Chih Kung Jen—A Remembrance

*Walter G. Berl**

Searching through my files I came across a copy of a letter that I had sent to Chih Kung last July. In the letter, I had written, "What a wonderful surprise package! I was thrilled to open the mystery envelope from California with no idea of the treasures it contained . . . ."

It was a handsome two-volume set of virtually all of Chih Kung's published scientific papers, lovingly put together by his daughter Erica and bound between gold and Chinese red covers. It began with a reprint of his MIT bachelor's degree thesis in the Department of Electrical Engineering in 1928 on "Theory of an A.C. Commutator Motor"; it ended with a thoughtful article on "A Physicist's View of Science and Technology in China" that had been published in the *Johns Hopkins APL Technical Digest* (1981).

Chih Kung's academic training at Tsinghua College in Beijing, where he won a country-wide competition for a scholarship in the United States, was so thorough that MIT accepted him as an advanced sophomore and allowed him to skip the junior year altogether. An M.A. degree at the University of Pennsylvania soon followed (1929), with a study of the refraction of radio waves in the ionosphere (in parallel with a similar investigation by Merle Tuve of the Carnegie Institution of Washington, who a decade later became the founder of The Johns Hopkins University Applied Physics Laboratory, where Chih Kung spent his most productive scientific career years). Harvard University granted him a Ph.D. degree in 1931.

After Chih Kung returned to China in 1933, his research career was interrupted for 15 years by the Japanese invasion of Manchuria that spread into the Chinese heartland in 1937. For Chih Kung, the invasion included a long march (much of it literally on foot) from Beijing to remote Kunming, husbanding students, books, and equipment in a dramatic show of courage and determination.

*Walter G. Berl retired from APL in 1994 after 50 years of service.

He returned (like the Second Coming) to Harvard in 1948, in a new wave of Chinese intellectuals who were encouraged to go abroad to resume their training that had been interrupted by war and unrest. What was intended to be a 1- or 2-year sabbatical became, in fact, a permanent move to the United States.

The late 1940s were then a "yeasty" time for physicists, since the many insights into nuclear physics (a legacy of the development of the atomic bomb) and into microwave devices (as fallouts from the development of radar) offered greatly enlarged opportunities to work on fundamental properties of matter with novel tools and vastly expanded insights.

Chih Kung threw himself wholeheartedly into the study of the structural property of matter by the use of microwave-based detection devices. This was a bold extension of one of the classical fields of physics, spectroscopy, in which the interrogating wavelength was much longer than the traditional ultraviolet, visible, and infrared radiation. Teaching himself the necessary background in the theory of microwave interaction with matter and having the experimental skills of designing and building equipment with which to carry out meaningful experiments, he joined a distinguished group of physicists at Harvard. In one article ("Molecular and Nuclear Magnetic Moments in Microwave Zeeman Spectra," *Physica* **17**, 378–385, 1951) his 14 references contained the names of no less than seven present and future Nobel Prize winners.

After nearly 4 years as a Research Lecturer in Electronics at the Cruft Laboratory at Harvard, the most productive stage in Chih Kung's career opened, when he joined the Applied Physics Laboratory in the fall of 1950 as a supervisor of a Microwave Physics Group, a position that he held for nearly 17 years. During those years he never abandoned his fascination with the interaction of microwaves with matter.

It is often difficult to form a judgment about the significance of any one specific scientific article. There is, however, one way of measuring whether a published article has made an impression in the scientific community. A frequently cited work inspires others to use it in their own work or to comment on its value, often for many years after its date of publication. Among Chih Kung's contributions there was one such paper. This article, "Electron Spin Resonance of Atomic and Molecular Free Radicals Trapped at Liquid Helium Temperature" (*Phys. Rev.* **112**, 1169–1182, Nov. 15, 1958), was an inspired cooperative venture between two separate groups in the APL Research Center, one team joining their skill in the generation and handling of highly reactive free radicals with Chih Kung's skill of providing the measuring tools appropriate to the interrogation of the immobilized and "trapped" free radicals. The technique, conceptually so simple but tricky to make work in practice, permitted rapid extension to many different free radicals and to many trapping matrices. Reviews and monographs were soon written on the topic of the formation and trapping of free radicals, with APL and Chih Kung the leading lights.

Alas, one of the practical applications of this technique that was thought to be achievable, the trapping of highly reactive substances (such as atomic hydrogen) in sufficiently high concentrations to make a "super fuel" for propulsion devices, never came to pass. The actual concentration of the highly reactive species was so low that the overall effect on fuel performance was negligibly small.

Scientific papers, by tradition, leave out the moments of exhilaration when things work and of despair when they do not. They do not describe the intellectual struggle to understand the results, the needed effort to reduce data to a cohesive report. They do not reflect the long hours, the all-night sessions to tame balky helium liquefaction units. They do not record the joy when the first experiments demonstrate clear-cut results. What may have looked like a straightforward exercise was, in reality, a complex interplay of personalities, leadership, perseverance, and guts. With all these ingredients, Chih Kung's contributions were superb and up to the highest standards of a professional scientist.

As the experiments in trapping free radicals were proceeding, a separate group at the APL Research Center was tuning in on the strange "beeps" from the Soviet Sputnik that was circling the Earth and whose high-frequency signal changed in pitch as it approached and passed by a stationary observer. A pair of researchers (Guier and Weiffenbach), unfunded and unauthorized to pursue a phenomenon that had never been observed before, needed a frequency-measuring device and needed it in a hurry. The only one available was used by the Jen/Foner/Cochran team in the trapping experiments. In a classical case of unselfish cooperation, that team delayed progress on their own project and made a substantial contribution to the satellite detection effort, which soon became a major APL program when it was realized that the satellite's noises could be turned into a surveying and navigating device of unprecedented accuracy in the form of a Transit navigation system.

What manner of man was Chih Kung? All his colleagues agree about his lively inquisitiveness, about his ability to match a good theoretical understanding with the design and output of his carefully chosen experiments. They agree that he was good-hearted, thoughtful, and involved in the passions of the day, whether they had to do with his country of birth or his adopted country.

When he was asked why in his later years he trained himself to be a bridge between China and the United States and why he spent endless hours as a scientific goodwill ambassador, giving numerous lectures and seminars in China to serve the next generation of Chinese scholars, he said, "I am still sentimentally attached to China. But I have now lived in America longer than in China. Which is my country? Both."

A legacy remains that will be remembered many years after Chih Kung's scientific contributions will have been quietly absorbed into the edifice that he helped to build. I am referring to the C. K. Jen Scholarship Prize, awarded annually since 1989 to top graduating high school students in his home province of Shanxi, the mountainous hard-scrabble province from which he came 89 years ago. The prize is given to encourage Shanxi students to persevere in their scientific studies and to bolster their belief in the rewards of a life dedicated to the study of the natural sciences.

Perhaps no better summary of the man can be given than to cite the personal qualities required of scholarship prize winners: patriotism, love of science, high moral character, physical well being, deep interest in the natural sciences, diligent work habits, innovative style of thinking, strong inventive abilities, and active involvement in extracurricular scientific projects.

Indeed, these were Chih Kung's characteristics. They describe the man we knew and loved. No better legacy can be left than to encourage others to follow in footsteps that proved so singularly successful.