Fu Sinian Awards

by Jing Yu, Mu-Tao Wang, Tai-Peng Tsai, Ming-Lun Hsieh, and Jeng-Daw Yu

Jing Yu

The Fu Sinian Award was established by the Taida Institute for Mathematical Sciences (TIMS) in 2010. This is a mathematics award given every other year by an international jury invited by the President of the National Taiwan University. Fu Sinian was a distinguished scholar and educator, he served as president of National Taiwan University from 1949–50. He made very profound influences on the development of the Taiwan University. The award is given to outstanding achievements in mathematical sciences, for the purpose of promoting mathematical researches in Taiwan. The awardee can be mathematicians in any institution worldwide. Each awardee (if not shared by more persons) receives total three million NTD in a period of three years, and during that period, he/she should work at TIMS (for recipients from abroad, the required stay can be reduced).

In 2011, the first Fu Sinian Award was awarded to Mu-Tao Wang from Columbia University. In 2013, the second Fu Sinian Award was awarded to Tai-Peng Tsai (University of British Columbia), Ming-Lun Hsieh (National Taiwan University), and Jeng-Daw Yu (National Taiwan University).

The jury of the Fu Sinian Award in 2013 consists of: Shing-Tung Yau (Harvard University), Horng-Tzer Yau (Harvard University), Wen-Ching Winnie Li (Penn State University), Chang-Shou Lin (National Taiwan University), and Jing Yu (National Taiwan University).

The following are brief descriptions of researches achieved by the awardee in 2011 and 2013, given by the awardee themselves:

Mu-Tao Wang

My main research topics are "mean curvature flows in higher codimensions" and "quasi-local mass in general relativity". The two seemly unrelated problems share the same object of interest: a 2-D surface in a 4-D space. I have been interested in the geometry of surfaces since I took Prof. Wu-Hsiung Huang's Differential Geometry course when I was an undergraduate at NTU. He showed us how fascinating minimal surface theory is. Minimal surfaces are 2-D soap bubbles in the usual 3-D space and have been well studied in the last century. On the other hand, geometers know relatively little about surfaces in 4-D.

In the second year of my graduate study, I came across a conjecture relating the topology of a 2-D surface and the 4-D space where the surface lives. Assuming the surface was minimal, I was able to prove half of the conjecture. I then started to use the mean curvature flow to deform the surface to a minimal one. In doing so, many difficulties were encountered because of singularity formation. I did not pursue this direction for a separate reason but this idea did plant a seed. When I went to Stanford as a postdoc, I got interested in a different problem: deforming a symplectic surface into a complex one. I tried various approaches, but naturally returned to the approach of the mean curvature flow since any complex surface is minimal. Prof. Leon Simon at Stanford was an expert on the mean curvature equation. He was the chairman at the time and was extremely busy. I stopped by his office one day and asked if he had any advice if I would like to work on this direction. I was asked to come back to see him in a few days and I did. He told me "Nobody has worked on this problem and you should decide yourself whether you want to go for it or not". I was young and bold, and I decided to give a try.

I got interested in quasi-local mass because of a paper by Chiu-Chu Liu and Shing-Tung Yau around 2002. Quasi-local mass is a physical quantity related to a 2-D surface in the 4-D spacetime. At first, Prof. Shing-Tung Yau and I were trying to understand how this quantity changes when the surface is moving in the spacetime. We spent a lot of time, but only came to realize that the quantity did not satisfy a very important property. We seemed to move way ahead of ourselves when we were doing these calculations. As a result, we had to turn back and reconsider the definition of this quantity at a more fundamental level. It took us another five years before we were able to give a satisfactory definition.

The point I would like to share with young students is the following:

> Studying in school is a rather "linear" process during which progresses are made most of the time, but doing research may be totally different. My research career trails on a bumpy road and it is not uncommon to take a detour or even a complete U-turn. This is what happened to many working mathematicians. After all these years, with perseverance, I am glad that I can make some contributions. Of course, this would not be possible without the great support of my family and collaborators.

Tai-Peng Tsai

My research field is partial differential equations (PDE), and my main research topics are:

– the properties of solutions of the 3D incompressible Navier-Stokes equations with bounded scaling invariant norms, and
– the stability and interactions of solitary waves of dispersive PDEs.

Although utilizing very different machineries from functional and harmonic analysis, they both emphasize on the asymptotic behavior of solutions at spatial-temporal infinity or near a hypothetical singularity.

When I was a child, my parents owned a motorcycle parts store and we lived in the store for more than 10 years. In the elementary school, my school grades were not good until grade 5, when I also started to get interested in mathematics and learned xiangqi (or Chinese chess, 象棋) from my father. I later learned go (or weiqi, 圍棋) from my classmates when I was in grade 7. It was fortunate to me that my primary school had a special class with two teachers for talented students, so that I had a chance of pursuing higher education without going to cram schools which my family could not afford. In senior high school I participated in the Mathematics Competition and Science Exhibition. When I was an undergraduate math student in National Taiwan University (NTU), I studied commutative algebra and algebraic geometry and thought I would one day work on them for career with my high school teammate Chia-Fu Yu. However, when I went to Minnesota for PhD, I could not find a suitable supervisor and switched field after one year. Although not directly used in my research, I consider xiangqi, go, commutative algebra and algebraic geometry all integral parts of my training.

I learned how to do rigorous proofs in NTU. It was very good for a starting student like me. I later learned the importance of intuition from my PhD advisor Vladimir Sverak and postdoc supervisor Horng-Tzer Yau. Of course I learned more from them, such as how to approach a problem. I was extremely lucky to be able to learn from such superior mentors. I recommend young students to look for a mentor and seek advices from the mentor as often as possible.

My PhD thesis was on problems arising in the regularity theory for Navier-Stokes equations. It was very rewarding when I was able to understand my thesis problem after long work. When I went to New York for postdoc, I started working on Schroedinger and gKdV equations. On one hand it was good to broaden my scope. On the other hand I did not know what I could do with the difficult regularity problem. It was not until I got a tenure-track position in Vancouver that I returned to Navier-Stokes equations.

When I applied for graduate school, Minnesota was the only school which offered me a teaching assistantship. When I started my PhD study, the job market in US was extremely poor and many senior students found jobs in computer programming. These circumstances also contributed to my change of research field. I feel thankful that I could remain in math and have a comfortable life.

Through my education and career, there were always more talented students and researchers around me. It could sometimes be discouraging. However, I think I need to compete with myself rigorously, but need not compare myself with others. I should be happy with myself as long as I work hard and progress in a worthy direction. This sentence should be also said in the other order: Although I need not compare myself with others, I do need to compete with myself rigorously and strive for excellence.

Among the professional go players, I have my greatest respect for Qingyuan Wu (吳清源) and his student Haifeng Lin (林海峰). I was always fascinated by Wu's balance, intuition and positional judgment, and how he was able to move fast along the situations. On the other hand, I was always impressed by the solidity and perseverance of Lin, and how he could defend a losing game all the way until the end.

Finally, I would like to express my deep gratitude to the great support of my family and collaborators.

Ming-Lun Hsieh

My research area is number theory. More precisely, I am interested in the p-adic methods in algebraic number theory. In the past, I was working on Iwasawa theory for CM fields. In particular, with three-years effort on a study of Eisenstein series on unitary groups, I obtained an one-sided divisibility result towards Iwasawa main conjecture for CM fields and p-adic Birch and Swinnerton-Dyer conjecture for CM elliptic curves over totally real fields. Recently, I am interested in the circle of beautiful ideas about p-adic constructions of algebraic cycles due to Bertolini, Darmon and many other people. Hopefully, I can contribute something to this field.

Jeng-Daw Yu

Hodge theory is an important subject in algebraic geometry; it appears in various areas in mathematics and has many applications. Recently I work on the generalization of the Hodge theory to a setting which involves irregular singularities in its coefficient systems. In this particular circumstance, we expect that many classical results in Hodge theory would have the corresponding statements, which should give interesting applications. On the other hand, this new structure may shed new light on our understanding of very old subjects, e.g., a Hodge structure attached to Airy or Bessel functions. Together with H. Esnault and C. Sabbah, we obtain the analogous degeneration of the Hodge to de Rham spectral sequence, which can be regarded as a first step toward developing the whole properties of this new theory. I feel this development exciting because many problems from different areas seem all related within this theory; it certainly deserves a deeper investigation.

Mathematics is such a beautiful subject of research; it needs serious thinking and very hard working in order to really discover some of its inner structures. Many interesting problems have different angles of approaches. This also means that to have a better understanding of the problems, one needs to learn various tools to attack them. I suggest students to open their eyes by learning different theories when it is possible. Once they find an interesting subject or problem, then study very hard. A beautiful result never comes easy, but requires the full dedication. However the reward of proving it is all meritorious and delightful.

I am very glad to share this award with Tai-Peng Tsai and my colleague Ming-Lun Hsieh. I thank my collaborators Esnault and Sabbah. I certainly learned a lot from them through our joint work. I would also like to take this opportunity to express my appreciation to my colleagues in National Taiwan University, especially Hui-Wen Lin, Chin-Lung Wang, and Jing Yu for their warm support and constant encouragement. Their resistance and enthusiasm on researches and educations provide a role model for the younger generations and keep upgrading the research environment in Taiwan, which cannot be underestimated.