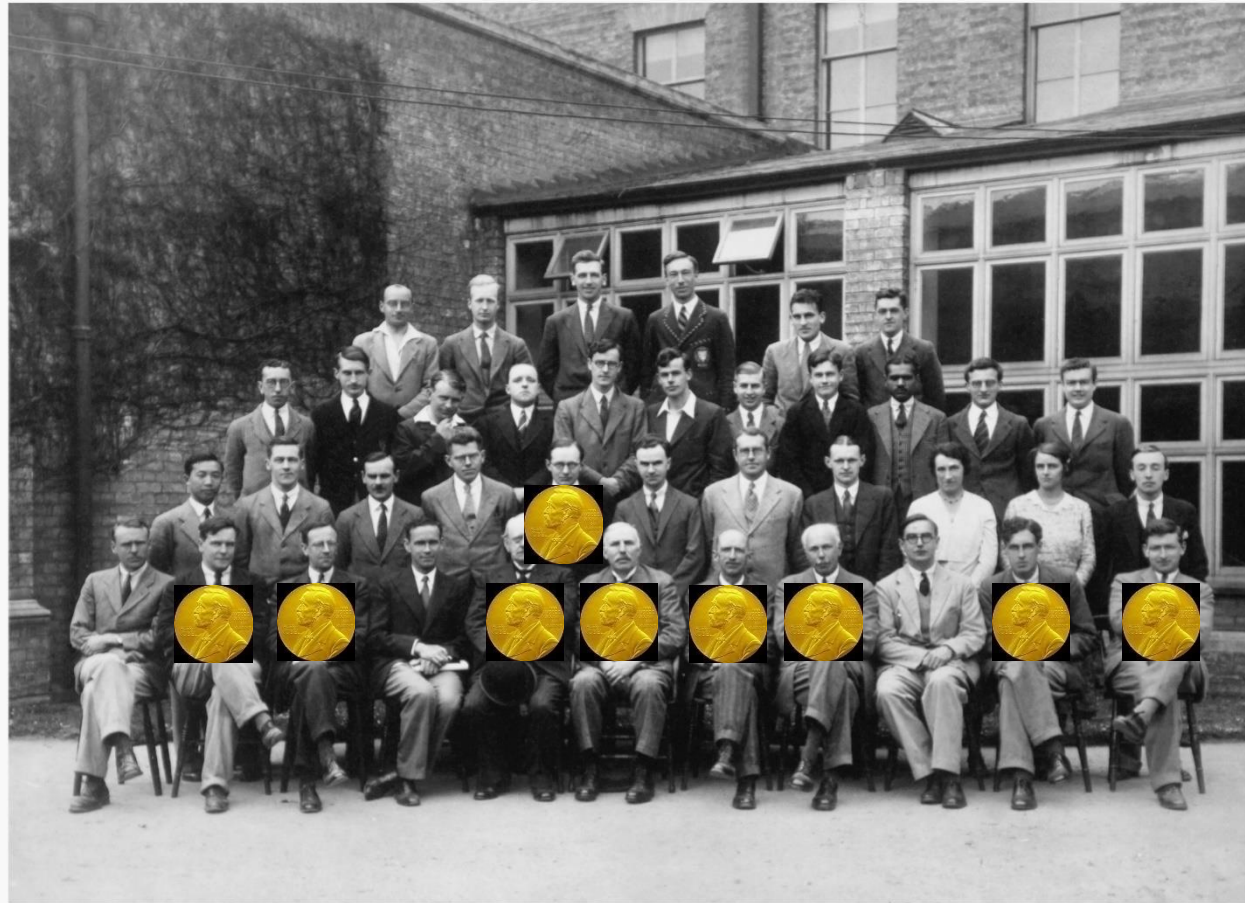
Wilson 1912

STUDENT NUMBERS



The diagram shows the growth of graduate student numbers up to 1909. Note the large increase when students were allowed to come to Cambridge as graduate students. Note also that the numbers of Cambridge graduate students did not increase. (Data from Isobel Falconer)

Physics Research Students, June 1932.



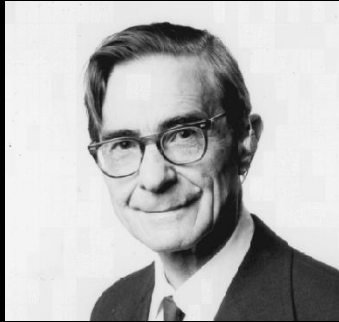
N.S.Alexander. P.Wright. A.G.Hill. J.L.Pawsey G.Occhialini. H.Miller

W.E.Duncanson. E.C.Childs. T.G.P.Tarrant. J.M.McDougall. R.C.Evans. E.S..Shire. E.L.C.White. F.H.Nicoll. R.M.Chaudhri. B.V.Bowden. W.B.Lewis.

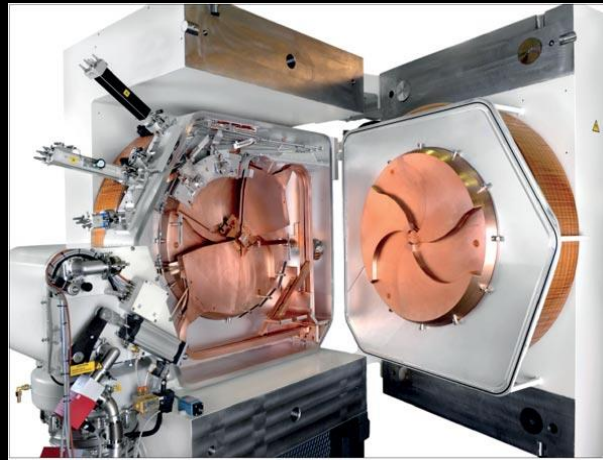
P.C.Ho. C.B.Mohr. H.W.S.Massey. M.L.Oliphant. E.T.S.Walton. C.E.Wynn-Williams. J.K.Roberts. N.Feather. Miss.Davies. Miss.Sparshott. J.P.Gott.

J.A.Ratcliffe. P.Kapitza. J.Chadwick. R.Ladenberg. Prof.Sir.J.J.Thomson. Prof.Lord.Rutherford. Prof.C.T.R.Wilson. F.E.Aston. C.D.Ellis. P.M.S.Blackett. J.D.Cockcroft

Lesser Known Heroes



Norman de Bruyne and his Mosquito fighter-bomber, nicknamed the 'wooden wonder'. It came into service in 1942 and was the fastest and most versatile aircraft of the War.

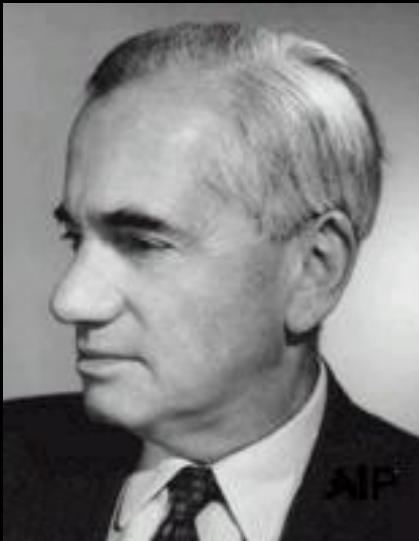


Derek Vonberg and the first cyclotron developed at the Hammersmith hospital for neutron therapy and the formation of short lived radioactive isotopes for medical diagnosis.

Lesser Know Heroes



Ray Dolby in his development laboratory. The Dolby noise reduction system is used universally as a means of enhancing the high frequency performance of audio reproduction.



Otto Frisch and **John Rushbrooke** with the Sweepnik scanning machine for the analysis of bubble chamber tracks. The same software was commercialised for map-making.

CAVENDISH RESEARCH AREAS

EXTREME

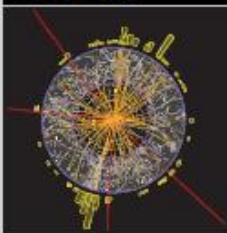
The Scope of Physics Research in the Cavendish Laboratory

MATERIALS

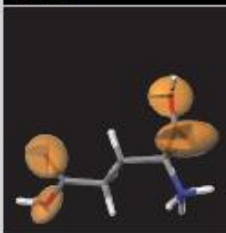
ASTROPHYSICS



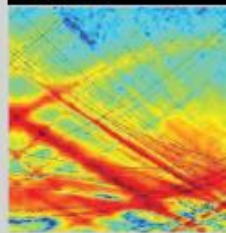
HIGH ENERGY



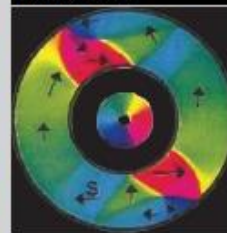
THEORY



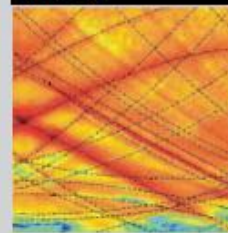
SURFACES



MAGNETISM



FRACTURE



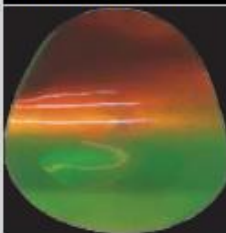
DETECTOR



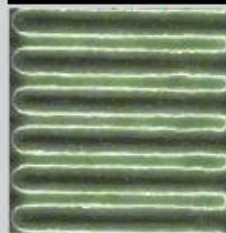
QUANTUM MATTER



NANOPHOTONICS



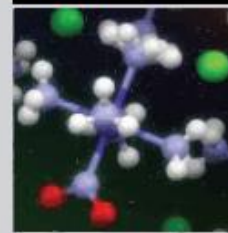
OPTOELECTRONICS



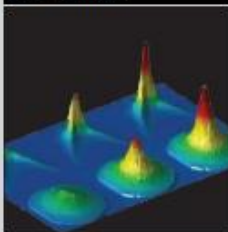
SCIENTIFIC COMPUTING



STRUCTURE



COLD ATOMS



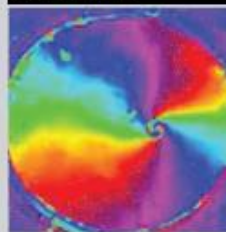
MICROELECTRIC



SEMICONDUCTOR



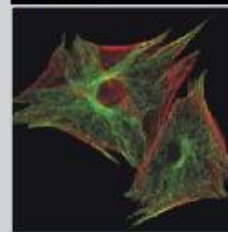
SOFT MATTER



BIOLOGY



MEDICINE



QUANTUM

BIOLOGICAL

THE MAXWELL CENTRE



The Maxwell Centre is the centrepiece for industrial partnership with the physical sciences, located on the West Cambridge Physical Science and Technology Campus.

Opening 7 April 2016