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The Passing of the Father of Neutron Diffraction in Europe

Professor G.E. Bacon, the first neutron scatterer in Europe, passed away peacefully on the 18th March 2011 at the age of 93. He was born in Derby on the 5th December 1917, and educated at the 800-year old Derby school, and Emmanuel College, Cambridge.

George became Deputy Chief Scientific Officer at the AERE Harwell immediately after the war, and built the first neutron diffractometer in Europe. In a paper with J. Thewlis entitled simply "Neutron Diffraction" submitted to the Royal Society in 1948 he wrote "it is also shown that the powder method, which it is desirable to use when structure factors are to be determined, will be feasible if the number of pile neutrons which hit the monochromatizing crystal is greater than 10^5 per sec". In 1950 he described in *The Journal of Scientific Instruments* "Some Mechanical Features of a Double-Crystal Neutron Spectrometer".

Many papers on the application of neutron diffraction to both powders and single crystals followed, with evocative author lists such as "Bacon and Pease" and "Bacon and Curry", such is the reputation of post-war English cuisine. Of particular note is

his work with R.S. Pease in 1955 on the ferroelectric transition in Potassium Dihydrogen Phosphate (KDP) using single crystals polarised by an electric field. KDP was still being studied with neutrons decades later at Harwell and ILL by Richard Nelmes, Werner Kuhs, Garry McIntyre, Christian Vettier (at high pressure) and others including the humble author of these lines!

With N.A. Curry in 1956 George was the first to use neutrons for the study of hydrogen bonding in organic molecules such as alpha-Resorcinol, and with Curry and Wilson in 1964 the solid structure of crystals such as Benzene, which are normally liquids. Stuart Wilson was later one of the first British recruits to the ILL Diffraction group. George was also one of the first to use deuteration to study hydrogen bonding in crystals like hydrated Copper Sulphate. He was also interested in magnetism in materials such as K_2ReCl_6 , later taken up by Jane Brown and Bruce Forsyth.

George's first book, "Neutron Diffraction" (1955) became the "bible" for early neutron scatterers, and ran to three editions and several languages. There followed "Applications of



Photograph of (from left to right) Alan Leadbetter (UK Director, ILL), Pierre Convert (ILL) and George Bacon (aged 81) in 1998 with some of the bones he was investigating with powder diffraction at the ILL.

Neutron Diffraction in Chemistry" (1963), "X-ray and Neutron Diffraction" (1966), "Neutron Physics" (1969), "Neutron Scattering in Chemistry" (1977) and "The Architecture of Solids" (1981). His last book was as editor of "Fifty Years of Neutron Diffraction" (1987) which was also the title of the formal celebration in 1998 of his 80th birthday.

As a young man, George had worked throughout the war on the detection of the height of incoming

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bombers using the reflection of 1.5m radio waves. The idea was to use a vertical array of dipoles, producing a very narrow beam in the vertical plane due to interference effects, a little like x-ray diffraction in crystals. This effort resulted in a simple but effective “Chain Home” radar surveillance system of the entire coast in time for the Battle of Britain.

George became Professor of Physics at the University of Sheffield from 1963 until his “retirement” in 1981, but still visited Harwell, which he had helped establish as the first “user access” neutron source, for experiments. I met him 40 years ago when I was a young postdoc there with Terry Willis, the most unassuming and gentle man I have ever known. While I was struggling to understand the dynamics of structural transitions in KTN and KDP, I remarked to George that there were big changes in the powder patterns with temperature, if only we could extract that information. George smiled gently and remarked that some fellow in the Netherlands had been working on that recently. It turned out to be Hugo Rietveld.

Years later, well into his 80’s, George was still working on D1B and D20 at ILL with Pierre Convert, on the texture of bones! The photograph shows him with Alan Leadbetter (UK Director) and Pierre Convert in 1998, but his last ILL experiment was in 2002. George was of the old school of gentlemen scientists, typically dressed in coat and tie in the laboratory. He believed in empirical methods, integrating Bragg peaks by drawing them on paper, cutting them out and weighing them, before Pierre Convert converted him to Macintosh computers when he was only 81. Young scientists today cannot imagine experimental physics before the arrival of the ubiquitous Personal Computer.

George was not a strong man at his remarkable age, so we joked about “Bacon’s Bones”. But he was onto something interesting as usual. He knew that the apatite crystals in bones were aligned for maximum strength, and that when a broken bone healed, it would reputedly never break again in the same place. So he wanted to know whether the crystals in the new bone were also aligned. Using neutron pow-

der diffraction he showed that the new growth wasn’t aligned; the extra strength was simply because the bone grew thicker at the break.

Then he asked about the apatite alignment in the various bones of animals, slaughtered at different ages after their bones had been broken and healed. Neutron diffraction was a great tool because it could penetrate thick materials. He found many examples of how nature had designed bones to be as strong and as light as possible. His most famous bone study was of prehistoric man. He showed that men who lived at the top of a cliff and had to climb up and down to the sea had stronger leg bones than those who lived by the shore and never needed to climb. These studies developed to fruition an approach initially suggested by his son Philip, a research biologist, who also helped with the early work.

George Bacon, the father of Neutron Diffraction in Europe, is survived by his son, and his daughter Jean, his wife Enid having died in 2003.

Alan Hewat, April 2011 (with Sax Mason, Pierre Convert, Thomas Hansen & Philip Bacon).

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