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CAVENDISH LABORATORY

Rasskazov I.L., Alekseenko I.V.
Scientific supervisor - Associate professor Alekseenko I.V.
Siberian Federal University

The History of the Cavendish

The Cavendish Laboratory has an extraordinary history of discovery and innovation in Physics since its opening in 1874 under the direction of James Clerk Maxwell, the University's first Cavendish Professor of Experimental Physics. Up till that time, physics meant theoretical physics and was regarded as the province of the mathematicians. The outstanding experimental contributions of Isaac Newton, Thomas Young and George Gabriel Stokes were all carried out in their colleges. William Cavendish, the Seventh Duke of Devonshire, provided £6,300 to meet the costs of building a physics laboratory, on condition that the Colleges provided the funding for a Professorship of Experimental Physics. This led to the appointment of Maxwell as the first Cavendish professor.

Since its foundation, the Laboratory has had great fortune in appointing Cavendish professors who, between them, have changed completely our understanding of the physical world. Maxwell died in 1879 at the early age of 48 and was succeeded by Lord Rayleigh, who was responsible for setting up a systematic course of instruction in experimental physics, which has remained at the core of the Laboratory's teaching programme.

Thomson

JJ Thomson succeeded Rayleigh in 1884 and began the revolution in physics which was to lead to the discovery of quantum mechanics in the 1920s. Among the first generation of physics graduate students were Ernest Rutherford and Charles Wilson, who, along with JJ Thomson, were to win Nobel prizes for their researches. The discovery of the electron by Thomson, the invention of the Cloud chamber by Wilson, the discovery of artificial nuclear fission by Rutherford are examples of the extraordinary advances in experimental technique which ushered in what became known as modern physics.

In 1919, Thomson was succeeded by his former student Rutherford, under whose tenure Francis Aston discovered the isotopes of the chemical elements, Patrick Blackett first photographed artificial nuclear interactions, James Chadwick discovered the neutron and John Cockcroft and Ernest Walton carried out the experiment which produced the first controlled nuclear disintegrations induced by accelerated high energy particles, as well as proving experimentally for the first time that $E = mc^2$.

Lawrence Bragg

Lawrence Bragg succeeded Rutherford as Cavendish professor in 1938 and developed the use of X-ray crystallography as an extraordinarily powerful tool for understanding the structure of biological molecules. The culmination of these studies was the determination of the double-helix structure of the DNA molecule by Francis Crick and James Watson.

Bragg was succeed by Nevill Mott in 1954 and under his leadership, many pioneering studies were carried out in what is now be termed condensed matter physics, including his own work on amorphous semiconductors which was to lead to his Nobel prize.

The move was completed in 1974 and a completely new phase of discovery began. Large facilities were developed in radio astronomy and semiconductor physics, which continue to be frontier areas of research within the Laboratory. Completely new disciplines were fostered. With Sam Edward's appointment as Pippard's successor in 1984, soft condensed matter became a major component of the Laboratory's programme. Polymer semiconductor physics has flourished under Edwards' successor Richard Friend. In the first decade of the 21st

century, new frontiers have been opened up in the areas of nanotechnology, cold atoms and ultra-low temperature physics.

Since the founding of the Nobel Prizes by Alfred Nobel in 1895, 29 members of the Cavendish have won one of the illustrious prizes. Not all of the Prizes are in physics.

The Present Cavendish - The Move to West Cambridge

A slate plaque in Free School Lane commemorates the first hundred years of the Cavendish, from its foundation by the first Cavendish Professor of Experimental Physics, James Clerk Maxwell, to the move of the Physics department to a green field site in West Cambridge.

Old Cavendish Laboratory

The name, made famous by Maxwell and his successors, was transferred and the original buildings are now the Old Cavendish Laboratory. Only those who never saw the conditions of work in the old buildings, overcrowded and often far from robust as to internal walls and floors, could deplore the sacrifice of rooms hallowed by J.J. Thomson and Rutherford in exchange for new quarters where their successors might stand a better chance of maintaining the great tradition.

This is not to imply that the choice was easy. Fears were expressed, both within the department and by many other members of the University, that teaching and research in Physics might become isolated from the rest of Science in Cambridge. Indeed, if there had been any reasonable chance that the Old Addenbroke's site would become available in the early Seventies, as was once envisaged, this would have been welcomed by all concerned as the ideal location for Physics, close to Engineering and Chemistry.

As things have turned out it was lucky this plan was abandoned, and in any case the presence of Astronomy and Geophysics in West Cambridge has provided congenial neighbours.

Separation from the other departments involved in the Natural Sciences Tripos has not proved as great a problem for the teaching as was feared by some, and as for the research it has thrived in a way that would have been impossible without the extra space now available.

Finally, in justification of the move it must be remembered that the space vacated at the centre has allowed rehousing of other departments whose problems were hardly less acute. In the course of time it is to be hoped that the Cavendish will be joined in West Cambridge by others whose needs are still unsatisfied.

This, however, is very much in the future since there is no money coming in from Government sources for major building projects. Even in the late Sixties when the New Cavendish was being planned there were moments of grave doubt about the adequacy of the building grant, and this is reflected in two aspects of the buildings that eventually came into being: the cost was very low in comparison with earlier physics buildings elsewhere, and the hesitation that delayed the early stages of planning resulted in much more thorough discussion of the design than is usual with University buildings.

Robert Matthew, Johnson-Marshall

This second point is worth stressing. The architects, Robert Matthew, Johnson-Marshall and Partners, were chosen for their notable work in the planning of York University, and by the time they arrived on the scene a building committee made up of members of the Department had already come to some conclusions about the desirable features of a physics laboratory. Even so, when a number of senior partners in the firm took up residence for a few days and talked to staff and students, they came back to the building committee with a battery of searching questions that the committee had not thought to ask themselves.

As a result a clear view evolved about the organisation of a laboratory, especially the social organisation - who must have access to whom, who must be allowed to hide from public view, is it desirable for undergraduates to have free access to research laboratories etc. - the overall layout of the buildings reflects the outcome of these preliminary talks.

The siting of the library, administration, stores and common room at the cross-roads to encourage chance meetings of people from different buildings; the embedding of Part II practical classes in the research areas; the open layout of the Mott building, with research groups clustered on two or three floors around a hall and staircase, visible to the passer-by yet not wholly exposed since the individual rooms that lead off the hall have their own privacy; these are all examples of the benefits of leisurely pondering on the issues, and they have resulted in a laboratory that has most notably achieved what was intended - scope for individual initiative, and incentive for workers in different groups to cooperate.

The work on disordered materials in the Mott building exemplifies this point. Although the research groups that had developed separate, even competitive, identities in the old buildings still hold to their primal loyalties, with their own assistants, secretaries, workshops and darkrooms, there is much more exchange of ideas than hitherto between those in the Physics and Chemistry of Solids group whose primary interest is in the electrical behavior of amorphous semiconductors, and those in (then) Metal Physics and Low Temperature Physics who are more concerned with the mechanical and thermal properties of glasses, both dielectric and metallic.

One unfortunate consequence of shortage of funds, that the theoreticians who require less heavily serviced accommodation have to occupy the top floor instead of being mixed up among the experimenters, has not prevented valuable collaborations developing.

The move away from well ordered crystalline solids towards the more difficult problems of disorder finds its parallels upstairs in the development of analytical and computational techniques for handling atomic groupings without the simplifications introduced by periodic structure.

And catalysing the whole process, from a vantage point deeply embedded in the experimental areas, is the father-figure of disorder, as of so many other major advances in solid-state physics, Professor Mott himself.

At a time when we hear on every side how difficult it is to gain support for research it must be gratefully admitted that the Cavendish has nearly always been well treated by the University and the Research Councils, and in consequence has maintained an enviable range of modern equipment.

Unfortunately, we are short of a most valuable commodity, technical experts dedicated to getting the best out of the highly sophisticated instruments and developing them still further.

How to incorporate such people into the university structure is a country-wide problem for which no solution is yet in sight, but the obvious stimulus provided by those we have managed to attract encourages us to continue seeking means to appoint more.

It is one of the hazards of allowing the greatest freedom to first-class staff that their ideas may not always tally with conventional definitions of physics. It has long been Cavendish policy not to worry overmuch, provided the teaching does not suffer and the ideas are intellectually worthy.

This policy, summed up in the motto

"Physics is what physicists do", made the Cavendish thirty years ago the nursery of Molecular Biology, and then gave justification (if any were needed) for the presence of a thriving Energy Research Group whose techniques are nearer economics than physics.

It is on the cards that some of the most popular research fields will fairly soon be priced out of the market, and a more liberal interpretation of what physics is about will then become commonplace; if so the Cavendish will find itself, as so often before, in the van of progress.