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W. L. Bragg at The Royal Institution, 1953-66

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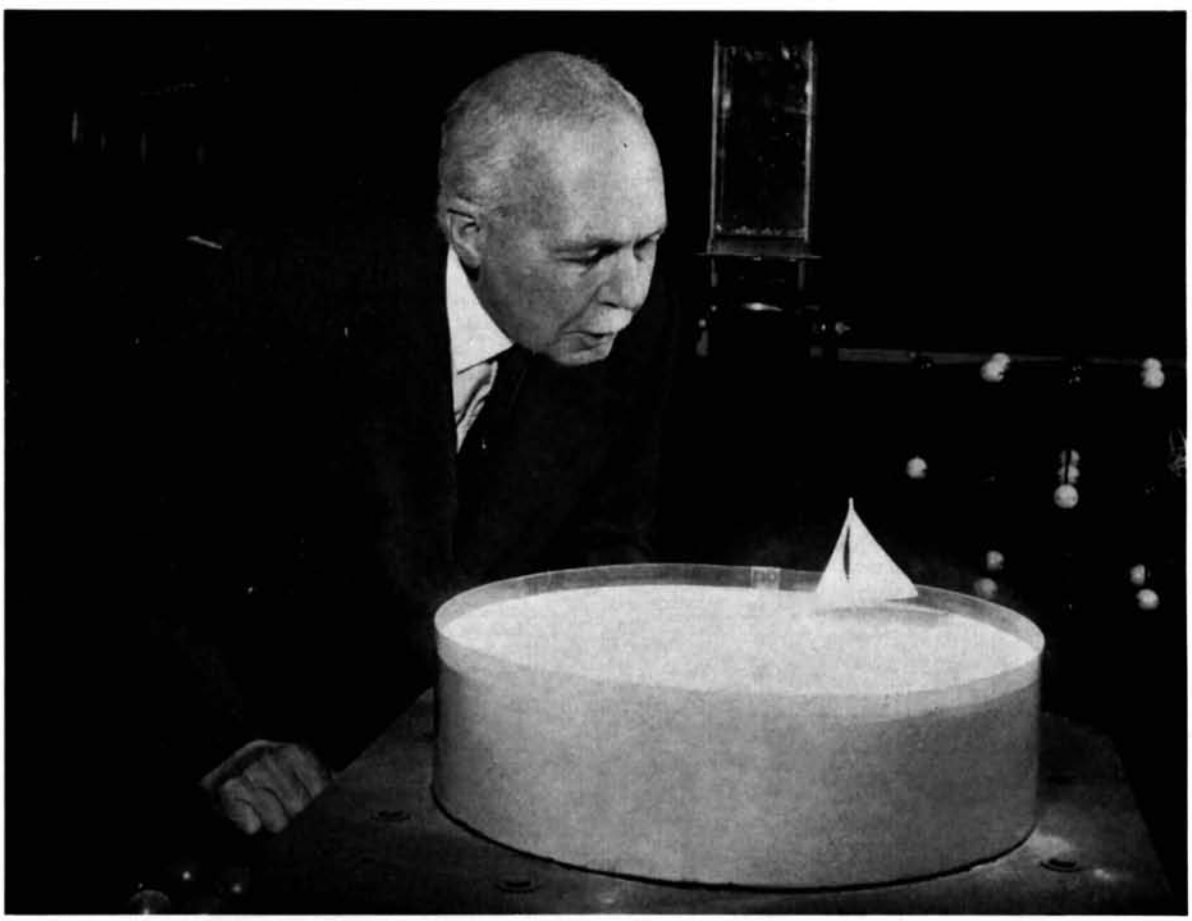
The Royal Institution of Great Britain, to give its full and uninformative title, is well-known to crystallographers, yet there must be many who have little idea of what kind of institution it is and what goes on inside the remarkable building in Albemarle Street, London W.1. It was founded by Count Rumford in 1799 for 'the promotion of science and the diffusion and extension of useful knowledge' and is a private society depending for its support upon the subscriptions of its members, the income from its endowments, donations from various sources and the grants in aid of research which it receives from government agencies and others. Davy and Faraday were mainly responsible for establishing its style during the early part of the last century, and it was they who showed how the founder's objectives could be achieved (in part, at least) by conducting fundamental research in the Institution's laboratories and lecturing in the Institution's lecture theatre about the latest scientific discoveries to crowded audiences drawn from London's high society. The character of the Institution has been shaped most of all, perhaps, by the fact that since the time of Davy its senior professor has lived on the premises. These living quarters are strangely mixed up with the public rooms and laboratories and the effect is to create a family atmosphere of quite remarkable intensity.

In 1953, when the 'Managers' of the Institution under the active Presidency of Lord Brabazon persuaded Sir Lawrence to accept the post of Resident Professor and Director of the Davy–Faraday Research Laboratory, it was not a very happy family. The position of Resident Professor had been vacant for over a year, its research reputation had fallen away, it was financially insecure and its role in the exposition of science seemed increasingly uncertain as radio, television and popular science journals entered the field. Nevertheless Sir Lawrence accepted the challenge and it seems easy to guess some, at least, of the reasons why he did so. First of all he had a strong family connexion with the Institution, where his father had been Resident Professor from 1923 to 1942. The family atmosphere of those years has been well described by Sir Lawrence's sister, Mrs. A. Caroe (Gwendolen Bragg) in the *Proceedings of the Royal Institution* (Caroe, 1965) and something of his own feeling for the place comes out in the account of his father's career written with his sister for the Royal Society (Bragg & Caroe, 1962). Certainly the possibility of starting a new research school and re-establishing the Institution as a scientific centre must have been appealing, particularly with the thought that his appointment at Cambridge was nearing its statutory end.

Equally clearly, however, the break with Cambridge must have been difficult and painful, not least because the protein structure research which he had nurtured since his arrival in 1938 was at last clearly within sight of success. Max Perutz had just shown how the method of isomorphous replacement could be applied to protein structure analysis and the future for his study of haemoglobin was bright. Sir Lawrence would have liked to bring Perutz and John Kendrew to London with him but they could hardly leave Cambridge at such a moment and he had to move alone, though with the promise of their support in starting parallel work at the Royal Institution. Both Perutz and Kendrew were appointed Readers in the Davy–Faraday Laboratory and the unstinting way in which they redeemed their promise to help is evident in the story of the next thirteen years.

Unfortunately, however, research was not the only problem at the Royal Institution, nor the one which occupied most of Bragg's time, so that some account must be given of his other activities. These can be summarized by saying that, with the support of Ronald King (later appointed Professor of Metal Physics in the Institution) and other members of the staff, he set about developing the Institution's activities in ways which exploited its accumulated experience and yet were relevant to modern conditions. The Christmas lectures to a 'juvenile auditory' which were begun by Faraday in 1826 are one of the best known activities. They depend for their success very largely upon the dramatic lecture demonstrations that are traditionally included in them and, indeed, such demonstrations are a characteristic feature of most of the lectures given at the Institution including the Friday Evening Discourses to members and their friends. Sir Lawrence built on these traditions by developing a new programme of lectures to school children (Bragg, 1965*a*) in which he set out to show sixth formers (and subsequently younger children) many of the experiments establishing fundamental principles which they would otherwise not see. Very soon the Institution was alive with young people: by 1965 about 22, 000 were coming to the lectures each year from more than 400 different schools. Twice a week during each term they crowded in to see re-enactments of experiments first performed by the great pioneers of scientific discovery, Galvani, Volta, Davy, Faraday, Crookes and Dewar, to mention only a few. Sir Lawrence of course gave many of these lectures himself and it was always a delight for those of us who worked in the laboratory to slip into the gallery at 5 o'clock and watch him enthral, stimulate and occasionally provoke his audience. One week there



Sir Lawrence sails a boat on a sea of sand, demonstrating that the slight separation of particles turns a solid into a liquid. (From the first of a series of talks on *The Nature of Things*, televised from the Royal Institution on 12 November 1959. Photograph reproduced by permission of the British Broadcasting Corporation.)

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Sir Lawrence as Christmas Lecturer at the Royal Institution, 1961. (Copyright of Sport & General Press Agency Limited.

would be free-hand drawings of highland dances to illustrate the formation of ionic bonds and the next he could be seen lovingly caressing the Paget speech models and beaming with pleasure at every successful 'Ma-Ma'. Science – or at least scientists – seemed very different from the dry stuff of text-books after these performances.

The Friday Evening Discourses were, of course, continued in all their Victorian state. At 8·55 p.m. each Friday evening during term the audience (mainly in evening dress) would quieten as Lady Bragg led in the dinner party guests followed soon afterwards by the President himself escorting the lecturer's wife and supported by a stately procession of Managers. The doors would then be closed until the stroke of 9 when the lecturer appeared dramatically through one door while Sir Lawrence soon afterwards came in through the other one, his duty of ensuring that the lecturer did not escape at the last awe-inspiring moment (as Wheatstone did) completed for another week. During his years as Resident Professor, Bragg must have listened to three hundred or more of these lectures and the experience certainly gave final shape to his views on lecturing (Bragg, 1966*a*). One of his favourite sayings, which came up often when the lectures were discussed during the following week, was: 'If most of the audience remember *one* idea next morning with some enthusiasm and interest the lecture has been a stupendous success.' Many a lecturer, I am sure at least of one, has felt some little anxiety at his presence in the audience and has been enormously encouraged by the sudden snort of approval that greeted a particularly telling remark or successful experiment.

The public activities of the Institution were developed in other ways during these years so that there seemed always to be some new scheme to be discussed in Committee or worked on by the lecture staff. Science teachers used to come for 'Research Days' at which workers from various laboratories described their work; television programmes were planned, rehearsed and recorded; films were made (it was no surprise to us to meet an authentic looking Faraday in the basement); and, towards the end of the period, a new series of lectures to civil servants was begun. Bragg's account of this venture (Bragg, 1966*b*) brings out well the continuous process of innovation and development in which he was involved with King and others during all of these years as they sought to create a modern role for the Institution. The general support of industry during this time and the recent success of the Institution's appeal are measures of his success though it is a struggle that is not ended and perhaps never can be.

Faraday's laboratory was in a room in the basement which can still be seen (it says 'Servants' Hall' on the door) and which soon will be restored to its original state. Throughout these years the basement still housed the main X-ray laboratory, with its massive high-tension system, but the smaller laboratories and offices were on the upper floors of the house next door connected to the main building of the Institution at a number of levels and served by a hydraulic lift of character, in which Sir Lawrence refused to travel alone. The uppermost connexion with the Institution was along a winding corridor between attic offices which suddenly arrived at a door to the Resident Professor's quarters. It was along this corridor that the familiar tread would echo whenever affairs of state left a moment for research, and it was in these rooms that the new research team was installed. Under these circumstances we were soon part of the family. Uli Arndt seemed always to have been there and he was joined in 1955 by Helen Scouloudi, David Green, Tony North and Jack Dunitz: I arrived in January, 1956. Jack Dunitz unhappily left in 1957 but the rest of us remained until 1966 and we were joined during that period by others who stayed to the end, Winifred Browne and Colin Blake, and by many more who came and went, not the least important and memorable of whom was Roberto Poljak.

Initially the work was very closely linked with that going on in Cambridge. John Kendrew came nearly every week to advise and encourage us and it wasn't long before we were caught up in the developments of the myoglobin and haemoglobin work. Throughout 1956 and 1957 the excitement grew high as the isomorphous replacement method was applied to the study of myoglobin in three dimensions, and it was at this time that Sir Lawrence impressed his own style most strongly on the laboratory. His approach is perhaps best revealed by his account of the *First Stages in the X-ray Analysis of Proteins* (Bragg, 1965*b*) which describes many of the Cambridge experiments with Perutz and others which preceded the latter's triumphant application of the isomorphous replacement method. Not only does this reveal the expected grasp of the underlying physical principles but there is also a clear regard for careful measurements of individual structure amplitudes (not for nothing did Lipson tell us that the early Manchester diffractometers were digitally operated too), and a belief that thought and a few good observations can solve most problems. One of his favourite papers was written with West (Bragg & West, 1928) on *A Technique for the Examination of Crystal Structures with Many Parameters* and the general approach described there blossomed again as the study of myoglobin developed. The immediate problem was how best to determine the positions of the replaceable heavy atoms in the various isomorphous derivatives. The popular reaction was to consider variants of the Patterson function but Bragg set to work with pencil and paper and soon devised methods based upon consideration of various small classes of reflexions (Bragg, 1958). In these days of dependence on computers, it is pleasant to note that one of these approaches has proved essential to Holmes's and Klug's recent successful studies of tobacco mosaic virus.

Sir Lawrence has described the atmosphere of those

days better than I could hope to do (Bragg, 1965*b*). 'I remember well the thrill of that time. The collection of the vast body of data needed was shared between the laboratory at Cambridge and the Davy Faraday Laboratory at the Royal Institution. I made a private test of my own. Kendrew supplied me with sets of data for the *hk*0 and 0*kl* projections, for which general phases had to be determined because they have no symmetry centres. I developed a method for getting the relative reactions of the heavy atoms (Bragg, 1958) and verified that the phases could be found by drawing vector diagrams, with a very convincing agreement between the results for the different ligands. This investigation played no part in the final analysis. Kendrew fixed the heavy atom positions by a more general and powerful analytical treatment aided by the electronic computer, and the phases for all *hkl* components were systematically determined. My investigation only had a meaning for myself because it showed that the problem had been solved, and that final success was now certain. Kendrew first determined the structure to a resolution of 6 Å. It showed dense rods marking the stretches of α-helix, and the flat disk of the haem group. It was a proud day when he brought the model to show it to me.'

It was, of course, a proud and happy day for all of us in the laboratory and there were more to come as we continued the close collaboration with Cambridge until myoglobin was solved at 2 Å resolution and haemoglobin followed at 5·5 Å resolution. By now the body of data needed really was becoming vast and we had a small army of assistants measuring photographs as we struggled to develop other methods of handling the problem. Through all of this Bragg's encouragement and support was unfailing, yet in retrospect it seems as though for him some of the fun had gone. He has written about X-ray analysis (Bragg, 1965*c*) '--the subject calls for certain special qualities in the researcher. For the most part the apparatus is relatively simple and inexpensive (though this can hardly be claimed for the latest advances into the structure of large molecules). No complex mathematics is involved in the analysis and it might well be asked in what does the expertise consist? I think one may say that it demands a cast of mind rather like that which is successful in breaking a very difficult cypher or the script of an unknown language. The clues are indirect, and the imagination of the researcher who has familiarized himself with them must play over them until the happy time when the solution begins to appear, with abundant proof that one is on the right road at last.' Certainly we saw such happy times at the Royal Institution but much of the later work fell into a category which he has described less enthusiastically (Bragg, 1961): 'the new feature is that the element of guesswork has gone, and been replaced by the handling of vast masses of measurements and calculations'.

The fun now is in the results and where they lead and we had our share of that too at the Royal Institution before, all too soon, it was time for Sir Lawrence to retire (if that is the word) and for the rest of us to move away. The story of those years, how he helped and encouraged us and finally found us all places to go, is for our grateful remembrance and for another to tell.

The lasting impression is of family life in the Professor's household complete with domestic calamities, such as the way our laboratory floods always soaked Lady Bragg's bed on the floor below, and pleasures like the summer parties at Waldringfield where we hunted treasure, collected shark's teeth, watched birds, admired unknown plants and protected Sir Lawrence from terrorist attack. From so many family jokes and stories, let me end with the true one about the bored small boy who attached himself to Sir Lawrence on a trans-Atlantic voyage. 'Lets look for a whale' said Sir Lawrence, and off they went around the deck. Sure enough, before they had completed the circuit there was a whale – spouting. 'Can I stay with you always?' said the boy. We should have liked that too.

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