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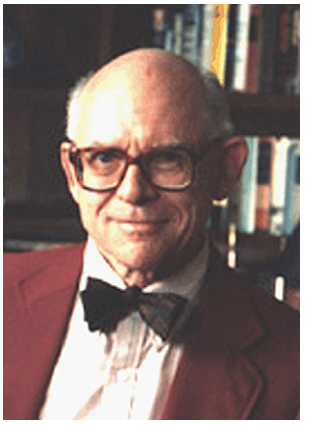
Obituary / Nécrologie

Frank Albert Cotton (1930–2007)



On February 20, 2007, the chemical community lost one of its most distinguished scholars, F. Albert Cotton, in College Station, Texas, a few weeks short of his 77th birthday. He was a great friend, collaborator, and mentor to 118 Ph.D. graduates and over 150 postdoctoral associates, with six of these coming from France. He will be sorely missed by colleagues, friends, Diane (Dee), his wife, and his daughters, Jennifer and Jane.

Al Cotton loved to visit Paris. He enjoyed good food, art and good music. In addition, he loved to watch the French Open tennis tournament. He and Dee often traveled there together. He had many persons in France who knew him as a friend, not just as the world famous American inorganic chemist, a foreign member of the French Academy of Science, and the principal contributor to the renaissance of his discipline after World War II. His research (over 1600 research publications), his graduate teaching, his textbooks[1] and his drive have put the discipline of inorganic chemistry on par with the other strong sub-disciplines of chemistry worldwide.

The half century of Cotton's active work was led by his focus on fundamental, basic studies that he liked to call "curiosity-driven research". Much has been written about F. Albert Cotton's research career,[2] and even more will appear in the near future, including his autobiography, which he had completed just a few days before he was hospitalized. Clearly he is widely recognized for his contributions to the understanding of metal–metal bonding and his careful and rather simple characterization of the quadruple bond in $[Re_2Cl_8]^{2-}$. He and his group at the Massachusetts Institute of Technology

[1] *Advanced Inorganic Chemistry*, John Wiley and Sons, co-authored with Geoffrey Wilkinson in 1962. Now in its sixth edition with additional co-authors Carlos A. Murillo and Manfred Bochmann; *Chemical Applications of Group Theory*, John Wiley and Sons, NY, 1960, now in its third edition, 1990; *Basic Inorganic Chemistry*, John Wiley and Sons, 3rd Edition, 1995, co-authored with Geoffrey Wilkinson and Paul Gaus; *Chemistry: An Investigative Approach*, Houghton Miffin Science Program, 1973, with C.L. Darlington and L.D. Lynch.

[2] Carlos A. Murillo, Inorg. Chim. Acta. 360 (2007) 2519; Tobin J. Marks, Science 316 (2007) 214; Stephen J. Lippard, Nature 446 (2007) 1; J.P. Fackler, Jr., Angew. Chem., Int. Ed. Engl. 46 (2007) 3790.

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had studied this compound with the initial belief that it might be the first example of a low-spin tetrahedral complex of a second-transition-row element. It took him an incredibly short time to develop the realization that sigma, pi and delta bonding exists in this and related systems, something that no one previously had recognized to be possible. He and his group continued studying multiple metal–metal bonding, and a major research book on this topic resulted.[3] Incidentally, he moved from instructor in 1955 to Professor in 1961, the youngest MIT faculty member at that time to achieve this rapid promotion.

Cotton's gift for bringing a theoretical understanding to complex inorganic systems was remarkable. Ligand field theory became part of his repertoire of tools while a student, when he spent a semester in Copenhagen with C. Ballhausen, C.K. Jorgensen, and J. Bjerrum. His thesis at Harvard, *Studies in bis-cyclopentadienylmetal complexes*, in 1955, dealt with the synthesis and development of an understanding of the bonding and properties of the new ''sandwich'' compounds for which Wilkinson later shared the 1973 Nobel prize with E.O. Fischer. Magnetic measurements and heats of combustion studies were essential to validate the ''aromatic'' character of these complexes. His thesis also describes symmetry-based molecular orbital constructs in the notation of J. Dunitz and L.E. Orgel for the bonding. A few years later, in lecture classes at the Massachusetts Institute of Technology, he described these ideas in a course on ''Chemical Applications of Group Theory'', and the book of the same name developed.[1] Chapter 3 in this book is one of the most clear and concise statements of ''Molecular Symmetry and the Symmetry Groups'' ever written in the English language. By 1960 he and Wilkinson published *Advanced Inorganic Chemistry*.[1] His gift for putting words to paper was phenomenal, duplicated by few, if any, chemists of our day.

This passion for creating a theoretical understanding of complex inorganic systems not only led Al Cotton to the quadruple bond, but also a thorough development of transition-metal single-, double- and triple-bonded species in di-metallic, tri-metallic, and larger metal-containing clusters.[3] The bond energies associated with these new types of bonding were always of great interest to him and he probed how relatively weak bond energy could lead to chemically dynamic behavior, which he called fluxional, and the related pseudo symmetry of these compounds. I believe that he first was attracted to these thoughts while trying to understand the difficulties Dunitz had to structurally characterize ferrocene. The barriers associated with interconversion from the D_{6h} eclipsed structure ultimately found in the solid state to the staggered D_{6d} structure are small. He and his students also recognized that the differences in the time constants of various forms of spectroscopy could explain why one technique might suggest a different structure from another. Ultimately, he deduced that definitive solid-state structures, obtained by single-crystal X-ray crystallography, were unquestionably the best starting point from which the structures in solution and the gas phase might be developed, using less certain spectroscopic means. He called them ''sporting methods''. Every tool available to chemists was used by him to probe structures and properties of compounds, mainly of the transition metals. However, it was not until electrospray techniques appeared that he trusted mass spectroscopy to answer his questions.

Cotton's love of horseback riding and the fox hunt, as well as a conservative politic and a confidence that he could do outstanding chemistry anywhere with proper funding led him to Texas A&M in 1972. This puzzled many of us who thought Cambridge, MA was the ''Mecca'' of modern inorganic chemistry. He bought a fine ranch a few miles from the campus and proceeded to successfully push, with the help of others, the creation of a strong chemistry department here. The commute to his office in Texas took much less time than the commute in Boston and he was always here six days a week unless traveling. How he found time to establish a hunt club baffles me. Over the last decade or so, his daughter Jennifer has run the ranch with its horses, cows and oil wells.

Although Cotton received numerous awards and accolades for his work, election to the French Academy of Sciences was one which he received with great pride. Cotton was a student of chemical history and knew well the names of the great scientists who had signed the book prior to him. I suspect that he dreamed about the debates he might have had with some of these chemists at general meetings of the Academy. He enjoyed languages, especially French, and became quite fluent in it. It is interesting to note that the Preface to the first volume of *Progress in Inorganic Chemistry*, a series he initiated in 1960, contains the statement that ''articles will be published in any of three languages, English, German and French, which research chemists are assumed to read.''

[3] *Multiple Bonds Between Metal Atoms*, with R.A. Walton, John Wiley and Sons, 1982, now in its 3rd Edition, 2005, with Carlos A. Murillo, a co-author.

Although he had been awarded 29 honorary doctorates by universities around the world, he was looking forward to his 30th. He was slated to receive this, his 5th French honorary, from the ''Université Paul-Sabatier – Toulouse-3'' in June, 2007.

A memorial service headlined by The Lord Jack Lewis took place on April 25, 2007 in College Station, TX, with an exceptional list of former students and internationally renowned contemporaries speaking about his contributions. His impact on the chemical community through his books, research and students has left him with few peers. We shall miss his clever wit, his inquisitive mind, his sometimes sharp tongue and especially his loyalty to his scientific family and his wife and children.

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