

# A Short History of the Cavendish

Daniel Gregory

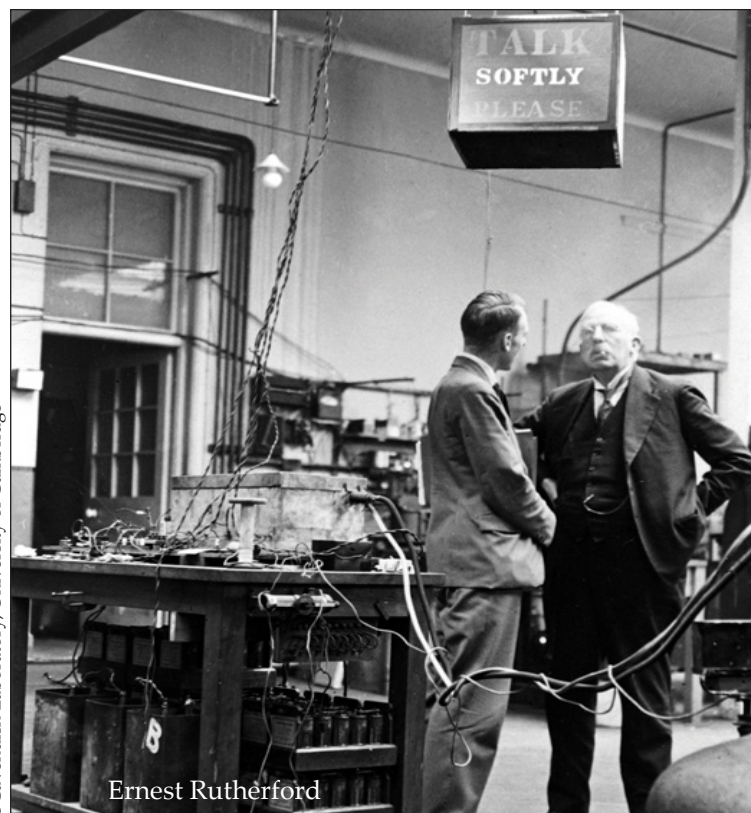
The Cavendish Laboratory in Cambridge is legendary in the field of physics. The electron, pulsars, X-ray diffraction, and mass spectrometry were discovered there. Since the opening of the Cavendish in 1874, twenty-nine Cavendish physicists have won Nobel Prizes—and not necessarily for physics. In 1953, Francis Crick and James Watson, working in the Cavendish, won their Prize in Physiology or Medicine for their discovery of the structure of DNA.

There were several developments in the history of Cambridge science leading up to the opening of the Cavendish. In 1851, the Natural Sciences Tripos was established as the new

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system of undergraduate science education. Physics at the time was taught as a branch of mathematics and there was no university laboratory available for experimental physics. Although Cambridge physicists had made experimental discoveries before the Cavendish, these had been made in the privacy of college rooms or private laboratories owned by wealthy amateur experimentalists. Isaac Newton and Thomas Young, for example, both carried out work on optics in their college rooms.

During this time, the only university laboratory in



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Britain was a converted wine cellar at Glasgow University and students learned by aiding trained scientists in their private experiments. Cambridge, and indeed, Britain, needed a place to train young mathematicians in experimental physics. Consequently, on 25th November 1860, a syndicate was formed which established a physics laboratory in Cambridge. In 1871, the syndicate appointed James Clerk Maxwell as the first professor of experimental physics.

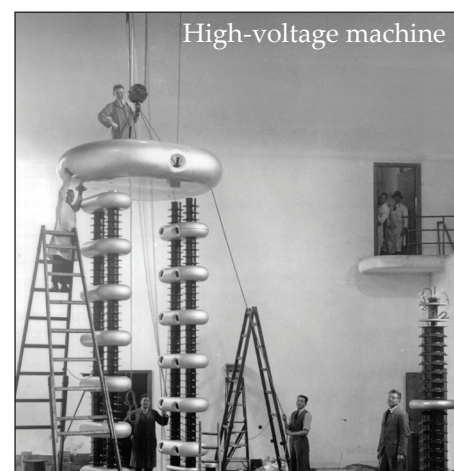
Today, Maxwell is famous for the unification of the discoveries in electricity and magnetism of scientists like Michael Faraday and Hans Christian Ørsted (who discovered that an electric current would deflect a compass needle) as well as for making discoveries in statistical and thermal physics. In particular, Maxwell's work on electromagnetism led to the prediction of a constant speed of light. This was instrumental in Albert Einstein's development of special relativity.

Yet electromagnetism has technological applications which were inconceivable in Maxwell's day such as TV, radio, radar, wireless internet, Bluetooth technology, fibre-optics and the generation of electricity (electromagnetic induction). Many inventions had to be made before any of these devices could exist, yet none of them would exist without Maxwell's equations.

Maxwell had not published his electromagnetism papers by the time of his appointment. Nevertheless, students looked forward to his inaugural lecture with interest. In the nineteenth century, inaugural lectures were of even more importance than they are today; but Maxwell barely announced the lecture and held it in an out-of-the-way lecture theatre exclusively for his students. During the lecture, Maxwell explained his vision for physics in the new laboratory: he outlined his plans for a comprehensive lecture course in physics followed by practical demonstrations and experiments.

The Cavendish under Maxwell was a different laboratory than it is today. Most notably, women were initially not allowed in the laboratory. Maxwell finally allowed women to work there during the summer, when he would be holidaying in Scotland. Lord Rayleigh became the professor of the Cavendish in 1879 and it was not until 1882 that he fully opened the laboratory to women.

The end of the nineteenth century and first half of the twentieth century heralded many great experi-



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mental discoveries in physics. At the same time important theoretical discoveries in physics would be made such as Niels Bohr's model of electron orbitals.

In 1928, Cambridge theoretical physicist Paul Dirac formulated the Dirac equation. This predicts negative energy solutions that Dirac interpreted as antimatter. Antimatter particles have the same mass as normal matter, but opposite

“ **It remains an exciting time for Cambridge physicists** ”

electric charge. Antimatter was first detected in 1932 by Carl Anderson at the California Institute of Technology, USA and today, positrons—anti-electrons—are used in PET (Positron Emission Tomography) scanners in hospitals.

By the Second World War, the Cavendish was under the guidance of Sir William Lawrence Bragg, who pioneered much of X-ray crystallography. In X-ray crystallography, X-rays are fired into crystals and the rays that emerge can be used to deduce the molecule's structure. The technique was essential to unlocking the structure of DNA by Watson and Crick in 1953.

Today, the research interests of the Cavendish Laboratory, headed under Professor Peter Littlewood, include semiconductor physics, radio astronomy, soft condensed matter and biophysics, cold-temperature physics, high-energy physics and medical physics. This year has just seen the completion of the new Physics of Medicine building, next door to the Cavendish. The faculty hopes to strengthen research into biological physics, allowing physicists to attack biological problems, and teaching biologists about the approach of physicists in biological and medical science.

Scientists at the Cavendish recently came closer to understanding how certain materials superconduct at room temperatures. Superconductivity is the ability some materials possess of allowing electric current to flow through them without resistance. In particular, this has applications in superfast levitating trains, more efficient Magnetic Resonance Imaging machines (MRI), and lossless power generators and power transmission lines.

In August 2006, an agreement was reached between the University of Cambridge and the Kavli Foundation to build the Kavli Institute for Cosmology, a research facility established to study the physics of the early universe and the formation of the first stars and galaxies. When it opens in 2009, the institute will include members of the Cavendish Astrophysics group, the Astronomy group, currently in the Institute of Astronomy (IoA), and the Department of Applied Mathematics and Theoretical Physics. The new Institute should hold an exciting position between theoretical and observational cosmology, thus strengthening the ties between the IoA and the Cavendish.

It remains an exciting time for Cambridge physics – and indeed, for Cambridge physicists. ■

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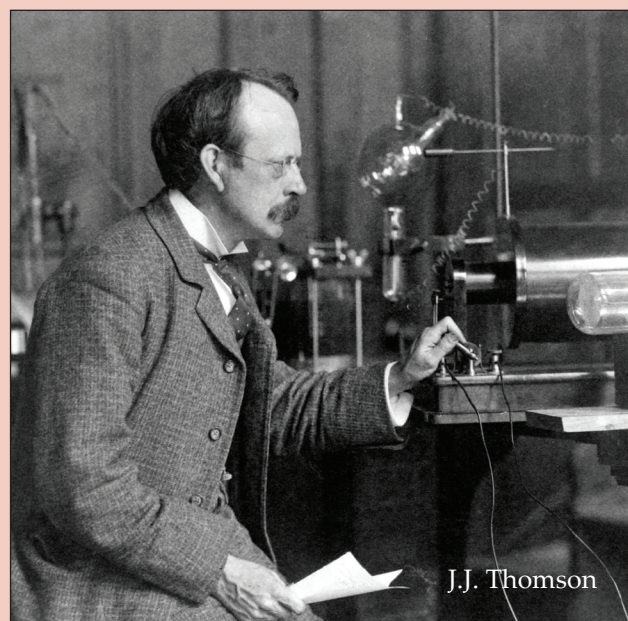
## The Influence of J.J. Thomson

Eric Anderson

Thomson published his discovery of the electron in 1897, which was an impressive feat at a time when some scientists questioned the existence of the atom.

Thomson later received the Nobel Prize in Physics in 1906 for his subsequent work on electrical conduction in gases. He later theorized how the electron fit into the structure of the atom using his “plum-pudding” model, where electrons can be thought of as small negatively charged particles embedded in a sphere of positive charge, yielding an uncharged neutral atom.

One of Thomson's most successful students was Ernest Rutherford, who focused on utilizing the newly discovered technology of X-rays. Rutherford's stay at Cavendish allowed him to develop his early work in



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radioactive decay that would later earn him a Nobel Prize.

Danish physicist and atom pioneer, Niels Bohr, arrived at Cambridge as a post-doctoral fellow in 1911 and also performed research under the direction of Thomson.

Bohr developed his theory of atomic structure involving the existence of discrete orbits of electrons surrounding the nucleus. Bohr later theorized that these electron orbits were associated with different energy levels. In 1922, Bohr was awarded the Nobel Prize for his investigation of atomic structure and its relation to emanating electromagnetic radiation. ■

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