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In memoriam

Professor Chang-Lin Tien (1935–2002)

On October 29, 2002, Professor Chang-Lin Tien died at the age of 67, after suffering from a debilitating disease that lasted more than two years. With this, faded the light that shone so brightly for more than 40 years on the heat transfer community and on the society at large. Reflecting upon his life, career, accomplishments, and contributions, one is left to wonder the enormity of this loss and the magnitude of his legacy.

Professor Tien was born July 24, 1935, in Wuhan, China. With a bachelors in mechanical engineering from National Taiwan University, he arrived in the United States in 1956 to study at the University of Louisville. He earned his masters degree there in 1957 and then a second masters degree and his Ph.D. in mechanical engineering just two years later at Princeton University in 1959. Later in 1959, at 24, he became the youngest assistant professor ever hired in mechanical engineering at UC Berkeley, where he would subsequently serve as a faculty member for 42 years. He became full professor in 1968, later chaired the Department of Mechanical Engineering between 1974 and 1981, and, for two years, 1983–1985, was UC Berkeley's vice chancellor for research. In 1988, he left the Berkeley campus to be UC Irvine's executive vice chancellor. He returned to UC Berkeley in 1990 as chancellor and as the first Asian American to head a major research university in the United States.

Since his graduate days at Louisville and Princeton and through his academic life at Berkeley, Professor Tien dedicated his research career to thermal science and engineering. By the time he retired in 2001, he had made contributions to almost all aspects of this field and was responsible for starting many of them. The hallmark of his research was to explore, understand, and exploit the extremes—ultra-large and ultra-small length and time scales, ultra-high and ultra-low heat flow rates and temperature, etc.

Starting in the 1960s, after working briefly on hydrodynamics and heat transfer of boundary layer flows, he focused his efforts on radiation heat transfer. His initial emphasis was on radiative properties of gases, which led to the landmark paper in *Advances in Heat Transfer* on this topic. He brought a new engineering approach based on the fundamental science of radiation–matter interactions, which involves understanding complex quantum and statistical mechanical interactions of photons with molecules, and then developing design rules that capture the essential physics while being

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tractable for engineering design. His approach had major influence on various technologies, most notably, aerospace and energy.

Spanning the 1960s and 1970s, he also investigated radiative heat transfer in cryogenic systems as well as interaction of radiation with particulates, fibers and various other micro/nanostructured solids. His work became the cornerstone of designing materials for space shuttle thermal protection, packed bed reactors, radiative heat pipes for space thermal management, ultra-high thermal insulation, as well as high-efficiency and environmentally-benign combustion systems.

Later in the 1980s and 1990s, he expanded his research to radiation–surface interactions especially in combustion system, and ventured into the new topic of femtosecond and nanometer-scale radiation–matter interactions. It is worth noting that in the 1960s, Professor Tien received much recognition for his work on near-field radiation heat transfer, which was used to improve cryogenic insulation. This work has now become a classic in the new and emerging field of micro/nanoscale heat transfer.

While many would have been satisfied with this range of contributions, Professor Tien's research repertoire included much more. Starting in the 1970s, much of his research effort concentrated on multiphase and multi-component flows and heat transfer. Responding to the energy crisis in the 1970s, his work led to major contributions in heat and mass transfer in porous media, condensation, two-phase flows, granular flows, etc. In particular, he investigated the fundamental mechanisms of mixing, dispersion, and flow channeling near a wall in complex media, which led to breakthroughs in our understanding. His work had significant impact on the design and operation of thermal insulation, drying technology, catalytic and packed bed reactors, geothermal systems, heat pipes, and nuclear reactors. In particular, his work on flow channeling at the interface of a porous and solid wall received the classic paper award after 20 years, due to its influence on the field and its positive impact on the petroleum industries as well as in microelectronics thermal management.

The 1980s and 1990s saw the emergence of the digital computers and information science as a major technological revolution. An underlying theme of this revolution is miniaturization and integration, which presents new opportunities and challenges in thermal science and engineering. Recognizing this as a critical transition in heat transfer research and following his quest for the extremes, Professor Tien single-handedly galvanized the heat transfer community, especially the young, and pioneered the field of micro/nanoscale thermal science and engineering. Following his instincts of discovering new physics at ultra-small length and time scales, his research led to investigations of phonon, photon, and electron dynamics in solid and liquid nanostructures and at femtosecond timescales. He left his mark on this field again, by combining fundamental science with engineering design. While his research on micro/nanoscale heat transfer can be traced back to the 1960s, he realized earlier than most in the 1980s that there was the possibility of a whole new technology based on nanoscale science and engineering, which would form the infrastructure and the foundation for future progress in information technology and biotechnology. This has become the most exciting area of research not only within the heat transfer community but also with mechanical engineering in general.

Over the span of four decades, Professor Tien has published one book, 15 edited volumes and more than 300 research journal and monograph articles. He was the most eminent scholar and leader in thermal science and engineering, and in mechanical engineering in general. Impacts of his research and scholarship can be judged by the many prestigious awards that he received: Max Jacob Memorial Award, 1981; National Academy of Engineering, 1976; Heat Transfer Memorial Award, 1974; NSF Distinguished Lecturer in Engineering, 1997; Chinese Academy of Sciences, 1994; Honorary Member ASME, 1993; ASME Heat Transfer Classic Paper Award, 1999; and National Academy of Engineering's Founders Award. However, an award that was special to him was the Berkeley's Distinguished Teaching Award, which he received in 1962 at age 26, making him to youngest professor in the history of Berkeley to receive this honor. This came from a deep commitment to teaching and education, not only in classrooms but in his research group as well. He mentored over 60 doctoral students, and today many of his former graduate students are now professors themselves, and are mentoring yet another generation of graduate students with key lessons he taught. These lessons are now fondly known as "Tienisms": 'Any new ideas?' 'Go to the extremes'; 'Ideas should be crazy enough to be rejected by your peers'; 'Sometimes the simple solutions have the greatest impact'; 'Dig deep' and 'Dream about your research'. What is intriguing, however, are the things he never told his students to follow, but set an example through his own actions—complete and utmost dedication to serve others and respect for all people. To his students, he was someone who set the benchmark for integrity, excellence, scholarship, creativity, and hard work. He was keen on building a community around himself and others. His contributions as a member of the editorial board of the *International Journal of Heat and Mass Transfer*, his founding editorship of the new journal of *Microscale Thermophysical Engineering*, and his numerous occasions of help and support to international researchers across various political boundaries were a reflection of his untold purpose in life.

Although the heat transfer community was privileged to witness the brilliance of Professor Tien's research

career, his life had many additional dimensions that are equally noteworthy. As Chancellor of UC Berkeley, Professor Tien was also an unofficial diplomat in Asia, meeting with heads of state and other leaders to promote the American values of democracy and freedom. He helped found the Committee of 100, a nonpartisan group of Chinese Americans that works to foster dialogue and understanding between Asia and the United States. He was an active member of the Pacific Council on International Policy, the Council on Foreign Relations, and many others. Indicative of the scope of his leadership in both domestic and international arenas were his appointments as Chairman of the Asia Foundation, Chairman of the San Francisco Bay Area Economic Forum, and Chairman of the Chief Executive's Commission on Innovation and Technology in Hong Kong. In 1999, Professor Tien was appointed as a member of the US National Science Board and the US National Commission on Mathematics and Science Teaching for the 21st Century. He has also served as co-chair of the National Commission on Asia in the Schools.

In addition to successfully reversing the effects of major state budget cuts in the early 1990s, Chancellor Tien developed approaches to counter the impacts of the 1995 UC Regents' ban on affirmative action. He launched the Berkeley Pledge, a nationally recognized partnership between UC Berkeley and California's K-12 public schools that today is called School/University Partnerships.

Professor Tien was a scientific consultant to many organizations, research laboratories, and private companies. He served on the boards of Chevron, Kaiser Permanente, Wells Fargo Bank, the San Francisco Symphony, and Princeton University. University Professor Emeritus for the 10-campus system, he was also the A. Martin Berlin Professor of Mechanical Engineering, and UC Berkeley's first NEC Distinguished Professor of Engineering. Along with the long list of awards recognizing his scholarship, he received the first-ever UC Presidential Medal and the Berkeley Citation, the two most prestigious awards for a member of the UC and Berkeley faculty.

Professor Tien will be missed by many in this world. To his former students, he was a father figure who provided an education not only in research but in life as well. To the Mechanical Engineering Department and the College of Engineering at UC Berkeley, he was a pillar of wisdom, sound judgment, warmth, and humility. We will miss his contagious laughter and joyous enthusiasm in the corridors of Etcheverry Hall. To the fellow editors of the *International Journal of Heat and Mass Transfer* and to the research community in general, he will be missed as a friend, colleague, intellectual leader and visionary not only for our own field, but also for science, engineering, and education in the world. To the Berkeley campus and the UC system, he was an exceptional leader, one who never compromised his principles and had the strength to support the students and faculty with compassion, energy, and optimism in the face many difficulties. To the Asian American community, he will be missed as an ambassador of scholarship, goodwill and cultural harmony. May his soul rest in peace, and his spirit live on among all of us.

A. Majumdar
P.F. Peterson
J.P. Hartnett
W.J. Minkowycz