MOST IMPORTANT INSTRUMENT OF THE 20th CENTURY?

When I was a teenager I went to school in southeast London. One of the perks was to be able to attend, with a small group of scientifically orientated youngsters, the Schools Lectures and Christmas Lectures at the Royal Institution. Teenagers, it is fair to say, have a limited sense of history, but I remember being impressed by being addressed in a lecture theatre in which the Christmas Lecture series had been instigated by Michael Faraday in 1825. They are broadcast, on BBC television, to this day. When the camera pans round the eager young faces in the audience, I strongly remember sitting there, with my friends, thrilled by the experiments we were shown, just as Faraday intended.

Some of the Schools Lectures were given by one Lawrence Bragg, who in the 1950s was Resident Professor. I had no idea I was in the presence of such a famous scientist, who, in 1915, when he was only 25, had won the Nobel Prize, with his father, for showing how X-rays could be used to work out the arrangement of atoms in crystals. Nor did I know that little more than 10 years later I would be standing in front of a class explaining the equation that bears his name. Lawrence Bragg was a wonderful lecturer, with an affable manner and a beautifully clear use of words. He pitched his talks just right, neither confusing nor patronising his young audience. There was no hint of arrogance or that he was aware of his personal brilliance. With the high-quality experimental props that the institution provided, the lectures were events that I really enjoyed.

Bragg's work entered my career during my PhD, in Durham, England, when using the instrument shown here – a Unicam single-crystal rotation and oscillation X-ray camera. I bought the one in the picture when another department auctioned some of its old equipment, and I have the unfulfilled intention of cleaning it up. The string is attached to a lead weight at the left and to an arm at the right guided by a heart-shaped cam, causing the sample to oscillate. During tutorial sessions I would tell students that it was the most important small scientific instrument of the twentieth century. I used it to study complex alkali feldspar crystals using a method invented by J. V. Smith and W. S. MacKenzie in 1955. At that time there were the first inklings that sub-millimetre 'single crystals' could in fact be composed of intergrown discrete phases and twins in a variety of orientations at a sub-optical scale. Joe and Mac's paper contains a memorable line, an early example of the 'hard sell' of a new technique: 'The procedure for obtaining the X-ray photograph is hardly more difficult than the operation of the universal stage on a petrographic microscope, and the photograph may be interpreted at a glance.' After struggling for several days to get the *b*-axis of a 0.5 mm cleavage fragment perfectly vertical, by taking successions of photographs, each with an exposure time of several hours, until the layer lines became straight, and then have the fragment fall off the glass fibre to which it was attached, I was prone to repeat their sentence in a creatively enhanced form!

So, why might this be one of the most important scientific instruments ever? In 1950, in King's College in London, Maurice Wilkins received some gelatinous DNA from the thymus of a calf. He was able to draw thin fibres from this material and make them into a bundle. He and Raymond Gosling mounted the fibres in a Unicam cylindrical camera very similar, if not identical, to the one in my picture. Wilkins and Gosling realized that it was necessary to keep the DNA fibres moist, so they passed damp hydrogen (to reduce scattering) through the camera body, sealing it imaginatively with a condom stretched around the camera collimator. With this set-up they took the first X-ray pictures showing that DNA could be obtained in crystalline form, and Alec Stokes, also at King's, deduced that it had a helical structure. Much better pictures of DNA were subsequently taken by Rosalind Franklin, using a miniature, flat-film Norelco micro-camera with a very finely focussed beam, and her photographs led to the discovery of the structure of DNA published by Watson and Crick in 1953. But the honour of first demonstrating the crystallinity of DNA, and its helical character, goes to the old Unicam. I rest my case.

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