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A Short Biography of Shui-Nee Chow

Shui-Nee Chow was born in Shanghai, China on July 13, 1943. He obtained his B.S. in 1965 at the National University of Singapore and his Ph.D. from the University of Maryland in 1970. He was at Michigan State University from 1970–1988 and was awarded the title Distinguished Professor in 1987. He has been a professor at the Georgia Institute of Technology since 1988, has held Honorary Professorships at six universities, and has held visiting positions at many universities, including Brown University and the National University of Singapore. He is one of the Editors-in-Chief of the Journal of Differential Equations and is on the editorial board of ten other journals. He has published more than 130 papers and co-authored two books, "Methods of Bifurcation Theory' and 'Normal Forms and Bifurcation of Planar Vector Fields."

Shui-Nee has a very special talent for initiating new areas of research in mathematics as well as identifying the important emerging areas and the researchers on the forefront of their development. At Michigan State, the visitation program which he initiated had a great influence on research in differential equations and dynamical systems.

In the early 1970s, Professor Taro Yoshizawa was invited by Shui-Nee to spend a semester at Michigan State and I took this opportunity to have Taro come to Brown University. Shui-Nee came with him. During their stay, Taro remarked: 'This young man is not bad. You should pay attention to him.' He was right.

Shui-Nee is devoted to mathematics, always making every effort to extend his knowledge of mathematics, to do excellent research and to encourage others to do the same. In the academic year 1974, we were fortunate to obtain Shui-Nee and John Mallet-Paret as postdocs at Brown. It was the first position for Mallet-Paret after his Ph.D., but Shui-Nee was already having a big impact on the mathematics department at Michigan State. It was a great financial sacrifice for Shui-Nee to come to Brown and, even more importantly, a great personal sacrifice since his wife, Marie, was not able to come.

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For me, that academic year was the beginning of a lasting friendship and extensive scientific cooperation with Shui-Nee and John.

Shui-Nee is certainly one of the best in the world in the field of nonlinear dynamical systems and nonlinear analysis. He has made significant contributions to the qualitative and analytic theory of ordinary, partial and functional differential equations. He injects new ideas on a wide range of topics and has been a catalyst for many important developments.

Among his many contributions, I select only a few to illustrate the impact of his work and begin with some topics in bufurcation theory. The understanding of the equilibrium positions of a thin plate governed by the von Karman equations requires a large number of parameters. To gain analytical insight into how the equilibria change with respect to parameters, Shui-Nee (jointly with Mallet-Paret and Hale) initiated a theory for the determination of all possible bifurcations when one restricted the discussion to only a few parameters at a time. To accomplish this, the perturbations of the equations had to enjoy some symmetry properties. This work played an important role in the general theory that is available today on bifurcation theory with symmetries.

Another important topic in bifurcation theory is the existence and bifurcation of homoclinic and heteroclinic orbits of evolutionary equations. Melni'kov in 1962 introduced a method for doing this which involved the integration of solutions on the stable and unstable manifolds of equilibria and checking analytical properties at the intersection of these two sets. In 1981, Shui-Nee (with Mallet-Paret and Hale) gave a method for solving the same type of problem which avoided the use of integration, but was based on treating the differential operator as a map on a special class of functions. This method has been developed extensively by Shui-Nee and other researchers and is now one of the basic tools of both theoretical and applied problems. Other significant works done by Shui-Nee on homoclinic bifurcations include those jointly with Deng, Fiedler, Lin, and Terman.

In parametrized family of mappings, it is important to understand the global existence of branches of bifurcation of equilibria and periodic orbits. The case of equilibria is treated well by Rabinowitz using a classical index argument. Shui-Nee (with Mallet-Paret) introduced the notion of Fuller index for the discussion of periodic orbits. This work, together with later work by them and Alexander and Yorke, has become standard technique in this subject.

For several years, Shui-Nee has worked extensively in the area of singular perturbations; for example, perturbations of a differential equation with a small parameter, say ϵ, appearing in the highest derivative. In these problems, the type of the equation changes when $\epsilon = 0$. It is very important to understand the relationship between the dynamics for $\epsilon \neq 0$ and the dynamics for $\epsilon = 0$. In these singular problems, one may, for exam-

ple, change from a hyperbolic partial differential equation to a parabolic partial differential equation or vice versa. The former occurs, for example, in the derivation of the Hodgekin-Huxley equation for the behavior of neurons, the latter for the case of a small viscosity term added to a conservation law. When the singular parameter is zero, one may pass from a differential equation to either a mapping or another differential equation restricted to a compact manifold. Shui-Nee has made important contributions to this subject, concentrating particularly on comparison of periodic motions, preservation of invariant manifolds, and bifurcation theory. His works with Mallet-Paret in the 1980s on rigorous study of the effects of singular perturbations in delay equations were among the first in the subject. Their showing, that the limiting behavior of periodic solutions to square waves, generated much research in this area. His recent work (with Liu and Yi) on the existence of center manifolds for compact invariant sets of finite dimensional flows is a far reaching generalization of the work of Fenichel and will have many applications.

Besides delay differential equations, Shui-Nee has made substantial contributions to infinite dimensional dynamical systems defined by partial differential equations, which include Floquet theory for linear, scalar parabolic equations (with Lu and Mallet-Paret), free boundary problems in combustion models (with Shen), inertial manifolds and smooth invariant manifolds in infinite dimension (with Lu, Lin, and Sell), and spatial patterns of gradient evolutionary PDEs (with Afraimovich and Babin).

Shui-Nee also has made important contributions in computational dynamics. His work with Mallet-Paret and Yorke in the late 1970s on homotopy methods for critical points of maps and works with Palmer in the late 1980s on shadowing methods are fundamental in these subjects.

While in Singapore, Shui-Nee began to devote himself to the application of dynamical systems to real world engineering problems. In particular, he worked with engineers in an effort to find an efficient method for converting analog data to digital data which would be insensitive to random perturbations. This work led to the National Technology Award from the government of Singapore – the highest award for the advancement of technology bestowed in Singapore. It also has led to some new theoretical problems in singular, perturbation theory of ordinary differential equations as shown in Shui-Nee's recent work with Huang. At the present time, Shui-Nee is investigating the relevance of this theory to the modeling of the behavior of neurons.

Shui-Nee has been one of the initiators of some of the recent work on lattice dynamical systems. The motivation came from a collaboration with the metallurgist John Cahn in an attempt to understand some of the interesting patterns observed in alloys. The famous Cahn-Hilliard partial

differential equation had for years served as the model. However, there were some discrepancies between the solutions and the experimental data. Theoretical and numerical computations led to the replacement of this model with discrete dynamical systems defined on lattices. The resulting research of dynamical systems on lattices with Afraimovich, Cahn, Mallet-Paret, Shen, and Van Vleck on patterns, traveling waves and spatial chaos will become textbook material.

The mathematical community is indebted to Shui-Nee, not only for his research, but for his efforts through serving on important advisory committees and the organization of conferences. The NATO conference "Dynamics in Infinite Dimensions" in 1986 in Lisbon was his idea (NATO ASI Series, Computer and Systems Sciences, Vol. 37). He initiated the "Americas Conference on Differential Equations and Nonlinear Analysis" in 1994 in order to encourage the interaction of researchers in all of the countries in North, Latin and South America. This conference is held every two years and many of the papers in this volume were presented at the meeting in Edmonton, Canada in 2002 honoring Shui-Nee on his sixtieth birthday. He served as the first president of the SIAM activity group on Dynamical Systems. At the present time, Shui-Nee also is playing an important role in the development of strong groups in dynamical systems around the world, in particular in Asian countries.

The role that Shui-Nee has played in improving the School of Mathematics at Georgia Tech deserves special attention. To the School, he brought enthusiasm, knowledge, vision and administrative abilities to obtain the committment of Georgia Tech to make the School one of the important ones in the country. He strengthened existing groups, started new ones and did this unselfishly with respect to his own interests. This unselfishness led to the international recognition of the School by the general mathematical community.

Shui-Nee is an excellent teacher and has had 31 students complete their Ph.D under his supervision.

It is indeed fitting that this volume be dedicated to Shui-Nee Chow for his excellent research record, his training of graduate students and his overall contribution to the international mathematical community.

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