

Preface



This volume is dedicated to the memory of Professor David Shen Ou Cai. David Cai was a theoretical scientist who made significant contributions to the theory of nonlinear waves (coherent, chaotic and weakly turbulent) and to neuroscience (the behavior of neuronal systems, large and small). He also had wide ranging interests in other areas of science and beyond. The articles in this volume sample specific areas in which David worked, and more generally areas in which he had interests. David would have enjoyed reading each of the articles in this volume.

David Cai, Professor of Mathematics and Neural Science at New York University, passed away on October 21st, 2017 at the age of 54. He was trained as a physicist and obtained his B.S. from Peking University, and the M.S. and Ph.D. from Northwestern University. David held a postdoc position in the Courant Institute of Mathematical Science at New York University, and afterwards became an assistant professor of mathematics at the University of North Carolina, Chapel Hill. He then returned to the Courant Institute, becoming an assistant, associate, and finally a full professor of Mathematics and Neuroscience at New York University.

David was first and foremost a scientist -- dedicating himself fully to science and to what mathematical reasoning and methods could contribute to science. He was a significant scientific engine and a role model for many on more than one continent. He had broad research interests and made many significant research contributions in wide-ranging fields. His complex personality of honesty, elegance, breadth, competency, and extraordinary kindness and generosity allowed him to interact broadly in many research fields and with many students and colleagues.

During his early career at Los Alamos National Laboratory, David worked on

nonlinear integrable systems and made key contributions to the understanding of contemporary experiments in superconducting Josephson technology. He made crucial contributions to the understanding of how models of electronic stopping should be parameterized and implemented into both binary collision approximations and molecular dynamics simulations for predictive modeling of dopant density profiles of irradiated materials; work that eventually helped predict — not just explain — experimental data of interest to both industry and the Laboratory.

At the Courant Institute, David made fundamental contributions to nonlinear and dispersive waves where he revealed many interaction properties between coherent waves, including the most violent waves that occur in the focusing nonlinear Schrödinger equation. David was also the first to uncover basic principles for weakly turbulent systems and to identify how the model must be adjusted to maintain the validity of weak turbulence theory under different conditions.

David's theoretical neuroscience work was significant and wide-ranging: for example, he applied information theory to coding schemes for cortical processing, investigated the importance of nonlinearity in the interaction of multiple synaptic inputs along dendrites, and played a significant role in developing comprehensive large-scale computational neuronal networks and in understanding the mechanisms underlying their response properties. He deepened the understanding of a common dynamical operating state of the visual cortex – the “fluctuation driven regime” – bringing to light the consequences of the cortex operating in this stochastic and heterogeneous state, and revealing the importance of sparse connectivity in setting up conditions for the state to develop and be stable.

In 2009, the Chinese Ministry of Education appointed David Shen Ou Cai as a Chang Jiang Scholar and, in 2010, a Chair Professor of Shanghai Jiao Tong University (SJTU) through the Thousand Talents Program in China. David developed and kept a sincere appreciation for the interplay among theory, computation, and experimentation throughout his career. This motivated him to establish a Courant-style research institute at SJTU. He was a co-founder of SJTU's Institute of Natural Sciences (INS) and played a pivotal role in making SJTU an active player in modern applied mathematics on the international stage. David had a deep sense of responsibility and duty. He was dedicated to the construction of the INS and spared no efforts to turn it into a “Courant Institute” in the East.

David was a kind and very encouraging mentor to students and postdocs, gave them excellent projects, understood their strengths and weaknesses and showed them how to emphasize the former and lessen the latter in day-to-day work, guided them until they finished successfully, helped them secure good jobs, followed their careers, and

gave them invaluable advice. He was particularly happy when one of his students or postdocs produced a clever or unexpected result.

His enthusiasm for exploration in both science and life was inspiring. It was really a great honor and privilege to be working with him. He will be deeply missed by his students, colleagues, collaborators and friends. The articles in this volume are intended to contribute to the memory of David Shen-Ou Cai.

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