Cecil Arnold Beevers

The death of Dr C. Arnold Beevers, Reader Emeritus in Crystallography at the University of Edinburgh on 16 January 2001 was the passing of a great man, who was scientist, teacher, inventor, humanitarian and humorist in a rare combination. He was born in Manchester on 27th May 1908, but his family moved shortly afterwards to Liverpool, a city of which he was always proud. He obtained a B.Sc in Physics from the University of Liverpool in 1929, and a D.Sc in 1933. While there he was greatly influenced by Professor Lionel Wilberforce, whose well-designed springs and clamps Arnold never tired of demonstrating. After graduation he was asked to work in the relatively new subject of X-ray diffraction, together with Henry Lipson, a colleague and friend for many years. The two of them made frequent trips to the University of Manchester to get advice from Lawrence Bragg, and Arnold eventually moved to a post there. After a short appointment at Hull, in 1938 Arnold became Dewar Fellow in Crystallography at the University of Edinburgh, a post offered jointly by the Departments of Physics and Chemistry, and he was elected a Fellow of the Royal Society of Edinburgh later that year. He remained in Edinburgh for the rest of his life, coming into his office in the Chemistry Department for the last time less than two months before he died.

Arnold's scientific contributions were many. From his early days he is most remembered now for the Beevers-Lipson strips, and the technique by which they reduced the huge calculations of three-dimensional Fourier summations to sums of manageable one-dimensional ones. These attractive boxes of strips of card were produced in great quantity until the digital computer became generally available in the late 1960's. The technique is still used in many computer programs. Arnold's earliest structural publication was a correct and beautiful reinterpretation of the structure of beryllium sulfate tetrahydrate as interpenetrating tetrahedra of $Be(H_2O)_4^{2+}$ and SO_4^{2-} ions. Previously, a remarkably imprecise treatment had found that the sulfate ions were planar! Arnold rapidly became involved in determinations using Fourier methods and the new Patterson method; important examples were the alums, copper sulfate pentahydrate, and particularly the so-called b-alumina, $NaAl_{11}O_{17}$, which he published with the late Dr Marion Ross. Originally studied as a troublesome impurity in Al_2O_3 production, it is now an important solid-state ionic conductor, and two sites in the structure are known as Beevers-Ross and anti-Beevers-Ross sites.

Arnold's arrival in Edinburgh was soon followed by the outbreak of the Second World War. As a member of the Society of Friends and conscientious objector, he was sent to assist Professor Norman Dott at the Western General Hospital in work on electroencephalography. Arnold threw himself enthusiastically into this, particularly as it threw light on the nature of sleep, and this interest remained with him for the rest of his life.

After the war, Arnold joined the staff of the Department of Chemistry and built up an X-ray diffraction laboratory there, mainly with equipment he designed himself. His generators and cameras were characteristically robust and precisely engineered. The arrival of Professor E.L. Hirst and the growth of his carbohydrate group encouraged Arnold to investigate the then daunting structures of sugars, including glucose and sucrose in the form of its sodium bromide adduct.

As a teacher, Arnold gave lectures of a highly individual nature, which generations of students found memorable. As an experimenter he delighted in demonstrations and younger colleagues were surprised (to say the least) to see him showing the bones of his hand to visitors by using the direct beam from the lab X-ray generators. Again his crystallography lectures featured a collection of plasticene elephants he used to occupy the sites of a lattice. He also had a large assortment of collecting boxes for Dr Barnardo's Homes for this purpose, frequently pointing out that this was an excellent charity and that the boxes had another useful function! Possibly his most lasting impact as a teacher was in teaching chemistry to dental students over many years. In 1946 he published an elegant interpretation of the structure of fluorapatite, the ideal bone and teeth mineral, showing the function of the fluoride ions in holding it together. Thereafter he became devoted to the cause of improving dental health by adding fluoride to drinking water supplies deficient in it and often spoke at rallies on this subject, cheered on by his students. He was very proud to receive life membership of the Edinburgh University Dental Society on his retirement in 1978.

Arnold was for many years active in the Edinburgh Cripple Aid Society and was much in demand as a helper, particularly as Master of Ceremonies at plays and concerts. He was not fazed by events such as an epileptic seizure affecting a leading lady and could immediately take over, often leading the audience in community singing. He displayed similar ability at international scientific meetings and was particularly famous for his version of "My Bonnie lies over the Ocean" in which the singers must stand up or sit down on each word beginning with "b". Generally by the third chorus even a group of scientists were coping with all the "bring backs"!

His involvement with disabled people was very important in Arnold's last major scientific contribution – now known as Beevers Miniature Models. Moving away from structure determination after 1960, as he was never

really happy with the advent of the digital computer, he sensed the need for accurate ball-and-spoke models on a much smaller scale than that of the inch to Ångstrom models then available, and developed precision drilling machines to enable the scale to be reduced to 1 cm per Ångstrom. After some experimentation he fixed on the 7mm perspex spheres and 1mm steel rod now used, being determined that the models must be both accurate and elegant. Typically he published his methods and did not consider the idea of a patent which he saw as unfairly denying public access to his ideas and methods. The calculations required for drilling he carried out manually, using a Wulff net for his stereographic projections. From the start, much of the work was done by disabled workers, including at one time Brian Wilson, the world's longest surviving patient on renal dialysis (as listed in the Guinness Book of Records!). These workers clearly took great pride in their products, which are now found all over the world from a school in Port Moresby, New Guinea, to IBM Research. The Models were eventually taken over by the University and Arnold accepted that lesser mortals would have to use a computer even for drilling calculations. The continuation of the Beevers Miniature Models Unit shows that he was right in thinking that, in museums, teaching or research, computer modelling would not replace completely the elegant, permanent model.

Arnold's deep faith in and with the Society of Friends (Quakers) greatly influenced his approach to science and to life. He was unswervingly committed to humanitarian causes, particularly world peace, and strongly disliked any form of superstition or other obscurantism, and any sort of pomposity. His life was touched by tragedy, especially the severe dementia which overtook his wife, Marjorie, in the late 1950's and worsened progressively until her death in 1992. Sadly, a similar problem affected Yvonne, his second wife, who died in 1998. In these circumstances his never-failing sense of humour was all the more remarkable. Arnold is survived by his daughter Lois and son John and by four grandchildren and five great-grandchildren. Many former students and colleagues world-wide have joined in sending them their sympathy and happy memories of a great and kind man.

From an obituary in *Crystallography News* reprinted by kind permission of the Editor.

Cecil Arnold Beevers DSc, FInstP: born 27 May 1908; elected FRSE 6 March 1939; died 16 January 2001