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Imports and Exports

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In August, I attended a conference sponsored by the State Key Laboratory for Turbulence and Complex Systems of Peking University. This meeting brought together experts from physics, engineering, and mathematics to summarize the state of the art in fully developed turbulence. The meeting had two additional, and unusual purposes:

• The meeting was "In commemoration of Professor P.-Y. Chou's 100th Anniversary." Professor Chou was educated in the West. In 1929, he returned to China, where he became an important scientific leader, eventually becoming the president of Peking University. For this meeting and other occasions his picture and his life is used to publicize a movement in which the nation is encouraging scientists trained abroad to return for part-time or full-time work in the universities, institutes, and corporations of modern China.

• In addition, Peking University and China were using this meeting to advertise their interest in and competence for international quality research in important areas of basic research.

This meeting contained several talks indicating the great strides China has made in rebuilding science since the low-point produced by the breaking of scientific relations with the USSR in 1960 and the subsequent cultural revolution (1966–1976). Much of the most recent progress is a result of an extensive chain of collaborations between Chinese and foreign

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researchers. For example, at the meeting, Zhen-Su She of the State Key Lab and UCLA described Peking's extensive research program on fluctuations in highly developed turbulence. One part of that program is aimed at checking the She–Lévêque[1] hierarchical symmetry model of multiscaling in turbulent velocity fluctuations. This approach gives partially empirical formulas for the probability of various sizes of velocity fluctuations. It has become an important part of the phenomenology of scaling, and it is pleasing to see how well it stands up to the critical experimental tests done at Peking[2] and also in Texas.[3]

The meeting included several talks on the Rayleigh–Bénard system, a closed box in which turbulence is forced by heating from below. Hong Kong has become an important focus of research on this subject. Ke-Qing Xia from Chinese University of Hong Kong measures and photographs the flow patterns produced in water at high levels of turbulence. I was particularly interested in this work because it extends earlier work in which I was involved,[4] and agrees in some respects, but not all, with the theory produced earlier. Emily S. C. Ching, my ex-student from Chicago, is also on the faculty at Chinese University. After leaving Chicago, she developed (along with several collaborators) the most extensive analysis of the spectrum of statistical fluctuations and statistics in these systems. Most recently, this work has continued in a collaboration with Itamar Procaccia (Weizmann Institute) who has had several multiple-month visits to Chinese University. Both described their work at this meeting. Local research in this area has been further enhanced by the movement of Penger Tong from the United States (most recently Oklahoma State and Harvard) to the Hong Kong University of Science and Technology. Taken together, these researchers make Hong Kong a world center in this area of science.

It is also impressive to see how effective Peking University has been in drawing in some of the very best people in statistical physics. For example, Shiyi Chen divides his time between Johns Hopkins and the State Key Laboratory and provides important simulational leadership at both places.

In a parallel effort, there is a very impressive part-time presence at Peking University of some of the best young Chinese-American scientists in theoretical biophysics, including Terry Hwa (UCSD), Yuhai Tu (IBM, Yorktown Heights) Shoudan Liang (NASA, Ames), Chao Tang (NEC), and Hao Li (UCSF). The experimentalists working in biophysics includes Qi Ouyang, a returnee trained in the labs of Swinney and Libchaber who is doing work related to DNA computing, gene expression, and molecular evolution. Between the full-time returnees and the part-time visitors, China has built up an exciting program using statistical physics.

The welcome presently being extended to returning scientists is a departure from the closed door of the period immediately after the

Tiananmen Square repression of June 4, 1989. At that point, the Chinese government was apparently quite afraid of the ideas that might enter with the students who had studied abroad. So these students and postdocs were encouraged, by both the U.S. and the Chinese government to stay right here in the U.S.[5] But the intervening years have eroded public support for the students' stated ideals of democracy, equality, and free speech, replacing them by an apparently successful mix of capitalism and leadership from above. With little reason to fear rebellion and much hope for the technological knowledge that might be acquired, China has made "return" one of the words of the day.

One reason that return seems so natural is that there has been considerable convergence of the systems of the two countries. Specifically, the Chinese system for the support and encouragement of science has been built upon a US model: university autonomy mixed with overall guidance from funding agencies. Under this system, a major and quite successful effort was put together to attract scientists from abroad by paying considerably higher salaries than were even conceivable a few years ago. Some come for months and quarters; others move back for good. China has won the involvement of many of the very best of the scientists who are just reaching intellectual maturity.

Many of these scientists would like to stay in basic research. China needs applied research, but its Confucian heritage is built upon respect for knowledge and learning. On the other hand, China (and the U.S. too) recently has felt a rush toward the business degree and the corporate life. So one cannot tell how either nation will fare in basic research.

From the U.S. perspective, it is now hard to imagine our own science, particularly on the theoretical side, remaining strong without the help of people from Asia. Our own population seems to be not sufficiently committed to science to fill our needs for scientists and engineers. Asia remains our most likely source, especially since we seem to be emptying the reservoir of talent in Eastern Europe.

I am told that China respects the US model, and in some ways wishes to emulate it. This is an interesting outcome to a history of complex interactions between our two peoples. The United States formed a part of the imperialist system that infuriated the people of China during the nineteenth century. This resentment gave rise to the Boxer Rebellion of 1899–1900, in which a broad spectrum of Chinese demanded the right to self-determination, free from Western control. The Western powers, including the U.S., used their armies to beat down that rebellion, and then demanded and obtained an exorbitant monetary payment from China. A major portion of the U.S. share of that payment, was used by the U.S. to endow the process of educating Chinese students here, with the long-range goal of

increasing our influence in China. Using money from that endowment, Tsinghua University was built in Beijing as a preparatory school for students who would study in the United States. Our conference's symbol for the return movement, Professor P.-Y. Chou, studied in the U.S. at Chicago and Cal Tech with a fellowship from this Boxer Rebellion money. Following a postdoc in Europe, he then returned to China. He became one of the leading theoretical physicist of his generation, particularly noted for his work on turbulence and relativity. He remained in China for the rest of his life, except for sabbaticals.

His story, as told at the conference by his daughter, Dr. Ru Ling Chou, was a relatively happy one—at least relative to the truly awful things which were happening during the Cultural Revolution and the Great Leap Forward.[6] Prof. Chou and his daughters had a tough time, but he managed to keep his family alive and his integrity reasonably intact. So despite Thomas Wolfe's book-title "You Can't Go Home Again," it might be possible to exist between two cultures. But it does not always work. Both the U.S. and China are capable of prejudice, brutality, and xenophobia. Chou's near-contemporary, Hsue-shen Tsien, also lived and worked in the United States. He started with a Boxer Fellowship in 1934 and rose to a position of respect and power at Cal Tech and in the U.S. aeronautics and missile program. He played a major role in bringing mathematics into aeronautic engineering. Starting in 1950, he got caught up in McCarthyite prosecution, and was simultaneously ordered to be under house-arrest, prevented from leaving the U.S., and ordered to be deported. After he returned to China in 1955, he helped design Chinese missiles, and also got caught up in the great political movements of the time. According to Iris Chang's *Thread of the Silkworm*,[7] Tsien became a toady to several Chinese governments. Highly respected by the present government, he is severely criticized by many scientists and intellectual leaders. They especially charge him with foolishly encouraging Chairman Mao's agricultural policy, and hold him partially responsible for a great famine which killed perhaps thirty million people. His life story suggests that there are potential dangers in both staying in the West and also returning to a much-changed "home." A potential returnee might worry that the U.S. has a doubtful attachment to basic science and is capable of capricious imprisonment, particularly of Asians. On the other hand, China has a potential for political instability, and a present reality of some capricious imprisonment, many entrenched bureaucracies, and only a little basic science. Despite much improvement over the past quarter century, this society still permits deplorably little personal freedom or cultural diversity and has very little protection of human rights.[8]

We in the U.S. view the return movement with mixed feelings. We do like our colleagues to have extra opportunities. Of course, we regret the possibility that some of our most-respected colleagues will be far away and therefore less useful to us. However, if we expect to keep up the stream of foreign students and young scientists who have provided much of the technical vitality for U.S. science and technology, we must offer them an America from which they will be free to leave. They will not come if they see an America which serves as a upholstered prison, as it did for Professor Tsien during his last years here. If the foreign students and scientists do not come, we will find it even harder to maintain our technical edge.

Ms. Chang's book presents Professor Tsien as having been chewed up by the complex, dangerous, and rapidly changing politics of his two nations. In contrast, I might present an old, simplified view of China, one which was held here before the Communist Revolution. I recall that I first learned about China from a book quaintly titled "400 Million Customers",[9] which viewed the country as a market filled with people who were interestingly different. In this view, pre-revolutionary China was a good place for an American businessman to live and work. But following upon the Japanese invasion and the Chinese Revolution relations between the U.S. and China (indeed two Chinas) got much more complex and confrontational. Now possibly we are coming to a time of fuller cooperation. China needs science and technology to meet its basic economic needs and help it develop the international strength that it feels is proper. In accepting these Western "goods" it will perforce absorb some of our ideas and ways of thinking. Many good things including rigorous logic, sharp observation of nature, and sharing of knowledge all form a part of that tradition, and China may well find them broadly beneficial. Conversely, we in the U.S. will be brought into contact with Chinese scientists and Chinese modes of thought. We may find some of these points of view, including a more holistic picture of nature and maybe a more organic view of society, enlightening and helpful. In any case we must expect that globalization will bring us much more than "customers". It will bring the U.S. a vital and strong partner and rival. Equally, Western scientists and technical people will have vital new partners and rivals . In many ways both our society and our science would benefit by being pushed in new directions. That is likely to happen.

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