Interview with Wen-Ching (Winnie) Li

Sujatha Ramdorai

Wen-Ching (Winnie) Li is a Distinguished Professor of Mathematics at Pennsylvania State University in USA. She was also the Director of the National Centre for Theoretical Sciences in Taiwan 2009–2014. Recently, Professor Sujatha Ramdorai had a chance to interview her.

Sujatha Ramdorai: Let us start by hearing from you about your early years in Taiwan and how you got interested in mathematics.

Winnie Li: Math has been my favourite subject since my childhood. Unlike other subjects, I did not have to memorise much once I understood the content. Winning math competitions in school gave me more encouragement and confidence. So I chose mathematics when I entered the college although I did not know at the time that the mathematics I was fond of was not the real mathematics I later encountered in college. Growing up in a mid-sized city in Taiwan, I did not learn calculus at high school, and nor did I have any sense of what mathematics was really about. I just mastered a bunch of small skills.

SR: You along with Fan Chung and Sun-Yung Alice Chang, are recognised as women mathematicians internationally, and are all contemporaries. Can you talk to us about this?

WL: My class was special in that the top students from the best girls' high schools (at that time high schools were mostly segregated) all chose to go to the mathematics department of the National Taiwan University. For instance, Alice was from Taipei, Fan from Kaohsiung, and myself from Tainan. My class was also unusual in that one third (ten) of the students were female. The girls got along very well. We discussed the homework problems, and we had our own fun activities, including celebrating each other's 20th birthday. In Chinese custom, turning 20 was a big event, as it signals entering adulthood.

SR: It was uncommon to hear of women scientists from Asia around that time, in the last century.

WL: Indeed, when I was growing up, the most famous female Chinese scientist was the physicist Chien-Shiung Wu, a professor at Columbia University, who was famous for doing the experiment to prove the theory that the conservation of parity is violated in the so-called weak nuclear reactions, proposed by two Chinese physicists, Chen-Ning Yang and Tsung-Dao Lee, for which they received the Nobel Prize in 1957.

SR: Please tell us about your years in France and the United States.

WL: I came to US in 1971 as a graduate student at UC Berkeley, supervised by A P Ogg. In 1974, I received my PhD and went to Harvard as the first female Benjamin Pierce Assistant Professor in Mathematics, a position I held for three and half years. The Harvard years were most crucial in my career. It was an eye-opening experience for me. All I did at Berkeley was writing a thesis, not much beyond that. Harvard was a very stimulating place; I learned a lot by attending classes and seminar talks, in particular from Tate and Serre. I also extended my research from classical modular forms to modular forms over function fields to automorphic forms in adelic setting. Many exciting developments in automorphic representations were happening at fast pace: Langlands proved his theory of base change, Arthur established the trace formula, Deligne–Serre attached Galois representations to

weight one cusp forms, etc. I was fortunate to start learning this fascinating subject at Harvard together with the students of Tate then, and later at the Corvallis summer school and IAS. While I no longer work on representation theory, the knowledge acquired in my early life led me to view things from a better perspective when I became interested in noncongruence forms ten years ago.

I have consulted at AT&T for four weeks in the summer for twenty years, thanks to the invitation by Ron Graham. During these years, I collaborated with people at the Bell Labs and AT&T Research on various topics, including number theory, coding theory, graph theory, block designs, and communication networks. My research interests have broadened, and I began to appreciate applied mathematics more and more. It was also fun to apply number theory to other areas. To this date I retain keen interests in interactions between number theory and combinatorics. For instance, I used results from character sum estimates to construct Ramanujan graphs, and from studying eigenvalues of certain Ramanujan graphs I realised that the Kloosterman sum conjecture over function fields should hold despite that it fails over the field of rational numbers. Also I extended my research from Ramanujan graphs to its higher dimensional analogue, Ramanujan complexes, which played an important role in my work with recent PhD students, where we succeeded in defining first zeta functions for higher-dimensional complexes with closed form and nice properties, extending the Ihara zeta functions for graphs.

I only spent one academic year, 1985–1986, visiting France. That was immediately after giving birth to my elder daughter. As a new mother I had difficulties to use my time wisely and efficiently. I was constantly in a dilemma. When I was taking care of my daughter, I felt bad since I should be spending time proving theorems. On the other hand, when I was attending a seminar, I felt guilty as I was not taking care of my daughter. This kind of struggle lasted for nearly one year until I learned how to switch my mind quickly: when I was at work I concentrated on math, when I returned home I spent quality time with my child.

Professionally the sabbatical year in France was also challenging. I spent the fall semester learning French conversations in order to teach a course at Université de Paris Sud, in French, in the spring semester. That was a course on calculus and differential equations, which was taught once per week for three hours to a special group of students in physics, who would not study mathematics between two classes. I lectured for half of the class time, and the remaining class time was devoted to problem solving, through which they were supposed to learn what they were responsible for and presumably to remember that until the next class one week later. That was the main challenge. At the end of the semester, the group mentor, a physics professor, called a deliberation in his office to gather all the teachers of that group of students, and asked student representatives to comment on each one's performance. This was an oral teaching evaluation made in public. I was really worried because, unlike other teachers, I barely spoke the language to manage to teach, let alone to please the students. The mentor certainly was aware of that, and I presumed that he was expecting criticisms. Surprisingly, when it was my turn, both students had no comments. The mentor asked them again, and they said it was OK and proceeded to the next person. I still remember the face of the mentor, fully taken by surprise, who cast an unbelievable look at me. It was an unforgettable experience in my life. It gave me a lot of confidence in myself. I also won a lot of respect from quite a few friends for my courage to take on the challenge and to succeed in it.

SR: You now spend a lot of time in Taiwan again as the Director of the National Centre for Theoretical Sciences (NCTS). How would you compare your experiences abroad with coming back to Asia at a time when the whole world is keenly looking eastwards?

WL: I returned to Taiwan in 2009 to become the Director of the NCTS, except the year 2011–2012 when I went back to Penn State for one year. The centre has two divisions, mathematics and theoretical physics. I was pleased to see that the theoretical research in Taiwan has matured a lot since the founding of the centre in 1998. People are publishing in international leading journals and there are excellent young theorists. In the past five years I worked hard to broaden people's horizon and increase the centre's international visibility by inviting the very top mathematicians, including J-P Serre, D Zagier, G Huisken, F-H Lin, M Bhargava, etc., to give short courses in our centre. We also organised high quality conferences on a wide variety of topics, four of which were jointly supported by the National Science Foundation in the US. By now our centre has hosted numerous dignitaries and visitors, who all had very high opinion of the progress the centre has made. I am confident that NCTS has built an international reputation. That said, compared to elsewhere in Asia, for instance, Singapore, Hong Kong, China, and Korea,

the progress in Taiwan pales. Even under the currently less favourable job market situation in America and Europe, the much less competitive salary in Taiwan makes it extremely difficult to attract talents to work in Taiwan for a long term, despite the very pleasing cultural environment in Taiwan. The Taiwanese government needs to make a substantial improvement in this regard.

SR: How are the scientific relations between China and Taiwan? Any remarks about this for the future?

WL: Generally speaking, the students in China are more motivated, while students in Taiwan are much less driven. The Chinese government has invested a bigger proportion of its budget in science than the Taiwanese government. The progress in Taiwan is hindered by its own democratic system, which made the government very inefficient, especially in recent years. In my view Taiwan is rapidly losing its edge and I am very sorry to see this happen. The scientific interactions between China and Taiwan are improving on one hand; on the other hand, some top talents in Taiwan are now working abroad, attracted by the much higher salaries in China, Korea, and South East Asia. It is sad for Taiwan.

SR: Do you see any changes in Taiwan from your years as a student, vis-à-vis students coming to research, especially women students?

WL: The difference is day and night. When I was a student, there was little research going on among the faculty, whereas now the faculty in better universities are under pressure to publish in good journals, and they have been doing well in this regard. In some universities, a PhD student has to meet some publication criterion before receiving the degree, certainly much more demanding than a Penn State PhD. The best students educated in Taiwan still study abroad. There are good young female mathematicians from Taiwan working in the US, for instance Melissa Liu, an associate professor at Columbia. There are also assistant professors and post-doctoral fellows at top universities. In Taiwan there are also female mathematicians, but no one is as outstanding.

SR: Tell us a little about your work and what you enjoy most as a researcher.

WL: I have mentioned some of my research interests above. In pure math, I worked on the theory of new forms and studied the arithmetic of new forms. Then I moved to representation theory, in particular, in joint papers with Gerardin, I established local Langlands correspondence between representations of rank two groups by showing how the invariants determined the representations in each case, instead of the trace formula approach where the corresponding representations are first identified and then the agreement of the invariants are shown. Using idele class characters, I obtained character sum estimates, which in turn are used to construct Ramanujan graphs and good sequences with low correlations. Jointly with Chai, we proved the Kloosterman sum conjecture over function fields. I proved high-dimensional analogue of the Alon–Boppana theorem and gave explicit constructions of Ramanujan complexes. Together with my ex-PhD students, we extended Ihara's zeta functions for graphs to zeta functions for higher-dimensional complexes, obtained a closed form expression, and showed that the Ramanujan complexes are characterised by their zeta functions satisfying the Riemann Hypothesis. In the past decade, working jointly with Long and Liu, we rejuvernised the study of the arithmetic of noncongruence modular forms. In applied math, I worked on spectral graph theory and coding theory.

As a researcher, I enjoy most working with students and young postdocs and see them making good progress.

SR: It is important that Asian countries network amongst themselves in international research. What are your views on this.

WL: As the role of Asian countries becomes more important in global economy, the scientific research in these countries also progresses at a rapid pace. The developed countries are certainly keenly eying their prospective students from Asia. While the research in Asia is still shaping up, it is essential that the Asian countries network amongst themselves to support and help each other. Hopefully in the near future, a critical mass will be formed, and Asian countries will lead in some areas of the scientific research. Our best talents will choose to remain in Asia or return to Asia to contribute to his/her home country.

SR: Congratulations on your recent birthday conference, it is very satisfying to see the world take note of your contributions. How do you feel about this?

WL: As I said at the banquet, this conference was the

highlight of my career. I was very humbled by the list of speakers, and I was glad to be an excuse to call for such a high level conference.

SR: Do you have any stories or experiences you might like to share with younger students, especially women students?

WL: This is my advice to female students. To be a mathematician is a very tough profession. Mathematics is still a men's world. To succeed in men's world, a female has to be better and stronger than their male counterpart in order to get the same respect and treatment. Also a woman has more responsibility when she has a family. There is no need to seek equality with man in this aspect. It is part of the nature that a child will ask more for mommy when in need. It only shows the status of mommy in a child's mind although this will undoubtedly increase a woman's work load. I view this as a sweet load. It is an opportunity to build a strong bond with a child. It is a good feeling to be able to help someone. Personally I find bringing up my two daughters are the most rewarding thing I have done in my life. It certainly makes my life more complete.

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