

Newsletter Vol. 3 Fall 2017



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Director's Message

This August, we celebrated the 20th Anniversary of NCTS. Having serving the mathematical society of Taiwan for two decades, NCTS has grown into a center of excellence with international reputation. We are very proud of our previous program for young scholars and students. It turns out that almost all active mathematicians in Taiwan are closely related to NCTS.

In order to provide a better training for young students and further collaboration between faculties in different places in Taiwan, we initiated the project "Taiwan Mathematics School." With this project, we expect that not only students can benefit from the versatility, but also professors can benefit by working together. Another news that I would like to share with our friends is that the new location for Mathematics Division of NCTS is expected to be completed within a couple of months. I believe that our members, visitors, students and friends will find it pleasant in our new place.

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NCTS Director Prof. Jungkai Chen



HAPPY BIRTHDAY NCTS! Celebrating the 20th Anniversary of NCTS, Math in Taipei August 1st, 2017

The National Center for Theoretical Sciences (NCTS) was established on August 1st, 1997 by the National Science Council (NSC). The community of theoretical sciences in Taiwan has benefited considerably from NCTS over the past 20 years. We have organized the celebration activities for an exciting event at the NCTS, Math on August 1st. As part of the celebration activities, we have had two public talks and a forum.



Public Talks

Personal Experience on the Subject of Geometric

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You can find out the videos via NCTS YouTube page!

▶ YouTube TW

NCTS Math Division

Below you can find some photos of the events.



Forum of Research Centers

he forum was attended by members and friends of NCTS and a panel of distinguished speakers were invited:

NCTS founding director, Professor Jing Yu, NCTS current director, Professor Jungkai Chen, President of the American Mathematical Society, Professor Ken Ribet, and Former president of the Korea Institute for Advanced Study, Professor JongHae Keum.

Opening Statements

In opening remarks speakers shared their experiences and views relating to NCTS. In particular, as NCTS was originally largely based upon the Mathematical Sciences Research Institute (MSRI) at UC Berkeley, Professor Ribet drew parallels between the development of NCTS and his personal experiences in MSRI and other centers:

"There are lots of different possibilities for NCTS, and every institute has to unify its own characteristics and try different things. At the



beginning it's very natural that you copy an existing center to have a starting point. Then you say "we have lots of miles to travel so let's see how that works". However, you should never be afraid to experience and try out new things. You should really say, "you know, we are unique, this is Taiwan, we have our own kinds of visitors, our own facility, our own local students, and our own general public. Let's try something of our own and see how it works.""

Striving for Excellence and the Importance of the Advisory Board

Professor Ribet pointed out that for a research center to be successful, striving for excellence is the most important and perhaps the only criterion. Specifically he emphasised that a very strong advisory board is a key factor. He illustrated this with his own experiences on research centers' advisory boards:

"I have spent a lot of time in MSRI. I've never been part of the government of MSRI, but I was there at its creation. I was in one of the first programs, a year long program. I was on the scientific advisory board for many years, and now I am a member of the scientific advisory board for the Simons Institute for the Theory of Computing which is on the Berkeley campus, and I would say that institutes are quiet varied, and there is no one single way which they can succeed. I think it's very important to have a very strong imaginative scientific advisory board, because the actual scientific activities at the institute very often are dreamed up by the advisory board before anything happens."

Discussion of Funding

The panel went on to comment on the the issue of funding in Asia and United States. Government support is sometimes unstable so alternative sources must be explored. One advantage centers certainly have in the United States is that there are so many people who loved mathematics as undergraduates. If they went on to successful business careers, they can still feel attached enough to mathematics to make donations. They might like to support young researchers, women or people transitioning from postdocs or fellowships to move ahead in their careers. Also many have pet projects, and you just have to find the right project for them. They really can be very generous. However, by contrast it seems that the situation is different in Asia. Prof. Keum shared that it's difficult to raise money in Korea. There's the same problem in Taiwan. People think it's the government's responsibility to support research centers but not the public's.

Future Plans for NCTS and Post Doctoral Programs

Nowadays in mathematics there are a lot of postdocs but the job markets for them are not so easy. How can we help them more? More regular visitor type programs for postdocs to attend may help them in the international market.

Professor Yu proposed initiating joint postdoc programs, of 3 month or half year durations, between research centers of nearby countries, such as China, Japan, Korea and Taiwan. Even though Asian countries are not as homogeneous as European countries, it was still considered to be an interesting and potentially worthwhile idea among panel speakers.

Finally the speakers looked forward with our members and friends to an exciting future as NCTS continues to develop and improve.





Interview with Dr. Wu-Liang Loring Tu



Loring W. Tu was born in Taipei, Taiwan, and grew up in Taiwan, Canada, and the United States. He attended McGill University and Princeton University as an undergraduate, and obtained his Ph.D. from Harvard University under the supervision of Phillip A. Griffiths. He has taught at the University of Michigan, Ann Arbor, and at Johns Hopkins University, and is currently Professor of Mathematics at Tufts University in Massachusetts.

An algebraic geometer by training, he has done research at the interface of algebraic geometry, topology, and differential geometry, including Hodge theory, degeneracy loci, moduli spaces of vector bundles, and equivariant cohomology. He is the coauthor with Raoul Bott of "Differential Forms in Algebraic Topology" and the author of "An Introduction to Manifolds" and "Differential Geometry: Connections, Curvature, and Characteristic Classes."



Q. Since most of your education and teaching experiences are in America, would you like to share some advantages and disadvantages of American education environment?

American high schools and universities are very different. Although there are some top-notch high schools in the United States, I think most American public schools are not challenging enough. American universities, and here I am speaking of research universities, on the other hand, are probably the best in the world. They have professors who are also researchers, and their level is quite high. Also, American universities emphasize good teaching as well as research. Students evaluate professors at the end of every semester. Moreover, an undergraduate education in the United States is what is called a "liberal arts education." It requires the student to learn about many different areas as well as concentrating in one area. I think it is a good model. In addition to mathematics, I studied art history, literature, physics, chemistry, and biology in college. With a liberal arts education, the student becomes a more well-rounded, well-informed,

interesting person, capable of critical thinking. In Taiwan, perhaps students specialize too early.

Q. According to your experience in mathematical research, what are the differences between Taiwan and America in terms of education environment?

This is the first time since I left at the age of thirteen that I have lived in Taiwan for more than two weeks. I have taught a course at Taida, but I have never taken a class at a Taiwanese university, so I am not really familiar with the educational environment in mathematical research in Taiwan. In the class I taught, which was a second-year master-level course on equivariant cohomology, the students were excellent. I was surprised that the students spoke up in class and often challenged me. I was not expecting that. I had expected Taiwanese students to be passive. In the United States, the emphasis is on understanding and not on learning facts, and the students often ask questions and challenge the professors. My course in Taiwan was like that, but I don't know how widespread this is.



Highlights of Events

7/18 – 7/21	5th India-Taiwan Conference on Discrete Mathematics 2017
9/4 – 9/7	NCTS PDE Workshop on Fluid Dynamics and Related Prob- lems
9/4 – 9/8	2017 The Fourth Taiwan Interna- tional Conference on Geometry
9/11 – 9/15	NCTS Workshop on p-adic L-functions and Algebraic Cy- cles

Highlights of Courses

Summer Courses

6/26 – 7/5	Additive Combinatorics
6/26 – 7/5	Free Probability
6/26 – 7/7	Scientific Computing on Super- computer
7/10 – 7/21	Mathematical Modeling and Analysis of Infectious Diseases
7/10 – 7/21	Introduction to Knot Theory
7/14 – 8/18	Brownian Motion
7/21 – 8/11	Dynamical Systems: Symbolic Dynamics
8/3 – 8/16	Mathematical Biology
8/7 – 8/16	Introduction to Brownian Motion and Partial Differential Equations
9/4 - 9/7	Introduction to Mathematics in
	Modern Technology
Courses	Modern Technology
Courses 6/8	Modern Technology Short Course on Parareal Meth- od for Time-Dependent Prob- lems
Courses 6/8 6/26 – 6/27	Modern Technology Short Course on Parareal Meth- od for Time-Dependent Prob- lems NCTS Short Course on Applied Mathematics
Courses 6/8 6/26 – 6/27 7/6 – 7/12	Modern Technology Short Course on Parareal Meth- od for Time-Dependent Prob- lems NCTS Short Course on Applied Mathematics Mini-Course on Perfectoid Spaces
Courses 6/8 6/26 – 6/27 7/6 – 7/12 7/10 – 7/13	Modern Technology Short Course on Parareal Meth- od for Time-Dependent Prob- lems NCTS Short Course on Applied Mathematics Mini-Course on Perfectoid Spaces Mini-Course on Representation Theory



Q. What made you start to cooperate with NCTS and since when? How was the experience?

I first learned about NCTS in July 2010, when Wen-Ching Li was the director. She invited me to give a talk, which I wrote up into an expository article. The article, "What is equivariant cohomology?" was published in the Notices of the American Mathematical Society. In 2013, the director Alfred Jungkai Chen offered me an office space for a month in August, and I worked on an article "From sheaf cohomology to the algebraic de Rham theorem." In December 2014, I gave a talk about my student Jeff Carlson's work equivariant formality in Hsinchu. It led to a collaboration between an NCTS postdoc Chi-Kwong Fok and my student Jeff Carlson. In 2017, I was really fortunate to be able to teach a course on equivariant cohomology at Taida and NCTS, because it was based on a book that I was working on. At the same time I finished a book on differential geometry. Overall, my experience at NCTS has been very productive. NCTS is a nice environment to work in. The facilities and the support are very good.

I am now turning my course on equivariant cohomology into a small book, a different book from the one I was originally writing.

In terms of interactions, NCTS introduced me to Taiwanese mathematicians at other cities. Through the connections I made at NCTS, I have given talks



at Tsing Hua, Cheng Kung, and National Normal Universities. I have also interacted with some visitors and postdocs, such as Jeff Carlson, Alex Chi-Kwong Fok, and Hiep Dang. In fact, many of my colleagues abroad would like to visit NCTS. They are waiting for an invitation.

Q. How do you think NCTS can provide supports to mathematical researchers and students in Taiwan and worldwide?

There are two models for mathematical institutes. One has a full-time faculty like the Institute for Advanced Study at Princeton, IHES in France, and Max Planck Institute in Bonn. The other has only temporary members and sponsors conferences and workshops.

It makes sense that NCTS follows the second model, since there are plenty of full-time research mathematicians at Taida and at Academia Sinica, which share the same building. NCTS can support researchers and students in Taiwan by having postdocs and visitors for a year and sponsoring workshops on hot topics.

Q. Are there any suggestions you would like to offer to NCTS for promotion of its in-fluence?

NCTS is already doing many things right — it has a beautiful facility, excellent support, great geographical location, an excellent library, postdocs, visitors, workshops, conferences. However, it is not well known internationally. None of my friends have ever heard of it until I told them. I think it should advertise more widely. For example, it should advertise its openings and workshops in the Notices of the American Mathematical Society and it should advertise the openings in MathJobs.org, because that is where everyone looks.

Upcoming Events

2017

10/12 – 10/14	ReaDiNet 2017: International Conference on Mathematical Bi- ology
10/28 – 10/31	International Conference on Nonlinear Analysis: Kinetic The- ory, Gas Dynamics, and Related Fields
11/1	2017 NCTS Workshop on Opti- mization
11/18	The 15 th Taiwan Geometry Symposium
12/4 – 12/5	2017 NCTS Workshop on Differential Equations and Dynamical Systems
12/12 – 12/15	2017 NCTS Workshop on Non- linear PDEs
12/22 – 12/25	2017 Taiwan-Japan Workshop on Dispersion, Navier Stokes, Kinetic, and Inverse Problems
2018	
2/1 – 6/22	NCTS Course on Random Matri- ces
2/23	2018 NCTS Young Dynamics Day
3/3 – 5/12	NCTS Mini-course on Geometry Measure Theory
5/28 - 6/1	2018 NCTS Workshop on Mathematics Biology



NCTSTaiwan Mathematics School High-performance Computing for Tomorrow

Taiwan Mathematics School

aiwan Mathematics School was established by NCTS in 2017. It is a co-teaching platform designed by four organizers: Tsung-Ming Huang from NTNU, Wen-Wei Lin from NCTU, Yu-Chen Shu form NCKU, and Weichung Wang from NTU. This school is meant to cultivate talent, lead the new Taiwanese generation towards the world stage and strengthen the Taiwan Mathematics community. Taiwan Mathematics School is a joint co-teaching school that covers all aspects of learning that instills knowledge, skills in students, and to broaden their horizons. The concept of Taiwan Mathematics School originates in its Berlin predecessor, the latter gathered teachers from all over the world and partner in teams to demonstrate their specialties to students. Their cooperation is likely to inspire each other and come up with many different teaching approaches that would benefit students most.

Www.ith the approaching fall semester of 2017, six mathematics departments of Taiwan universities including National Taiwan University, National Taiwan Normal University, National Cheng Kung University, National Chengchi University, National Central University and National Sun Yat-sen University have cooperated to design the curriculum for the first year based on "High-performance Computing for Tomorrow". Mathematics and computers have always been important tools for solving many scientific and engineering problems. Especially in the age with prevalent big data usage and parallel computers, combining high-efficiency numerical methods and high-speed computers we can explore and unveil the mysteries of nature to build a better tomorrow! Entering high-speed parallel computing and learning to use multi-core CPU and GPU is not as difficult as one may imagine. These courses will guide students to understand the important ap plications of contemporary issues and to research the internal mathematical structure for the further use of high-speed computer of numerical methods.

his series of courses have three characteristics:

- Internationalization: Invite mathematicians from all over the world such as the USA, Germany, and Japan to join Taiwan Mathematics School and participate in teaching so that our students will be able to catch up the latest trends of computer science.
- 2. Most advanced content: Explain the latest development of high-speed computing, update them with the latest knowledge and sophisticated technology.



3. Inter-collegiate collaboration: A shared platform for both teaching and learning resources operated by professors from mathematics department of Taiwan's universities, aiming to achieve excellent mathematics education by fully utilizing each professors' specialty through co-teaching.

Besides better education through co-teaching, Taiwan Mathematics School also seeks to promote the goal of "3 I", which is "Inter-discipline", "Internationalization", and "Industry". We plan to develop a mutually beneficial cooperative relation and a coordinated system which links companies and different universities together and transmits feedback between different parties. Our teaching team wishes to instill the "3 I" core value into the upcoming or still-planning courses. With so many great opportunities offered by the rich and diverse mathematics teaching and research environment, we hope we can better prepare our students in future professional achievements and career developments.









NETS National Center for Theoretical Sciences

NCTS Research Spotlights

STABILITY OF MEAN CURVATURE FLOW IN HIGHER CODIMENSIONS

Chung-Jun Tsai got his Ph.D. at Harvard University in 2011. He was a postdoc at NCTS 2011-2013, and has been an assistant professor at National Taiwan University since 2013.

ean curvature flow in local model of manifolds with special holonomy. In the joint work of Chung-Jun Tsai and M.-T. Wang, they study the mean curvature flow in some famous local models of manifolds with special holonomy. By examining those metric properties carefully, they found that the distance function has a strong



convexity. Due to the maximum principle, they obtained a strong rigidity result for minimal submanifolds in these local models.

hen, along the mean curvature flow, the strong convexity estimate becomes a nice C^0 estimate. This C^0 estimate can be used to estimate higher order derivatives. With it, they showed that the mean curvature flow in these models has long time existence and smooth convergence, provided the initial submanifold is C^1 close to the calibrated submanifold. There are not much known about the mean curvature flow in manifolds of special holonomy, and they hope that this result would shed some light in this direction.

inear stability and dynamical stability. The mean curvature vector is the negative gradient vector of the volume functional. Thus, deforming a submanifold along the mean curvature vector decreases its volume, and is a natural way to look for minimal submanifolds. However, the analysis for the mean curvature flow equation is difficult, and

there are still lots to be explored. Most known results are for the hypersurface case.

he second variational formula of the volume functional is studied systematically first by J. Simons. A natural question is that whether the positivity of the second variation implies the dynamical stability, i.e. the stability of the mean curvature flow.

hen the volume functional is analytic and the initial condition is C² close, one can invoke the general theorem of L. Simon. The volume functional is in general not analytic. However, the mean curvature flow has geometric nature, and one expects to say more than the general gradient flow.





The great circle in the round sphere is not stable under the mean curvature flow.



Mean curvature flow in negatively curved space tends to be more stable.

hung-Jun's next work, *A C¹-dynamical stability result of the mean curvature flow*, is in a way a generalization of their previous work, *The stability of the mean curvature flow in manifolds of special holonomy*. They examined the key mechanism and identified a strong stability condition. The condition is that the zero-th order part of the second variation operator is positive. They showed that this condition implies that the distance function to the minimal submanifold has convexity, up to a dimension constraint. This convexity estimate can be used to prove a strong rigidity result and the C¹ stability of the mean curvature flow. Many examples, including several well-known types of calibrated submanifolds, satisfy the strong stability condition.

art of their work was carried out when M. T. Wang was visiting NCTS. The key part was done when Chung-Jun was visiting Columbia University by the support of the NCTS Young Theoretical Scientist Award. Both the research environment and the travel support of NCTS benefit this collaboration a lot.

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Join Us!

NCTS is calling for 2018 postdoctoral fellows!

Application will be open from Sept. 1, 2017 to Feb. 28, 2018. The appointment starts from August 1, 2018, for 1 or 2 years, extendable up to 3 years. Every talent pursuing academic excellence is welcome. Priority will be given to the following areas: *Algebraic Geometry, Differential Geometry and Geometric Analysis, Differential Equations and Stochastic Analysis, Scientific Computation, Data Science.*

NCTS is calling for Research Pairs!

A Research Pair consists of 2-4 researchers, without the same affiliations. Each member in one pair is expected to spend 2-4 weeks at NCTS for research collaborations, and will be supported as a visiting scholar for NCTS. Application is always open!

Please visit http://www.ncts.ntu.edu.tw/ for position details.

Undergraduate Summer Research Program

NCTS held an Undergraduate Summer Research Program during summer vacation, in order to make undergraduates combine their mathematics knowledge learned from school and project research together through team work.

There were 2~4 students in a group with 1 mentor, and there were 4 groups this year.

- •The topic of Group 1 was Analyzing Smartphone Generated and Medical Imaging Data.
- The topic of Group 2 & Group 4 was Diffusion Map and its Application on Stock Analysis; these 2 groups worked together.
- The topic of Group 3 was Interfacial Motion of Liquid Films on Heterogeneous Substrates.

After the final presentation, Director Chen awarded certificates to students. Among this month, students not only made a thorough study of the subjects they were interested in, but alo learned the way to do research and write papers. They all benifited greatly and learned a lot from this program.





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Visitors:



1. Prof. Leon Simon (Stanford University) will visit NTU & NCTS from Mar 3, 2018 to May 12, 2018. He will teach a mini-course on Geometry Measure Theory.



2. Prof. Kaoru Ono (RIMS) plans to visit NCTS in Spring 2018 (date is not fixed yet).



3. Prof. Horng-Tzer Yau (Harvard University) will visit NTU & NCTS in Jan. 2018 for a semester. He will teach a course on Random Matrices.

NCTS will organize a Reading Seminar on Random Matrices to go over some of the basics in Prof. Yau's book.



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