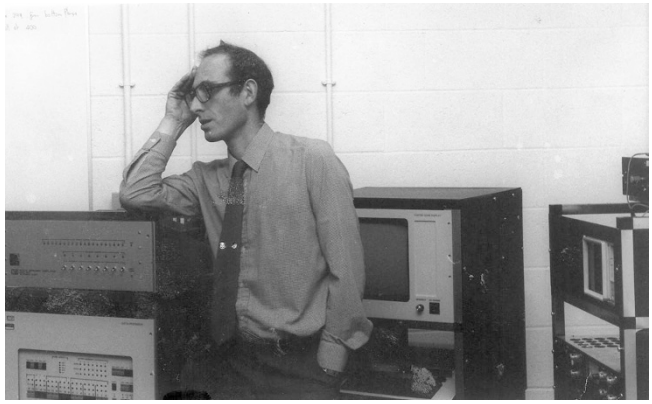

University of Oxford

Iain D Campbell 1941–2014

Christina Redfield

Iain Campbell was born in Blackford, near Perth, in Scotland. He attended Perth Academy and then studied Physics at the University of St. Andrews, obtaining a BSc in 1963 and a PhD (thesis entitled *ESR Studies of Optically Excited States*) in 1967. After spending a year as a postdoctoral researcher in Bradford, Iain took up a postdoctoral position at Oxford, working with Rex Richards, initially in the Physical Chemistry Laboratory and later in the Department of Biochemistry. Iain continued to follow his interests in magnetic resonance, moving from ESR to NMR. Iain's first paper, published in 1970 (G.E. Chapman, I.D. Campbell and K.A. McLauchlan, *Nature* **225**, 639–641, 1970), was a deuterium NMR study of collagen. During the early 1970s, Iain published papers with household names in the field, including Raymond Dwek, Ray Freeman, Keith McLauchlan, Sir George Radda and Sir Rex Richards. These papers focused on topics in magnetic resonance including spin echoes, nuclear Overhauser enhancement and the effects of spin labels and paramagnetic metal ions on relaxation, as applied to model systems and proteins including phosphorylase and carbonic anhydrase.


University of Oxford

Iain Campbell in front of the console of a home-built 500-MHz spectrometer, circa 1985.

In the early 1970s, Iain also began a very productive collaboration with Christopher M. Dobson and Robert J.P. Williams, using a 270-MHz spectrometer acquired by the Oxford Enzyme Group. I first came across Iain's work in 1980 when, as a first-year graduate student in the Dobson group at Harvard, I read many of the papers by Campbell, Dobson and Williams. One of Iain's most highly cited publications is the 1973 paper 'Resolution enhancement of protein PMR spectra using the difference between a broadened and a normal spectrum' (I.D. Campbell, C.M. Dobson, R.J.P. Williams and A.V. Xavier, *J. Magn. Reson.* **11**, 172–181, 1973). This convolution difference method was widely used to improve resolution in 1D spectra of proteins, and it allowed resonance assignments to be made on the basis of peak multiplicities and connectivities established with spin decoupling. Instructions for carrying out convolution difference on a Nicolet 1080 system feature on page five of my very first lab notebook (circa June 1980).

Another important early paper, published in 1975 by Campbell *et al.* (I.D. Campbell, C.M. Dobson and R.J.P. Williams, *Proc. R. Soc. Lond. B Biol. Sci.* **189**, 503–509, 1975), reported that the tyrosines in lysozyme give NMR resonances consistent with aromatic ring flips at rates exceeding 10^4 s^{-1}. (Similar observations had been made independently by others, including Wüthrich and co-workers for basic pancreatic trypsin inhibitor.) Campbell *et al.* stated that "it may be necessary to invoke some sort of breathing motion in the protein to allow this proposed flipping process to take place." The unexpected observation of ring flips was an early indicator of the power of NMR spectroscopy for defining protein dynamics.

I first met Iain in the autumn of 1980, when I moved from Harvard to Oxford with Chris Dobson. By that time, Iain's research focus had moved to what is now called 'in-cell' NMR. His group studied metabolism, enzyme kinetics and membrane transport in erythrocytes by using spin-echo NMR and hydrogen/deuterium exchange.

Developments in NMR spectrometers, 2D NMR methods and sequence-specific assignment in the early 1980s meant that X-ray structures were no longer required for the interpretation of protein NMR spectra. Iain's research efforts returned to protein NMR in the mid-1980s. In a landmark study in 1987 (R.M. Cooke *et al.*, *Nature* **327**, 339–341, 1987), Iain and co-workers determined the structure of epidermal growth factor. This was the first NMR protein structure determined in the UK. It also represented a biologically important structure that provided a basis for understanding the properties of epidermal growth factors and related proteins.

Structure determination by NMR is limited to relatively small proteins (up to ~30 kDa). The recognition that many large proteins are composed of much smaller, autonomously folded protein modules allowed Iain and co-workers to develop a dissection approach to study these systems. Efforts in the early 1990s focused on structures of individual modules including the type I, II and III domains of fibronectin and the complement control protein module. Extension of this approach to domain pairs allowed the definition of interdomain interfaces and dynamics. This provided the insights needed to build models of much larger regions of these multidomain proteins to gain an understanding of their biological function. NMR was also used to define the protein-protein interactions, for example, elucidating the interaction of fibronectin with collagen and demonstrating how pathogenic bacteria bind to fibronectin. Iain's research most recently focused on the proteins involved in the formation of focal adhesions, dynamic assemblies of modular proteins that form and dissolve as cells migrate. NMR, in conjunction with other biophysical and computational methods, was used to study proteins including

Christina Redfield is at the Department of Biochemistry, University of Oxford, Oxford UK.

integrins, filamin, migfilin and talin. Investigation of the interaction between the cytosolic tails of integrins and talin has suggested the basis of inside-out signal transduction.

Iain's contributions to science have been recognized in numerous ways. He was elected as a Fellow of the Royal Society in 1995, and he delivered the Royal Society's prestigious Croonian Lecture in 2006, entitled 'Structure and the living cell'. Iain was elected as a Member of the European Molecular Biology Organization in 1990 and as a Fellow of the International Society of Magnetic Resonance in 2011. On St. Andrew's Day (30 November) in 2012, Iain was awarded the Degree of Doctor of Science *honoris causa* by his alma mater, in recognition of his "major contribution to science."

Iain was committed to educating the next generation of biochemists and structural biologists at both the undergraduate and graduate level and to mentoring postdoctoral researchers. After his official retirement in 2009, Iain continued as Director of Teaching for the undergraduate biochemistry course and wrote a textbook, *Biophysical Techniques* (Oxford University Press, 2012). Iain's influence on structural biology in the UK and abroad will continue for a long time. Former group members hold faculty positions at more than ten UK universities including Oxford, Cambridge, Imperial College, Manchester, York and St. Andrews. His influence reaches across the globe to Australia, where former group members can be found at universities in Adelaide, Brisbane, Canberra and Melbourne.

Iain Campbell died on 5 March 2014 after a long battle with bone cancer. His death is a tremendous loss to his colleagues in Oxford and to the wider structural biology community. Iain made many important contributions to NMR methodology, but I think he would want to be remembered for the way in which he used NMR spectroscopy to tackle important biological problems. He will be missed.