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100 years ago

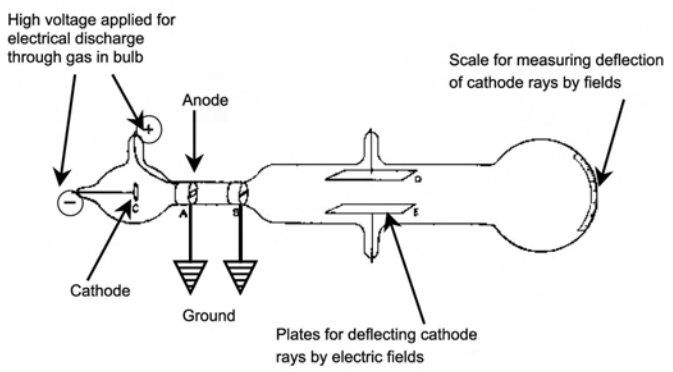
Around 1900, the idea that the atom was composed of smaller particles was being explored in physics laboratories in Europe. In a span of three decades, scientists at the Cavendish Laboratories in Cambridge England shaped our modern view of the atom with discoveries about electrons, positive ions, and neutrons. This display contains replicas of instruments used by scientists at Cambridge during this period of fruitful research and discovery.

Why a Crocodile? A striking feature of the old Cavendish site is the carving of a crocodile on the outer wall of the Mond Laboratory. The Laboratory was built in 1933 by the Royal Society for Kapitza to continue his work into intense magnetic fields. During the building work, those passing the lab were suprised to see a figure in a brown monk's habit busily chipping away at the brickwork behind a tarpaulin screen. This was Eric Gill who had been commissioned by Kapitza to carve both a plaque of Rutherford and this Crocodile - "The Crocodile" being Kapitza's pet name for Rutherford, either because of his fear of having his head bitten off by him, or because his voice could be relied upon to precede his visits, just like the crocodile's alarm clock in "Peter Pan".

Cathode Rays and the Electron

In the late 19th century, a number of physicists were investigating the phenomena accompanying high voltage discharges through gases. Cathode rays were observed in these experiments but their exact nature was not clearly understood. J. J. Thomson of the Cavendish Laboratory in Cambridge was the first to demonstrate in 1897 that cathode rays could be deflected by electric fields.

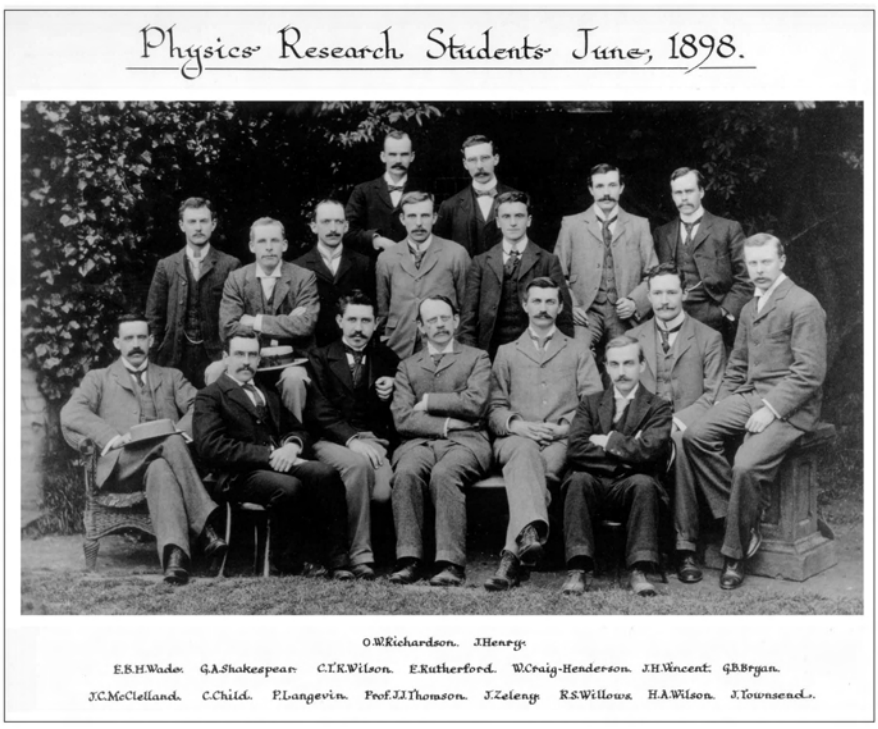
Thomson's Apparatus for Research on Cathode Rays



Reprinted from Thomson, J. J. *Phil. Mag.* **1897**, 44, 293.

The glass apparatus (below) is a replica of the device that Thomson used for his cathode ray studies. The rays were produced in the small bulb at the left by passing a high voltage electric discharge through the gas in the bulb at low pressure. The rays were then accelerated in a straight line to the right-hand bulb, where they produced a narrow well-defined pattern on a phosphorescent patch. A potential difference applied across the pair of parallel metal plates in the center of the tube provided an electric field to deflect the cathode rays. They could also be deflected by a magnetic field placed on either side of the tube in the region of the metal plates (not part of the replica). Thomson adjusted the electric and magnetic fields so that the deflections produced by them were equal. This arrangement determined the velocity of the cathode rays. He then measured the deflection of the rays produced by the electric field alone, which, combined with the value of the velocity, gave the value of the ratio of the charge, e, to the mass, m, of the cathode rays.

He repeated these measurements for different gases and for different materials for the electrodes, and found that the value of e/m was independent of both the nature of the gas and the material of the electrode. He therefore concluded (Philosophical Magazine, October 1897):

> *"We have in the cathode rays, matter in a new state, a state in which the subdivision of matter is carried very much farther than in the ordinary gaseous state; a state in which all matter is of one and the same kind; this matter being the substance from which all the chemical elements are made up."*

Thomson was able to prove conclusively that cathode rays were actually negatively charged particles, or in his terms, "corpuscles of negative charge". Today we call these particles electrons. Thomson was awarded the Nobel Prize in Physics in 1906 for this work.