Biography of Alvin L. Kwiram

In 1858, August Kekule proposed that carbon atoms could join together to form chains, and in 1865, he introduced a rationalization of the structure of benzene that ultimately led to the concept of π-electron delocalization. Although Kekule's work quickly set synthetic chemists on the path to exploring the great chemical diversity of carbon, a century would pass before physical chemists would launch the systematic exploration of the impact of π-electron delocalization on the electrical, optical, and magnetic physical properties of organic materials that could be exploited for technological applications. The 1960s can be characterized as a time of great scientific ferment, as the new techniques of magnetic resonance and laser spectroscopy were used to characterize solid-state organic materials in unprecedented detail. Electronic structures, electron−phonon interactions, radiation damage mechanisms, local mode dynamics, spin−spin interactions, etc. were investigated with previously unobtainable resolution. Even excited states could be investigated in great detail as was demonstrated by various research groups, e.g., those led by Kwiram, El-Sayed, Harris, and van der Waals using optical detection of magnetic resonance (ODMR). The ability to characterize solid-state π-electron materials certainly helped motivate the wider exploration of such materials for applications such as superconductivity, and this was followed in short order by the discovery of polyacetylene (conducting polymers), which was recognized by a Nobel Prize in Chemistry [to Professors Heeger, McDiarmid, and Shirakawa] in 2000. These advances have in turn been followed by the discovery of organic light-emitting device materials, electrooptic materials, novel magnetic materials, two-photon materials, etc. that are now starting to enter the commercial marketplace. More recently, even the extremely challenging fields of organic photovoltaics and organic electronics appear to be yielding important advances. And, of course, our thinking about π-electron organics was changed forever by the discovery of the fullerenes and carbon nanotubes, again recognized by a Nobel Prize in Chemistry [to Professors Curl, Kroto, and Smalley] in 1996.

This issue focuses on the now well-recognized, important discipline of solid-state electroactive organic and hybrid materials and upon the methods and tools (including those based in nanoscience and nanotechnology) used to produce and characterize such materials. This issue also honors one of the pioneers in this field and one who, early on, championed interdisciplinary approaches, which have come to characterize not only this field but also science more generally. This issue celebrates Professor Alvin Kwiram of the University of Washington both for his research contributions to organic, inorganic, and biological materials and for his broader contributions to higher education and scientific research in general. Alvin Kwiram helped establish a number of new research directions that have since been pursued in many other laboratories. As an administrator, he has dramatically impacted and promoted the careers of those around him from undergraduate students to senior researchers/educators. He has advanced the constructive collaboration of academia, industry, state, and federal government. As chemistry is "the central science", Alvin Kwiram has been a "central scientist".

Following Ph.D. (1963) studies with Prof. Harden McConnell at the California Institute of Technology, a special postdoctoral Alfred A. Noyes Instructorship at Caltech, and a postdoctoral fellowship with William Fairbank in the Physics Department at Stanford University, Dr. Kwiram's faculty career started at Harvard University (1964−1970). There he pioneered the field of optically detected magnetic resonance (ODMR) applied to solid-state organic materials. He was also one of the early developers of electron nuclear double resonance (ENDOR) as applied to organic materials. Indeed, he was the first to demonstrate room-temperature ENDOR, and he was the first to develop a detailed interpretation of powder (disordered materials) ENDOR spectra. In the late 1960s, Kwiram demonstrated the technique of ENDOR-detected nuclear magnetic resonance in organic crystals and showed how detailed structural and dynamic information could be obtained for solid-state organic molecules. He demonstrated that such data could be an important complement to X-ray crystallographic data and yield hydrogen coordinates comparable to those achieved with neutron diffraction methods. To provide a detailed theoretical understanding of these novel magnetic resonance techniques, Kwiram executed the first comprehensive investigation of spin−lattice, spin−spin, and cross-relaxation in organic materials. Measurements were carried out from 2 K to room temperature. A variety of new relaxation mechanisms were discovered, and a general understanding of nonlinear magnetic resonance spectroscopic techniques was developed that would later aid the study of polyacetylene (see article by Kwiram and co-workers in this issue). While at Harvard, Kwiram served as doctoral advisor (jointly with Professor Dudley Herschbach) to the late Derek Lindsay, who took up the study of small clusters of alkali metals as a way of understanding the transition from atomic to bulk properties. (This could be viewed as an early venture into nanoscience, and indeed the conversations in the group at that time explicitly considered the goal of building materials with unique properties from the ground up by creating defined atomic and molecular clusters.) Various oxides of these alkalis were also characterized using EPR. Kwiram and co-workers also looked for and detected by EPR what may have been the first example of a trapped transition state complex (K- -HCL) in the solid state at low temperature.

In 1970, Prof. Kwiram moved to the University of Washington (UW) where he has spent the remainder of his career. He continued the research activities that he started at Harvard although in some cases significantly altering directions. For example, he extended ODMR studies to the triplet state of porphyrins, of tryptophan in proteins, and of aflotoxin bound to DNA. He continued work on developing a detailed understanding of magnetic resonance and particular the effect of molecular dynamics on various types of magnetic resonance spectra. His goal was to define which techniques could provide the best insight into particular types of dynamics and what were the limitations of the many new time-domain and multiple magnetic resonance techniques for defining structure and dynamics. In the late 1970s and early 1980s, my group at USC joined with Kwiram and other colleagues at the University of Washington, to focus on the study of soliton wave function and dynamics in the prototypical conducting polymer polyacetylene. Experimental studies included electron spin lattice relaxation studies carried out as a function of temperature (to 2 K) and magnetic field. These studies illustrated the importance of

10.1021/jp0401731 CCC: $27.50
Published on Web 06/17/2004

interchain interactions, a factor that was also observed to be important for understanding electrical conductivity in conducting polymers.

Alvin Kwiram was also known as an outstanding teacher. The lecture notes from his junior level Quantum Mechanics course have been widely circulated and used at other universities. In 1977, Prof. Kwiram assumed the position of Chair of the Department of Chemistry at UW, a position that would engage his energies for an entire decade. During his tenure, sponsored research in the department would grow by a factor of 10, an undergraduate biochemistry degree program would be implemented (currently some 150 chemistry/biochemistry degrees are granted each year at UW), some 20 faculty would be hired increasing the number of faculty lines to 35, a new chemistry building (adding 40 000 sq. ft.) would be approved and built, the NSF-funded Center for Process Analytical Chemistry would be launched with over 40 industrial sponsors, and important departmental research initiatives in biological magnetic resonance and environmental chemistry would be launched. Alvin Kwiram was the critical catalyst in each of these significant achievements.

From Chair of Chemistry, Prof. Kwiram moved to the central administration of the University of Washington serving initially as Vice Provost, then Senior Vice Provost, and starting in 1990 as Vice Provost for Research. As head of the UW research enterprise, Kwiram helped guide UW's rise to second place in the nation in terms of total external research funding ($933M in FY03). He also guided the technology transfer program to the ranks of the top 10 in the nation in licensing and royalty income ($30M in FY00). In doing so, he also championed the cause of young faculty, exemplified by the creation of the Royalty Research Fund, which awards roughly two million dollars each year for new faculty initiatives in research, scholarship, and artistic endeavors. He was also an early proponent of expanding both the human and financial resources to promote meaningful undergraduate research experiences. As an administrator, he helped to shape the current face of UW research including nationally recognized efforts in biomedical research and genomics; computer science and computer engineering; and materials science and nanotechnology. The Advanced Technology Initiative of the State of Washington is another example of transformative programs that he fought successfully to implement. He was an early and tireless proponent of interdisciplinary research at UW, and a number of current programs can be traced to his efforts. His efforts in research administration have not only transformed UW but have also impacted the surrounding region and the state. Nearly 100 companies were started in the 1990s based on UW developed technology. As an administrator, Prof. Kwiram also actively promoted creative educational experiments including distance learning and international research programs.

Quite naturally, Prof. Kwiram's career has included service at the national and international level. He was actively involved in the creation of the Council for Chemical Research and served as its first academic chair. As chair of CCR, he proposed and promoted a follow-up report to the Pimentel Report on the state of chemistry and set in motion the preparation of a parallel report on the state of chemical engineering. Kwiram served as the chair of the Chemistry Division of the American Association for the Advancement of Science (AAAS), and also served on the AAAS Program Committee for six years. He chaired the Council on Research Policy and Graduate Education of the National Association for State Universities and Land Grant Colleges. He encouraged and oversaw the creation of the award-winning *Northwest Science and Technology* magazine, which plays a significant role in bringing science awareness to the public. He was instrumental in creating joint institutes between Pacific Northwest National Laboratory (PNNL) and UW in areas of nanoscience/nanotechnology, environmental security, and in the biosciences. He also initiated the collaboration between PNNL and the UW that had as a goal the building of a 1 GHz NMR instrument, and today a 900 MHz instrument is in operation at PNNL. Finally, Prof. Kwiram has influenced national science policy through service on numerous advisory committees.

In 2002, Prof. Kwiram stepped down from his position in the central administration at UW and returned to the Chemistry Department. However, his administrative efforts continue as Executive Director of the National Science Foundation Science & Technology Center on Materials and Devices for Information Technology. He continues to serve as a strong proponent for interdisciplinary research (particularly in the areas of photonics and optoelectronics) at UW. He has been instrumental in helping to secure significant renovation of Bagley Hall, in winning several major federal grants and contracts, and in securing additional faculty lines in Chemistry, Materials Science and Engineering, and Electrical Engineering.

To this point I have refrained from personal anecdotes involving Alvin, but I would like to relate one experience because it reflects a subject of personal interest, namely, the recruitment of young people, particular individuals from under-represented groups, into careers in chemistry. From my personal experience over the past thirty years, it is clear that interaction with exceptional scientists is critical to this process. In my own case, encountering and interacting with Jim Dye (Michigan State), Dudley Herschbach (Harvard), Mostafa El-Sayed (UCLA/Georgia Tech), Alan Heeger (Penn/UCSB), George Olah (USC), and Alvin Kwiram (UW) are the reasons that I am in science and that I have stayed in science. In 1966, I decided to attend Harvard to pursue Ph.D. studies with Dudley Herschbach. I made an appointment to talk with Dudley shortly after I arrived. During that meeting, Professor Herschbach made a point of emphasizing that I should talk to a new faculty hire named Alvin Kwiram. I had also just received a letter from Professor Harden McConnell (Stanford) who informed me that I could redress my obvious mistake of choosing Harvard over Stanford by talking to Alvin Kwiram. With recommendations from such stellar scientists, I felt that I should at least talk to Kwiram, and so I made an appointment to do so. I assumed that our meeting would be the normal 30–60 min quick overview of a couple of research projects. Instead, I received a half-day preview of what would become hot research topics in magnetic resonance and solid-state organic materials over the next two decades. Alvin explained his ideas for ODMR, ENDOR of disordered materials (which had not been accomplished at that time), understanding nuclear spin diffusion [and developing ENDOR-detection of NMR], understanding magnetic resonance spectra at a more profound level by developing improved theory [this ultimately lead to a general theory of magnetic resonance based on density matrix theory] and by carrying out detailed relaxation studies that would require developing new pulse techniques, detection of triplet methylene using low temperature deposition techniques that would relax the initially formed excited structure, studies involving spin labels, quantized flux and new superconducting applications, and finally Alvin told me he felt that polyacetylene could be prepared and would be a very interesting polymer to study. I was, as one might expect, somewhat overwhelmed not only by the flood of ideas but also with the depth at which Alvin had thought about these topics.

He clearly had addressed each subject from a theoretical as well as an experimental perspective. I came away impressed that heroic experiments could be successfully executed with appropriate attention to detail. It was Kwiram's imagination backed up by both a broad and in-depth understanding that inspired me to tackle a career in research. Excitement for science has always been a characteristic of Alvin Kwiram. On numerous occasions over the years, I have picked up the phone and called him when I have encountered a perplexing problem. He has always provided great insight and frequently has inspired new and productive approaches. Indeed, it was his vision of what could be accomplished at UW that was a critical factor in my move from USC in 1998. Alvin clearly deserves, together with Alex Jen and Bruce Robinson, great credit for the success that the UW photonics program has achieved in the past 5 years.

Professor Alvin Kwiram has greatly advanced science by his own research contributions and by his contributions as an educator and administrator in advancing the careers of others and permitting those associated with him to realize their fullest potential. It is fitting that this Festschrift issue honors him.

Larry Dalton
University of Washington