



**ALM<sub>5</sub>**

Advanced Lectures in Mathematics

Hangzhou 2007    December 17-22

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*Vol. I*

**Editors:** Lizhen Ji · Kefeng Liu · Lo Yang · Shing-Tung Yau



高等教育出版社  
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Set of 3 Volumes

# 杭州华人数学家大会序

维五十九年冬，华裔筹人再会于浙江之杭州。算学菁英，何其众也。如浙之潮，如江之涌。四方来聚，咸集于斯。以广见闻，以扬所学，以纾所见，以传来者。把酒临风，对景长谈，固一时之盛也。

异邦俊秀，中土英髦，妙语悬河，玄思不绝。放怀于山水之间，创意于尘俗之外。参天地之造化，究人事之所共。费玛尤拉启于前，高斯黎曼宏于后。仰先哲之明智，虽弥高而弗弃。叹时贤之所处，或技深而未全。岂真理之无涯，非下智之可测乎。当代科研，已非一家之域。他年达者，当合众学之英。潜渊腾蛟，高岑起凤。骊珠未远，天道将其可窥耶。

由微知著，以朴制繁，众理如一，筹学之德也。然而数非一相，文非一体。或得之于心，或求之于物，或心物并驰。能者虽众，鲜能兼善。精而后博，数论之质也。朴而后坚，代数之骨也。分析如盘，众妙之门。几何纯厚，筹学之源。探天地之丽，究造物之形。计算巧微，百工以动。概率随机，统计是用。大千精妙，尽在斯乎。

大道行而自然兮，术同源而分流。登高岗而周览兮，望江水之扬波。惟天地之无穷兮，何真理之有常。道没世而不朽兮，惧乎时之不留。士携手而并进兮，国欣欣以向荣。

丘成桐

二零零七年十一月二日

附

## 庞卡莱之梦

丘成桐

### 第一章 庞卡莱之梦：空间女神的追求

我曾小立断桥，我曾徘徊湖边，  
想望着你绝世无比的姿颜。  
我曾独上高楼，远眺天涯路，  
寻觅着你洁白无瑕的脸庞。  
柔丝万丈，何曾束缚你的轻盈。  
圆月千里，何处不是你的影儿。  
长空漫漫，流水潺潺，何尝静寂，  
你的光芒一直触动着我的心弦。  
长流滚滚，烈火洪洪，怒涛澎湃，  
激动着那深不可测的永恒。

### 第二章 方程的创造：苦思的煎熬

默默长夜，  
灵光猛然照耀在纽约上州的校园。  
在普林斯顿的草茵场上，  
我聆听到康奈尔传来的讯息，  
你创作了宇宙共鸣的方程！  
碧海天蓝，  
在圣地亚哥的晴朗中，  
我们思量着方程的估值，  
在夏威夷的椰树下，  
你承受着百年问题的煎熬。  
道远天长，万缕千丝，  
知她真理何处，你总在思量，  
梦里有时曾去。  
烈烈风吹，绿绿潮涌，

冲激着你的衣裳，  
你何尝想起渐宽的衣带，憔悴的容颜。

### 第三章 估值的完成,热流的推导

微风拂着水波，  
月儿伴着孤独，  
在那平静的大洋里，  
一片光黄，闪烁着宇宙的心声。  
两纪的辛劳，廿载的研讨，  
都注在你凌天的一击，  
赢得她那嫣然一笑的朱颜。  
造物的奥秘，造物的大能，  
终究由他来启示。  
在那茫茫的真理深渊，  
空间展出了它的风华—素朴而安宁。  
洪洪的热流，  
冲出了空间的调和，  
冲出了引力的均衡。  
这般的无瑕，这般的洁净，  
这可不是一般的娇柔！

### 第四章 终极空间的形成:奇异点的切割

我凭栏远眺，  
看到了那终极的空间，  
一忽儿平坦，一忽儿双曲，  
一忽儿又像大漠上的穹苍。  
这典雅优美，  
何由而生，何由而灭，  
岂不在于那细致的拓朴，  
在热流中飘忽，  
任由那恼人的精灵接连。  
看啊！大鹏已经展翅，  
利剑已经出鞘，  
凌厉的舞姿，精准的手术，  
割除了多余的渣残。

你望见了拓朴的精华，  
你找到了几何的奇异，  
却还待跨越那剩下的鸿沟。

## 第五章 灿烂的诗篇，完美的歌剧

流芳远递，  
由圣彼得堡而来的苦思，  
从天上飞来，  
唤醒了沉默的大众。  
艰涩的语言，梦幻的推理，  
触着你学问的深处，  
引起我们估值的共鸣，  
他驱除了雪茄的奇异，  
道出了精灵的有涯。  
在中山的课堂，在吐露海旁，  
在哈佛园中，在纽约的上城，  
你的追随者，终于找出了最后的脉络，  
谱出了最后的篇章。  
啊！这一切的精灵，  
在梦里我们找寻过千万遍，  
一刹那间，展现出她灿烂的身形。  
这是绝代的朱华，  
这是旷世的奇遇，  
让我们来祝贺，让我们来高歌，  
这是宇宙最完美的诗章。

2006年7月29日

# Address of the Congress President

I warmly welcome you to the Fourth International Congress of Chinese Mathematicians (ICCM 2007), which will be held December 17-22, 2007 in Hangzhou, China. Over the next six days, several hundred guests, mathematicians, and students will gather to learn about the latest research and to reward the accomplishments of their colleagues with several important prizes.

Following tradition, on the opening day of the congress, the winners of the Morningside Medal of Mathematics are announced at an awards ceremony. At ICCM 2007, a total of seven medals will be given to exceptional mathematicians of Chinese descent under the age of forty-five for their seminal achievements in mathematics and applied mathematics. Since 1998 when the first Morningside Medals of Mathematics was awarded, the nineteen medallists have continued to make invaluable contributions to the advancement of mathematics. These medals provide encouragement to Chinese mathematicians at a critical stage in their pursuit of mathematical truth. Besides the Morningside Medals, the winners of the Chern Prize in Mathematics and the ICCM International Cooperation Award will also be announced at the opening ceremony. The recipients of these honors are recognized for their dedication and efforts to promote mathematics.

I am also pleased to introduce the New World Mathematics Awards which will be presented at ICCM 2007 for the first time. These awards recognize outstanding doctoral, masters and undergraduate theses written by mathematicians of Chinese descent who have graduated from universities and institutes in the past three years. The inaugural winners of the New World Mathematics Awards will be announced at a dinner on December 17, 2007. Another exciting development is the Taikang Mathematics Awards which recognize excellence in mathematics research projects among high school students of Chinese descent throughout the world. An official ceremony marking the establishment of the Taikang Mathematics Awards will take place on December 18, 2007.

A symposium, held in the afternoon of the opening day, will feature top mathematicians and university presidents who will examine mathematics-related topics. The first session focuses on how mathematics is playing an increasingly important role in biomedical science. Jill Mesirov, the chief informatics officer at the Broad Institute, will provide an overview of the latest cutting-edge developments



in genomics and biomedical research.

The second session looks at the challenges facing higher education in the twenty-first century. Panelists include former Dean of Harvard College Benedict Gross; Vice Chancellor of The Chinese University of Hong Kong Lawrence Lau; Dean of the Graduate School of Arts and Sciences at Columbia University Henry Pinkham; Chancellor of the University of California at Santa Barbara Henry Yang; President of Zhejiang University Wei Yang; and President of the University of Chicago Robert Zimmer.

The final session will examine the critical issues facing primary and secondary mathematics education in Europe and the United States. Wilfried Schmid of Harvard University and Jean-Pierre Demailly of Joseph Fourier University will share their thoughts and the ensuing discussion will be chaired by Hung-Hsi Wu of the University of California at Berkeley. The discussion will be carried over to the next day, when a new panel convenes to examine mathematics education in the mainland of China.

Beginning December 18, about 200 mathematicians will share and explain their discoveries. In all, there are 31 plenary lectures and over 40 sessions on specialized topics. Several distinguished mathematicians will also deliver special addresses, including the Morningside Lectures, the New World Lectures, and the Taikang Lectures. The content of all the lectures and sessions are published in the Proceedings of ICCM 2007 and the Program and Abstracts. It is our hope that these latest developments in modern mathematics will be disseminated widely so that this rich body of knowledge can be shared with everyone.

I wish to thank our sponsors for their generous support. Foremost, I would like to acknowledge the MORNINGSIDE GROUP, founded by brothers Ronnie and Gerald Chan, for making the Morningside Medal of Mathematics possible and for underwriting the opening ceremony. Since 1995, Morningside has played a tremendous role in promoting mathematics and tertiary education in the mainland of China. Next, I wish to thank the New World Development Company and Managing Director Henry Cheng for sponsoring the inaugural New World Mathematics Awards. I would also like to recognize Taikang Life Insurance and Chairman Dongsheng Chen for sponsoring the Taikang Mathematics Awards. Lastly, I would like to thank Mrs. Maria Man Mui of Mui's Kamsing Enterprises Limited for her donation to ICCM 2007, and the Higher Education Press for the publishing of the Proceedings and sending them to the participants free of charge.

Finally, ICCM 2007 would not be possible without the full support and resources of Zhejiang University, in particular, Professors Kefeng Liu and Hongwei Xu, and their team at the Department of Mathematics and the Center of Mathematical Sciences. I would also like to acknowledge the staff at Morningside, Hang Lung Properties, New World Development Company, and Taikang Life Insurance for their efforts to ensure that ICCM 2007 is a success.

I believe cooperation among Chinese and non-Chinese mathematicians is essential for the development of mathematics within China. There should be no boundaries for research in mathematics, and at each ICCM, all mathematicians are encouraged to take this attitude. It is this spirit of cooperation that will enable Chinese mathematicians to reach new milestones and to produce ground-breaking research.

Shing-Tung Yau  
President of the International Congress of Chinese Mathematics

## Past Congresses of ICCM

1998

Beijing

2001

Taipei

2004

Hongkong



2007 Hangzhou

# Past Morningside Medalists, Chern Prize Winners and ICCM International Cooperation Award Winners

## Morningside Medalists

2004

### Gold Medalists:

Yizhao Hou

California Institute of Technology

Kefeng Liu

Zhejiang University

Zhouping Xin

The Chinese University of Hong Kong

Ziliang Ying

Columbia University

### Silver Medalists:

Jinyi Cai

University of Wisconsin-Madison

Aiko Liu

University of California , Berkeley

Xiping Zhu

Zhongshan University

2001

### Gold Medalists:

Jun Li

Stanford University

Horng-Tzer Yau

New York University

### Silver Medalists:

Daqing Wan

University of California, Irvine

Chin-Lung Wang

Tsing Hua University (Taiwan)

Sijue Wu

University of Maryland, College Park

Nanhua Xi

The Chinese Academy of Sciences

**1998**

**Gold Medalists:**

Chang-Shou Lin

Chung Cheng University (Taiwan)

Shouwu Zhang

Columbia University

**Silver Medalists:**

Raymond Chan

The Chinese University of Hong Kong

Chong-Qing Cheng

Nanjing University

Kefeng Liu

University of California, Los Angeles

Tong Yang

City University of Hong Kong

**Chern Prize Winners**

**2001**

Song-Sun Lin

Chiao Tung University (Taiwan)

Jiu-Kang Yu

Purdue University

**2004**

Fanghua Lin

New York University

Lo Yang

The Chinese Academy of Sciences

**ICCM International Cooperation Award Winner**

**2004**

John Coates

University of Cambridge

# Medal and Awards of ICCM and the Background

At each International Congress of Chinese Mathematicians (ICCM), the winners of several prestigious awards are announced at the opening ceremony. These awards include the Morningside Medal of Mathematics, the Chern Prize in Mathematics, and the ICCM International Cooperation Award. At ICCM 2007, two new prizes will be introduced: the New World Mathematics Awards and the Taikang Mathematics Awards.

## Morningside Medal of Mathematics

The Morningside Medal of Mathematics is awarded to exceptional mathematicians of Chinese descent under the age of forty-five for their seminal achievements in mathematics and applied mathematics. The winners of the Morningside Medal of Mathematics are traditionally announced at the opening ceremony of the triennial International Congress of Chinese Mathematicians. The inaugural medals were presented in 1998. Each Morningside Medalist receives a certificate, a medal, and cash award of US 25,000 *for a gold medal* or US 10,000 for a silver medal.

## Chern Prize in Mathematics

The Chern Prize in Mathematics was established in 2001 in honor of Professor Shing-Shen Chern, one of the greatest geometers and Chinese mathematicians of the twentieth century. The Chern Prize is presented every three years at the International Congress of Chinese Mathematicians to mathematicians of Chinese descent who have made exceptional contributions to mathematical research or to public service activities in support of mathematics.

## ICCM International Cooperation Award

The ICCM International Cooperation Award is presented to an individual who has promoted the development of mathematics in the Chinese mainland, Hong Kong, and Taiwan through collaboration, teaching, and support of Chinese mathematicians. The inaugural award was presented at the 3rd International

Congress of Chinese Mathematicians in 2004.

## **New World Mathematics Awards**

The New World Mathematics Awards recognize outstanding doctoral, master and undergraduate thesis written by mathematicians of Chinese descent who have graduated from universities and institutes in the past three years. The purpose is to provide encouragement to talented Chinese mathematicians and to promote creativity and innovation in mathematics. The inaugural New World Mathematics Awards will be presented at a dinner on December 17, 2007.

## **Taikang Mathematics Awards**

The Taikang Mathematics Awards recognize excellence in mathematics research projects among high school students of Chinese descent throughout the world. The goal is to identify gifted mathematicians at a young age and foster their interest in this field of study. An official ceremony marking the establishment of the Taikang Mathematics Awards will take place on December 18, 2007. The first awards will be presented in October 2008 in Beijing.

# The Committees of the Congress

## Congress Chairman

Shing-Tung Yau                      Harvard University and Zhejiang University

## Scientific Committee

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Bong Lian	Brandeis University
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Yaxiang Yuan	Academy of Mathematics and Systems Science, CAS