Frank Albert Cotton (1930–2007)

Twentieth century dawned with a great legacy for inorganic chemists: the coordination theory of Alfred Werner. Lack of reliable structural tools and bonding theories did dampen this arousal in the following years, but not for very long. By the 1950s the no-looking-back posture of inorganic chemistry was firmly in place. Quantum mechanical valence theories had arrived, ligand field theory had been rediscovered, mechanistic ideas were shaping up, spectral and magnetic (including resonance) tools were becoming available, X-ray crystallography was slowly coming nearer to chemists, ferrocene had been discovered and so had been titanium-catalysed olefin polymerization, proteins and metalloproteins were no longer mere fuzzy objects… . For inorganic chemistry the 1950s defined a watershed, an era of unprecedented hope and promise. It was the best of seasons for young talents to arrive. Preeminent among the arrivals was Frank Albert Cotton – Al to his many friends.

Cotton received his Ph D degree in 1955 from Harvard University, working on metallocenes in the laboratory of Geofferey Wilkinson. In the same year he took up an Instructorship at MIT and within six years, at the age of 31, became the youngest full professor. In 1972 he moved to Texas A&M University where he held the positions of Doherty–Welch Distinguished Professor and Director of the Laboratory for Molecular Structure and Bonding. He became a legend and played a signal role in transforming Texas A&M into a world-class research institution.

Cotton was born on 9 April 1930 in Philadelphia where he attended public schools, Drexel University and Temple University from where he received a Bachelor's degree (AB) in 1951. He wanted to enjoy 'the thrill of discovery and the challenge of finding out something that perhaps no one has yet'.

Cotton's research spread its wings over many important phases of inorganic chemistry – those of *d*-block transition metal chemistry in particular. The findings of his vast activity spanning over fifty years and involving more than 100 Ph D students and 150 postdoctoral associates have been documented in about 1600 papers. Cotton had the foresight to consciously adopt the single crystal X-ray diffraction method as a structural tool from his early days at MIT. That was years before the technique was to become commercial and routine. He had an early and successful stint with high-resolution three-dimensional structure determination and mode of action of an important enzyme – staphylococcal nuclease. But his true love was with inorganic molecules.

Cotton made major contributions to the understanding of spectroscopic properties of metal carbonyls and dynamical behaviour of fluxional organometallic compounds. But the most important work of Cotton concerned metal–metal bonding. Although a few isolated instances were known earlier, it was Cotton who beginning in early 1960s, systematically brought to light how very widespread and fascinating such bonding could be in *d*-block chemistry – hardly any metal is now excluded. This journey was propelled by a remarkable symbiosis of skillful synthetic experiments with a panoply of physical methods and theoretical tools. Observed bond orders fell in the range 1–4 and thus the scientific community heard of double, triple and quadruple metal–metal bonds. His work in this area is correctly said to have 'transformed our understanding of how the chemistry of about half the elements in the periodic table really works'.

Cotton wrote and edited a large number of popular books. Two of these have become legends: *Advanced Inorganic Chemistry* and *Chemical Applications of Group Theory*. The former co-authored with G. Wilkinson, was first published in 1962 and is now in its sixth edition (having two additional co-authors). It incorporates more than four thousand references to literature and is like a *Bible* of inorganic chemistry. The second book, appearing in 1963, did the magic of instantly bringing the principles of group theory and its chemical use within the easy grip of every willing chemist for the first time. Cotton founded the important annual series *Progress in Inorganic Chemistry*, and edited the first ten volumes. The chemistry of metal–metal bonds has been chronicled in the book *Multiple Bonds between Metal Atoms*, co-authored with R. A. Walton. Cotton invented the commonly used terms like 'metal cluster' and 'hapticity'.

Starting in 1962 when he received the ACS Award in Inorganic Chemistry, Cotton has been honoured with many prestigious medals, awards, fellowships, honorary degrees and editorships. It will suffice here to note that he won the Wolf Prize, Lavoiser Medal, Priestley Medal, Robert A. Welch Prize, Paracelsus Prize, King Faisal Prize and the National Medal of Science. He has been an Honorary Fellow of the Indian Academy of Sciences, Bangalore and Foreign Fellow of the Indian National Science Academy, New Delhi. The jury of the Wolf Prize identified him as the 'preeminent inorganic chemist in the world'. Two awards bearing his name – the F. A. Cotton Medal and F. Albert Cotton Award for Synthetic Inorganic Chemistry – have been instituted to honour distinguished chemists.

I spent a postdoctoral year (1961–62) with Al at MIT. Initially the vortex of activity in his large group unnerved me, but it did end well. At that time Al was putting extra efforts in X-ray crystallography (it was still the precession camera period), his two books were in the offing and his first daughter Jennifer was born. I fondly remember attending his group theory course (the lecture notes became the book later), dining in their home and taking him and his charming wife Dee to a Ravi Shankar concert.

Years later I visited Al at Texas A&M for a few months. It was a free assignment with lectures in many institutes, including Texas A&M and occasional visits to Al's ranch. More importantly it brought me face-to-face with X-ray crystallography.

Al's message was clear: go and do it in your laboratory in Kolkata. This did happen within a few years. I met him again later in a Gordon Conference in 1987 and subsequently there was a memorable party in Boston to celebrate the occasion of his publishing 1000 papers.

Al passed away on 20 February 2007 at the age of 76. He is survived by his wife, two daughters, innumerable admirers and friends, and the countless students across disciplines who read his books.

In 2000 he wrote an article entitled 'A millennial view of transition metal chemistry'. Let me conclude by quoting a few lines: 'For the transition elements, chemistry of the past has been brilliant and that of the future is also likely to be brilliant... There will still be a lot of fun, intellectual satisfaction and profit to be had from advancing the chemistry of the transition elements in the third millennium'.

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