BIOGRAPHICAL MEMOIRS

Stuart Alan Rice

January 6, 1932 – December 22, 2024
Elected to the NAS, 1963

A Biographical Memoir by Joshua Jortner and Ronnie Kosloff

Figure 1 Stuart A. Rice. *Photo by Dan Dry.*

This Biographical Memoir bears witness to the life and science of Stuart Alan Rice, emphasizing that a memoir should remind us not only of his many and varied scientific contributions but also of his personal warmth, generous support of colleagues and students, and deep loyalty to friends and institutions. Legacies are often defined by scientific accomplishments, and in this respect creative scientists are fortunate: their contributions endure, or not, on their own merits, and Stuart Rice was a master scientist. His seminal experimental and theoretical contributions to physical chemistry and chemical physics were distinguished by intellectual depth, originality of concept, and innovative analyses. Remarkable in scope and impact, they helped shape contemporary scientific understanding and continue to influence researchers in a wide variety of fields.

Yet this record provides an incomplete picture of Stuart's legacy. Equally important were his humanity, his openness and generosity toward others, and the way his interactions altered lives and careers. He exemplified collegiality, forging productive collaborations with theorists and experimentalists in the United States, Israel, Denmark, England, Germany, and beyond. A gifted and devoted master teacher, he educated more than 100 students and postdoctoral associates, many of whom became major contributors to science. His career embodied that of a "scientist without bounds."

The Early Years

Stuart Rice was born in New York City on January 6, 1932, at the beginning of the Great Depression and on the eve of World War II. His parents were Helen Sarah Rice and Harry Laurence Rice. He grew up in the Bronx in a community largely composed of first-generation Americans, shaped by economic hardship, global conflict, and the New York City's public education system. These contrasting forces left a lasting imprint on his personal and intellectual development.

The economic difficulties of the 1930s were real and immediate. Until the age of five, Stuart lived with his parents, grandparents, and an uncle in a two-room apartment. His father, trained as an engineer, lost his position and was unable to find work in his chosen profession until the onset of World War II—a circumstance that both illustrated the period's hardships and redirected family life. Years later, Stuart recalled small but telling episodes from that time, including his father's patient efforts to rebuild savings lost from a household safe-deposit box.

World War II and its associated scientific and technological advances further stimulated Stuart's interest in science. In an era of minimal security restrictions, he had ready access to chemicals and equipment, allowing him to explore experimental chemistry at a young age. As he later observed, for those inclined toward science, it was easy to develop a fascination with how things work. His interests were enhanced and reinforced by the remarkable depth of talent in New York City's public school system brought about by economic conditions that drew many gifted individuals into teaching from other fields. Stuart's acceptance into the selective public Bronx High School of Science offered him a rigorous education that emphasized independence and individual worth—values that remained central to his outlook.

Stuart's first sustained research experience came during his junior year, when he worked in the laboratory of Michael Levine at Montefiore Hospital. Levine believed strongly in giving young people direct experience in scientific research. Under his guidance, Stuart studied the effects of aminopterin, vitamin K, and folic acid on cell division in onion roots. This experience left a lasting impression on Stuart and led to his first scientific publication in 1950. It also shaped his lifelong openness to hosting high school students in his laboratory.

Brooklyn College And Early Influences

In 1949, Stuart entered Brooklyn College, where he encountered two teachers of exceptional importance. Donald Wright, who taught an accelerated first-year chemistry course, conveyed chemistry's grand themes through a careful choice of materials and became both mentor and friend. Wright also provided crucial assistance during a serious medical crisis that arose shortly after Stuart's graduation.

Even more influential was Melba Phillips, an extraordinary physicist whose courses combined elegance of presentation with deep conceptual insight. From Phillips, Stuart learned what scientific taste means and how to recognize fundamental problems. Phillips and Rice became lifelong friends, a relationship of particular significance after she was dismissed from Brooklyn College in 1952 for refusing to testify before the House Un-American Activities Committee.

Toward the end of his freshman year at Brooklyn College, Stuart met Marian Coopersmith at a Chemistry Society picnic. They married on June 1, 1952, shortly before graduating, and entered the graduate program in chemistry at Harvard University that September. They had two daughters, Barbara and Janet. Barbara became a music teacher, and Janet, who earned a Ph.D. in chemistry at the California Institute of Technology and worked at DuPont Laboratories, passed away prematurely; her loss remained a profound sorrow in Stuart's life.

Marian and Stuart shared a deeply supportive marriage for forty-two years, which ended with Marian's untimely death from brain cancer at age sixty-three.

Graduate And Postdoctoral Years

Stuart's graduate and postdoctoral experiences at Harvard and Yale shaped his understanding of the research university. At both institutions, sharp distinctions between tenured and untenured faculty limited collaboration and participation in governance prevailed. Harvard actively defended academic freedom during the McCarthy era, exposing him to senior scientists who combined intellectual distinction with principled public engagement.

Harvard's graduate program emphasized early immersion in research. Stuart joined Paul Doty's laboratory in 1953, a choice that proved formative. Doty's mentoring style balanced independence with thoughtful guidance, and he encouraged Stuart's engagement with both theory and experiment. Stuart's thesis research addressed the helix-to-coil transition of DNA and included an early theoretical model developed with Akiyoshi Wada. Additional theoretical work, carried out with Frank Harris, addressed the behavior of charged polymer chains—ideas later connected in studies with Bruno Zimm.

Elected a junior fellow of Harvard's Society of Fellows in 1955, Stuart thrived in its intellectually diverse environment, which encouraged exploration across disciplines. During this period, he collaborated with Bill Klemperer on infrared spectroscopy of alkali halide molecules, producing a data set that enabled a critical test of ionic models of chemical bonding.

Determined to deepen his understanding of liquid-state theory, Stuart spent the second year of his junior fellowship at Yale University working with John G. Kirkwood. There, he engaged with problems of transport in liquids, developing approximate but influential approaches to irreversible processes in dense fluids. Kirkwood's mentorship and their regular discussions proved both scientifically and personally rewarding. Stuart believed that he had the unique distinction of being the only individual being supported by Harvard to work at Yale!

The University of Chicago

In the 1950s, the University of Chicago was a world class center of science. The Institute for the Study of Metals (now the James Franck Institute) was at that time unique because of the close collaboration among chemists, physicists, and computer scientists, making it one of the world's first high-quality interdisciplinary research centers.

Encouraged by both Kirkwood and E. Bright Wilson, Stuart applied for faculty positions and accepted an assistant professorship at the University of Chicago and was hired in 1957. The speed and informality of the appointments, which was based on wide-ranging intellectual discussions rather than formal proposals, reflected an academic culture very different from today.

At Chicago, Stuart found an unusually collegial and egalitarian environment. Senior faculty members welcomed him as a full participant, expected excellence, and regarded promotion to tenure as the natural outcome of high-quality scholarship. The structure of the university fostered interdisciplinary interaction, providing Stuart with continual exposure to new ideas and collaborators. Throughout his career there, he took full advantage of the freedom to redirect his research as interests and opportunities evolved, often pursuing multiple problems across physical chemistry and chemical physics simultaneously.

Stuart was a major figure in the chemical and physical sciences at the University of Chicago for almost sixty-eight years and embodied all the ideals that senior faculty had instilled in him. He made central contributions to the intellectual environment, to the highest quality scientific endeavor, to the remarkable interdisciplinary scientific collaboration, and to the intense focus of excellence at the University of Chicago. In an admirable way he promoted and perpetuated the unique culture of the university.

Scientific and Research Contributions

The outstanding, rich, and important research of Stuart and his group produced a marked impact on the development of modern chemical sciences in diverse areas, as chronologically outlined below.

The conceptual and operational basis of research in chemical physics and physical chemistry was modified by three changes of metamorphoses to these research areas:

I. Structural-electronic-level structure-function transport of relations in matter.
II. Time-resolved dynamics, radiationless transitions, and coherence effects in large, isolated, collision-free molecules.
III. Control, chaos, and disorder in classical and quantum systems.

These research areas were of great interest to Stuart since joining the University of Chicago until his last days.

Since 1957 Stuart pioneered the establishment of research area I in condensed matter that provided a conceptual and operational basis for the chemical sciences.

- The studies of transport in simple liquids established a new research discipline of soft matter chemistry.
- Progress in theoretical chemistry was inferred for excess electron localization and low mobility in liquid rare gases, based on the pseudo-potential theory for the electron He-atom repulsive interactions and for the observation of quasi free electrons with high mobility in simple liquids, which was inferred from attractive electron-atom interactions.
- The exploration of excited electronic states, exciton Davydov splitting, exciton transport, and collisions in molecular crystals led to the development of conducting polymers, and to the advent of molecular electronics and nanotechnology.
- The predictions and operational observation of excitons in simple liquids provided an iconoclastic view on the role of symmetry breaking in electronically excited states of condensed matter.
- The experimental work on elementary excitations, superfluids, electronic energy transfer, and excimer formation in liquid and solid rare gases provided a basis for the search for probes for the onset of superfluidity in liquid He and for the development of vacuum ultraviolet lasers.
- The exploration of liquid-metal interface led to the discovery that metal atoms can form a crystalline monolayer in the interface, which has an inhomogeneous, stratified, ion-core spatial distribution that dominates the relation between structure and transport parameters.
- The exploration of the important open problem of metal-nonmetal transitions in disordered materials, like expanded supercritical mercury and metal-ammonia solutions, provided a firm conceptual basis for the implications of structural disorder in chemistry.

Towards the end of the 1960s a metamorphosis occurred in Stuart's research by moving from research area I to research area II.

- The establishment in 1968 of the Bixon-Jortner theory of radiationless transitions in isolated, collision-free, electronically excited large molecules resolved the dilemma imposed for the occurrence of irreversibility of dynamics within a bound level structure.
- The radiationless transition rates obtained from the theory are governed by intramolecular coupling due to the breakdown of the Born-Oppenheimer approximation and the exchange effects, and by nuclear Franck-Condon factors obtained from the energy gap law.

- The theory of radiationless transitions was extended to account for vibrational mode selectivity, vibrational energy flow for intramolecular dynamics, and for the quantum theory of chemical kinetics in electron transfer and unimolecular reactions.
- Stuart became immersed in the theory of freezing, which evolved to the study of quasi two-dimensional liquids.
- The exploration of intramolecular coupling and dynamics in excited electronic states, which is determined by the intermediate level structure of molecular eigenstates and excitation modes, was explored and utilized by the Berry-Jortner theory of coherence effects and quantum beats in electronically excited isolated molecules.
- The establishment of the coherence effects in intramolecular dynamics led to the discovery of the novel and exciting discipline of femtochemistry, which explored dynamics in molecular, cluster and condensed matter on the time scale of nuclear motion.

In 1985 Stuart's research interests were expanded by the introduction of the third metamorphosis of research area III.

- The studies of intramolecular dynamics led to the exploration of direct, coherent and quantum control.
- Active control of dynamics can be achieved with carefully choosing times for excitation-deexcitation by high pulses, optimizing the formation of selected products. The modern field of quantum control of dynamics was developed by the methodology of optimal control of quantum mechanics. Active control to chemical dynamics resulted in the application of the theory to quantum computing and semiconductor electronics.
- Stuart recently proposed that a control field can be introduced to force a system to follow an adiabatic path in a finite time, establishing a framework known as "shortcuts to adiabaticity," which has since become widely used in quantum technologies.
- Stuart's work on deterministic chaos pertained to the Grand Problems of the emergence and breakdown of complexity and dynamics at extremes, which were of interest for him during the 60 years of his scientific career, inspiring the exploration of thermodynamics, entropy, and dynamic driving of disorder.
- The development of the theory of deterministic chaos in classical systems led to the theoretical and experimental exploration of the implications of the emergence, propagation and decay of disorder in chemistry.

In this memoir, the authors attempted to present an idiosyncratic overview of Stuart's outstanding accomplishments in science, describing the multitude of subjects that fascinated him. He hoped to show that there is much to be gained from a joint experimental and theoretical attack on important problems and from receptiveness to and modification of ideas from other fields. The message that Stuart had been fortunate to be able to transmit is that he was able to combine his avocation and vocation. All his research was curiosity driven, and he hoped that the long-term impact of it would be derived from applications developed by others for specific purposes. But he remained confident that the fundamental understanding of phenomena, properties, and processes constitutes an important contribution to the intellectual heritage of an enlightened society.

Contributions to Education, University Administration, Science Policy, and Public Service

Concurrently with Stuart's seminal contributions to science, he showed great commitment to forwarding scientific endeavor, to academic education, to remarkable service in university administration, to strengthening the chemical sciences, and to adherence to the values and principles of research, creativity and high education systems in an enlightened society.

Stuart's monumental contributions to the graduate school and research education rested on his deep desire to create the new generation of outstanding research scientists. An anecdote demonstrating Stuart's deep commitment to science education and to social values was manifested in 1963, when Stuart and Joshua Jortner were asked to plan and deliver a course in quantum mechanics for chemists at the graduate school of the University of Chicago. They used lecture notes based on a lecture series of the great physicist Enrico Fermi. Stuart and Joshua created warm contacts with students coming from underprivileged families from the south side of Chicago, where they were subjected by Stuart and Joshua to a special program of weekly meetings, using the masterful book of Landau and Lifschitz on quantum mechanics. This was a remarkable educational experiment on the border of physics and chemistry, in the spirit of the James Franck Institute, being praised by Norman Nachtrieb, the Chairman of the Chemistry Department. In 1967, Stuart and Joshua met one of these graduate students at an ACS meeting in Washington, DC, and were told that this course was the best scientific-educational experience encountered by him during his life.

Stuart was a devoted faculty member at the University of Chicago, who did not shy away from public, administrative, and academic service. He held many responsible administrative posts at the University of Chicago, ranging from director of the James Franck Institute to chairman of the Chemistry Department. He later became the longest-serving dean of the Physical Sciences Division in history. Through all that, Stuart's research continued at full speed and productivity. During the years Stuart was offered by some of the leading Research Universities on the East and West Coasts of the U.S. to move away from Chicago and accept a high academic position in New York or California. Stuart always declined these offers because of his devotion of most of his time to his scientific research, which indeed contributed tremendously to scientific endeavor in the U.S. and worldwide. At the national level he served on the National Science Board and received the Presidential Medal of Science of the United States. He continued his research program, working closely with his students and postdocs, even after he retired from Chicago. He was elevated to emeritus status and became special advisor to the director at Argonne National Laboratory. He also served as the first dean and later interim president of the Toyota Technological Institute in Chicago, which was established in 2003 to strengthen computer-aided technology innovation. Stuart's commitment to public service was evident in his roles on advisory boards for federal agencies, including serving on the National Science Board. Stuart also understood the significance of sharing research findings and communicating science to a broader public, as reflected by his sixty years as editor of a book series Advances in Chemical Physics, by John Wiley & Sons, his editorship of *Chemical Physics Letters*, and his twenty-year long membership on the board of directors of the *Bulletin of the Atomic Scientists*.

Stuart attributed considerable importance and significance to national and international scientific communication, as reflected by his 60 years' service as the Editor of the important series of Advances in Chemical Physics. This series, dedicated to reviewing new and emerging research topics in chemical physics and related fields, had a marked impact on inspiration and leadership of this research area.

Stuart was a major contributor to building and maintaining the strength of the chemical sciences from Chicago, in the United States, and throughout the world. His more than 100 Ph.D. research students and many postdoctoral fellows have become important figures in the field of physical chemistry and in other areas of science. Stuart has been an advocate for chemistry and for science generally, both nationally and internationally, and has helped to shape the direction of science for the future.

National and International Recognition

Stuart's scientific contributions were widely recognized and honored. In 1963, at the age of thirty-one, Stuart was elected as a member of the National Academy of Sciences and later honored by memberships in the American Academy of Arts and Sciences in 1967, and the American Philosophical Society in 1986. Stuart's accolades include the American Chemical Society's Award in Pure Chemistry, the Backland Award, the Peter Debye Award in Physical Chemistry, and the Joel Henry Hildebrand Award, as well as the Hirschfelder Prize in Theoretical Chemistry and the Centennial Medal of Harvard University. He received the National Medal of Science from U.S. president Bill Clinton in 1999. In 2011, Stuart was awarded the prestigious Wolf Prize from the International Wolf Foundation "for his creative contributions to the chemical sciences." Thirty percent of the Wolf Prize's past recipients were awarded the Nobel Prize.

Intertwined Other Worlds

In addition to his innumerable contributions to science and education Stuart had an intense and supportive family life intertwined with his many professional activities. As respite from the frenetic pace of activity in Chicago, Stuart and Marian spent highly valued family time in their home on Lake Michigan. Stuart was an active traveler and spent lengthy periods with his family as a distinguished visiting professor in Copenhagen, Cambridge, Oxford, Tel Aviv, and Jerusalem.

The intensity of interaction between Stuart and his friends is illustrated by the stories of the authors of this memoir. For Jortner, that interaction was initiated in September 1961, when Gabriel Stein, head of the physical chemistry department at the Hebrew University (where Jortner served as a senior lecturer) met Stuart in Cambridge and on his return to Jerusalem told Joshua: "You must go to Chicago to work with Stuart Rice, the two of you are so similar." This decisive statement began their lifelong personal friendship and scientific collaboration.

Their first meeting started with a scientific argument on the localization of excess electrons in liquid He. Stuart interpreted his experimental results on low electron mobility in this liquid in terms of the small polaron model, whereas Joshua proposed a new theoretical model of excess electron localization induced by large configurational distortion via cavity formation in liquid He. Joshua's cavity model was confirmed by theoretical computations, based on the pseudopotential theory of Neil Kestner, Morell Cohen and Joshua Jortner, providing a final solution to a fascinating problem. After reading this conclusion, Stuart graciously praised their insight.

For sixty years the friendship between the Rice and the Jortner families flourished. Stuart and Marian were very close to the Jortner children, and Joshua fondly remembers the Rice family's first visit to Israel in 1966 and the wonderful archeological trips by the Rice, Jortner, and Berry families to Egypt and Jordan. Stuart and Marian were gracious hosts when Joshua visited Chicago, and it was a very moving experience when Stuart's granddaughter Rachel contacted Iris, Joshua's daughter, to instruct her in cello lessons in New York and Chicago.

While Stuart served as the Dean of the Physical Sciences at the University of Chicago, he met Ruth O'Brien, who was the Assistant Dean for fundraising. They fell in love and married in 1997 and had a son, David, who is a Reed College graduate and lives and works in Chicago. Ruth was a wonderful companion, who traveled with Stuart to Israel, California, Egypt, and Jordan. She was a devoted wife, taking care of Stuart until his last day.

After Stuart's marriage to Ruth, they had a wonderful family life. Their friends were very happy when Ruth and Stuart came to Israel, visiting Joshua and his wife, Ruthi, in Tel Aviv, Ronnie Kosloff and his wife, Yafa, in Jerusalem, and David Tannor at the Weizmann Institute. During that visit they viewed an outstanding art exhibition of Van Gogh near Tel Aviv, and then Stuart and Joshua drove to see the archeological site of the Masada Castle at the Dead Sea. Near the Jordan-Israeli border the rented car stopped in the Jordanian territory and Joshua calmly asked Stuart: "Do you have your American passport with you?" This was an eye-opening event about the political situation in the Middle East. Ruth and Stuart came again to the Middle East for a wonderful archeological tour, together with friends of the Berry and Jortner families to the Nabataean city of Petra in southern Jordan, where Stuart had his first experience of riding a camel.

The other worlds of Stuart also included his interests in Jewish tradition, and most importantly, his involvement in the scientific endeavor in the State of Israel ran deep. During the Jewish Passover holiday, Stuart was happy to prepare the traditional Jewish food for the meal, and during his last years Stuart worked closely with the Jewish community in Chicago. The Stuart Rice we knew and loved was a straightforward individual who spoke his mind.

Stuart's interest in international collaboration reflected his strong commitment to the development of the scientific endeavor in an advanced society. Stuart attended the Spåtind, Norway, theoretical chemistry conference, where he trained a multitude of young bright scientists from the U.S., Denmark, Germany, and Switzerland, and was also taught by his friend Steve Berry to ski on an icy slope.

Stuart's remarkable interaction and collaboration with the members of the Israeli scientific community reflected the role of the sciences in bridging advanced societies. In the realm of international science policy, Stuart served as a member of the Board of Governors of Tel-Aviv University, which benefitted from his sage advice and experience in the planning and operation of an outstanding research university. Fruitful accomplishments in collaboration between Stuart and Israeli scientists were established by his collaboration with Joshua Jortner and Ronnie Kosloff, as described in this Memoir.

Final Reflections

By the end of 2024, Stuart's health had deteriorated, but he continued his quest in science through his outstanding scientific research and by writing and publishing excellent scientific papers. He published his last scientific paper, co-authored with colleagues from the Universities of Chicago and Stanford, on October 7, 2024, on dissipation and prediction rates of entropy in high dimensional optical matter systems. This last paper was published 75 years after the first scientific publication of Stuart, when he was 18 years old. Towards the end of 2024, Joshua wrote a long letter to Stuart, delivered to him on December 18, 2024. Regretfully, Stuart passed away from pneumonia on December 22, 2024, in his Hyde Park house, surrounded by his loving family, and the world lost an outstanding scientist and scientific leader.

Legacy

The life and career of an outstanding scientist such as Stuart Rice emphasize the importance of the principles of excellence, academic freedom, public outreach, and autonomy of science from government intervention. These should be of particular importance to the scientific world and public policy today.

We believe that Stuart's legacy had three components. First, and arguably most obvious, was the body of research he produced and the scientists he educated. During his career, Stuart authored and co-authored about 700 papers and four books and mentored more than 100 graduate and post-doctoral associates. He was a master in the training of graduate students and post-doctoral colleagues, many of whom have become major contributors to science in the U.S., Europe, South Korea, and Israel. Second is the lasting influence of his emphasis on the social responsibility of science and scientists and on the incorporation of science in public policy, which provides a standard for how to optimize the integration of what science contributes to what society requires. Third is the creation of a lasting venue for the exploration of new, exciting, and open questions across the entire spectrum of science.

The authors of this memoir about Stuart are deeply grateful for his wonderful friendship and his remarkable personal, institutional, national, and international scientific collaboration. We hope that readers, including the members of Stuart's scientific family, the science community, and the decisionmakers in leading scientific regions such as the U.S., Europe, and Israel, may (hopefully) reach two major conclusions on science policy after reading the memoir. First, we learned from Stuart that the establishment of an excellent research infrastructure and its accomplishments will ensure the qualitative edge of the advanced world. Second, Stuart taught us that human dignity is best realized by embracing knowledge.

The Monumental Legacy

On December 22, 2025, one year after Stuart was taken from us, the Chemistry Department of the University of Chicago honored the Legacy of Stuart Rice by the unveiling of his portrait in a moving ceremony.

Let us close by a citation from the ancient script of wisdom of Israel that states (in the Hebrew language):

חבל על דאבדין

We Miss Him!

Source Material for the Memoir

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