



# Department of Mathematics

Newsletter 2012-2013



## Foreword by the Chairman



On August 1, I took up the Chairmanship of the Department from Prof. Ka-Sing Lau. I would like to take this opportunity to thank him for his leadership and contributions to the Department for the past 16 years.

When Prof. Lau assumed the Chairmanship 16 years ago, our Department was at its nadir. Student quota was cut from 80 to 50, and research was not yet on track. Prof. Lau happened to be visiting our Department on sabbatical leave that year, and was convinced to stay behind as the Chairman by the then University Vice chancellor, Prof. Charles Kao. Working slowly against all odds, and with the cooperation and devotion of all colleagues, he gradually rebuilt the Department on more solid foundation. We have since then introduced to our curriculum different streams catering for the diversity of students. Scholarships have been added with the generous donations from alumni and friends. We also introduced summer internships in different parts of the world, which widen our students' horizon and exposure.

With these reforms, our programme, especially the Enrichment Stream and the Mathematics & Information Science Stream, is now the envy of everyone inside and outside of the Science Faculty. Our research is one of the best, if not the best, in Asia.

With the new 334 system and the consolidation of mathematics courses across the university, the Department is going to offer many more courses. It will be a challenge as well

as opportunity. It is a challenge because we will have to teach more than 1,200 first-year non-major students calculus and linear algebra; giving such a vast and diverse population the most suitable learning experience is no small task. On the other hand, it is also an opportunity because there will be additional funding for those new courses, empowering us to further improve our research and teaching standards.

Looking ahead, I can see the Department continuing to flourish under the good and well-tried practices laid down by Prof. Lau. I will keep these practices intact, especially in upholding our high standard in research and teaching, making changes only if necessary. One thing that is certain to change though is that I cannot work from 7:00am to 11:00pm in the office like Prof. Lau.

*Raymond Chan*

Prof. Raymond H. Chan

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# The Way I Remember It

Prof. Chu Cho Ho

In 2012, the Department was honored to host the International Conference on Jordan Theory, Analysis and Related Topics in celebration of the 65th Birthday of Professor Cho-Ho CHU. Prof. Chu is Professor of Mathematics at Queen Mary, University of London and one of the alumni of the Department. The following is Prof. Chu's sharing at the conference banquet.

Let me turn the clock back to 1966 when I first enrolled at the Chinese University. It was a turbulent time of the Cultural Revolution in China. At that time, the University was newly established and was not at the present campus but made up of three colleges at separate locations: the Chung Chi College, which occupied a corner of the present campus; the New Asia College, located in Kowloon; and the United College, which was my college and supports this conference generously, situated on Hong Kong island, right next to a mental hospital. I am happy to say that none of us in Mathematics ended up next door, and I don't remember seeing any early autistic signs among us either! In fact, we were very sociable: ping-pong, chess, basketball, music and the rest. The Chinese University moved to the present campus after I graduated in 1970.

The Chung Chi College was very lucky to have a star pupil, Shing-Tung Yau, who went on to win the Fields Medal and numerous prizes. Despite his fame, Shing-Tung took great efforts to help fellow mathematicians from Mainland China, Hong Kong and Taiwan. As some of you may know, he is the founder of the Institute of Mathematics here.



The United College, on the other hand, distinguished itself at my time by having an unprecedented large number of female mathematicians which made our lives very busy indeed! Thanks to Dr N.N. Chan, who was in charge of admission at the time. Dr Chan is a gentle person, well liked by students. He taught us Linear Algebra and Mathematical Statistics.

My mathematics education began with a course on the fundamental concepts in mathematics, taught by Dr S.T. Tsou who had a distinguished appearance, with a full head of white hair. His lectures were full of humor which made otherwise dry subject of set theory palatable.



$$f(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

$$\min_{u,d} \int_{\Omega} |d| \, dx + H(u) + \frac{\mu}{2} \int_{\Omega} |d - \Phi(u)|^2 \, dx$$

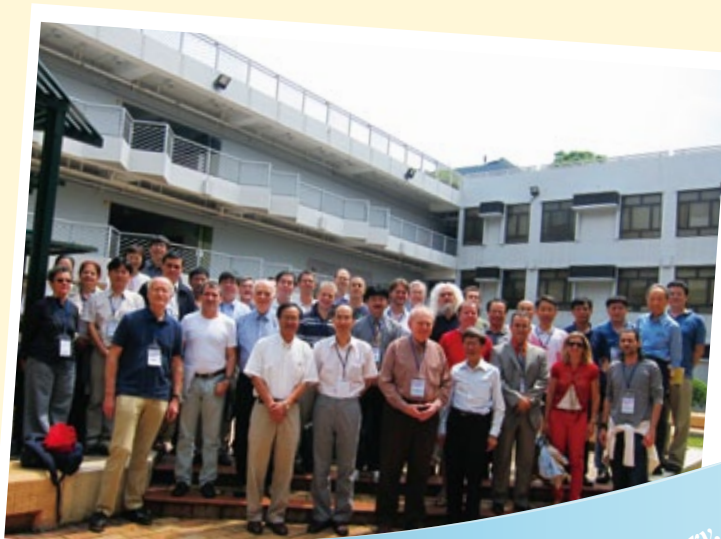


*Prof. Lau Ka Sing and Prof. Chu Cho Ho*

In our second year, we had two influential teachers, Dr James Knight and Dr David Fremlin, both brilliant new PhDs from Cambridge. They taught us Advanced Calculus and Analysis. Dr Knight was a very shy person, who hardly spoke in class, but wrote continuously on the blackboard till the end of the lecture. You see, at that time, we had no need of fancy things like student questionnaires, learning objectives, learning outcomes and online lecture notes. Dr Knight would have scored low in all these aspects; but for us, he was a great teacher. We learned a great deal from him in Advanced Calculus, including the Inverse Function Theorem. Dr Fremlin, on the other hand, was very approachable. He almost always wore shorts, and sometimes in winter, he put on a Mao's jacket. I thought it was cool at the time. His lectures were full of colours; different colour chalk for definitions, theorems, propositions and proofs etc. We learned for the first time the theory of metric spaces and filters – very important basic knowledge for us. Sadly, Dr Knight died in a car crash shortly after he returned to Cambridge. Dr Fremlin is now Emeritus Professor at University of Essex in UK.

In our third and fourth years, the most influential teachers were, undoubtedly, Dr K.F. Ng and Dr Y.C. Wong. They were also young and bright PhDs from the UK. They taught us Real Analysis and Complex Analysis and we learned a great deal from them. They were very friendly to students and very approachable. I don't quite remember whether they started the tradition of inviting students to lunch so that we had a relaxed atmosphere to discuss mathematics, and I am not sure if this commendable tradition has been maintained to this day!

$$\inf_{\Gamma, \alpha} \left\{ \mathcal{E}_{CV} = \mathcal{H}^1(\Gamma) + \lambda \sum_{i=1}^2 \int_{\Omega_i} |f - \alpha_i|^2 \, dx \right\}$$



*The International Conference on Jordan Theory, Analysis and Related Topics in celebration of the 65th Birthday of Professor Chu Cho Ho*

In my last two undergraduate years, Dr Ng and Dr Wong organized a weekly pro-seminar in which we studied Kadison's AMS Memoirs on Representation theory of Topological Algebras and Phelps's book on Choquet theory. Among the participants were Shing-Tung Yau, Shiu-Yuen Cheng and Ka-Sing Lau. These theories were the most important things I learned in my undergraduate years for later research. In fact, I still used Choquet theory in a paper published last year.

Sadly, Dr Wong is no longer with us. Dr Ng, however, is not only active in research but also excels in teaching. He is probably the most popular teacher in the Department, affectionately known as Dr Ng although he is a research professor at the university. The teaching award he won a few years ago, which he more than deserves, is hardly commensurate with his monumental contribution to teaching and supervision.

$$f(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

$$d_1^k(i, j) = \max \left( 0, 1 - \frac{1}{\mu_1^k(i, j)} \right) \mu_1^k(i, j)$$



86年畢業生

小時候的我，不知何故，總是對「無線電波為何能在真空中傳遞？」、「只用圓規及無刻度直尺為何不能三等分任意角？」、「為甚麼當下有我，而不是甚麼也沒有？」等課題感到無比困惑。我雖早知前兩題分屬科學和數學範圍，但較後才知道最後一題是哲學「難題」。帶著對這些課題能恰當處理的期望，我報考了中文大學。

我是最後一批乘搭「柴油火車」進入中文大學數學系的學生。在數學系六年的學習中，親受教於陳焯良、黃友川、吳恭孚、陸慶燊、譚秉均、黎景輝、林兆波及葉繼榮諸位老師。老師的教導，使我認識到數學的真與美，並學曉欣賞數學這塊不愧為人類藉理性思維、從（數學）真實中尋獲或建構的瑰寶。

隨便舉兩個例子吧！吳恭孚老師講學精彩，數學系同學校友無人不知。我記得在「實分析」課的第一

堂，吳老師便很清楚嚴謹地介紹整個「實分析」課程將要處理的課題。其中一個重點是，因為黎曼可積函數空間是不完備的，所以需要建立一種積分使得有關的可積函數空間是完備的。勒貝格積分就是這種積分，而建立勒貝格積分便需要測度論。測度論和勒貝格積分就是「實分析」課的主要內容。吳老師精彩的解說，使我一開始便對認識實分析的數學內容有極大的期待。

另外，在「高等代數」課中，我不僅學會了如何運用伽羅華的域論來證明「三等分任意角不可能」，更認識和學懂欣賞伽羅華域論及其更著名的群論所揭示的美妙代數結構。

我在一年級下學期，修讀了哲學系劉昌元老師的「哲學概論」課，才知道諸如「為甚麼當下有我，而不是甚麼也沒有？」等課題是屬於哲學範圍。這發現

可不得了。我立即往圖書館找各種各樣的哲學書來看。我仍記得，當時已看了 Stephen Barker 的 *Philosophy of Mathematics* 和不少有關存在主義的書籍。二年班時便選了哲學作為副修。在數學系完成哲學碩士課程後，即負笈英國蘇塞克斯大學。這一趟讀的是哲學；而博士論文是討論二十世紀最偉大哲學家之一的維根斯坦的名著《哲學邏輯論》。

甚麼是哲學？若要我回答這問題，我會提出這個定義：哲學乃運用理性來處理與基本、重要或自足價值有關的課題的思想活動。而當中所謂「基本、重要或自足價值」包括最基本的真、最基本的善和最基本的美。「無線電波為何能在真空中傳遞？」和「只用圓規及無刻度直尺為何不能三等分任意角？」等課題雖涉及真理、真相，但由於有關的真理並非最基本或最一般的，所以只分別為科學和數學問題，並不屬哲學範圍。至於「為甚麼當下有我，而不是甚麼也沒有？」等課題之所以屬於哲學範圍，是由於這類涉及存在之課題是有關基本和重要價值的。對於有關的課題，哲學的其中一個處理方法在於指出，「為甚麼當下有我，而不是甚麼也沒有？」不可能有具有認知意義的答案，因此並不表達一個真正的問題，從而消解了有關的哲學課題。其實，「為甚麼當下有我，而不是甚麼也沒有？」只是對自身實存狀態的回應、是表達一種驚訝。

然而，這哲學定義是不無問題的。古希臘哲學家視哲學為愛智慧、或追求智慧的活動；而對於他們來說，智慧即知識。因此，哲學即追求知識、或追求真理的活動。根據以上的哲學定義，許多古希臘哲學家視為哲學的活動，便不是哲學了。為甚麼追求真理的活動不可以都是哲學呢？是因為真理不一定是基本、重要或自足價值嗎？但是，若把一切追求真理的活動、或一切運用理性來處理與真理有關的課題的思想活動都看作哲學的話，則科學和數學也是哲學了。這其實是並無不可的。哲學家 W.V. 奎因 (W.V. Quine) 便認為，哲學、科學和數學根本無分際、亦不需替它們加上分際。不過，基於現代分割學問範圍的做法，根據以上定義把科學和數學劃分開去，仍是可取的約定。當然，包括科學和數學在內的追求真理活動仍可視為具有哲學精神的活動。

從數學家身上，往往更能看見哲學精神。黃友川老師便是其中一位。黃老師有次對我們一班同學說，每次上「泛函分析」課前一天的下午，他都會一邊喝咖啡、一邊演算和欣賞有關的證明。莫怪乎正式上課時，他就如站在舞臺上，忘情表演，融入數學世界（拓樸向量空間？）之中。這一幕幕情景均是我經常想起和懷緬的。

另一方面，數學在哲學發展上確不時擔當重要的角色。例如，弗雷格 (Frege) 藉從數學借來的概念和工具，建立數理邏輯系統；而羅素則企圖利用數理邏輯建立邏輯上可處理哲學課題的完美語言。這些都影響了某一時期的分析哲學。

對於個人而言，從數學系得到的數學訓練，對我的哲學研究亦起了很大的作用。有一年，黎景輝老師在「高等代數」課中，採用 Felix Klein 的 *Lectures on the Icosahedron and the Solution of the Fifth Degree* 一書，教授正二十面體及其變換群的理論。黎老師在課堂上，曾提及 Klein 的「幾何學乃研究變換群下的不變量」這一觀點。後來我才知道，這正是 Klein 的愛爾蘭根綱領 (Erlanger Programme) 的主旨。這其實大大幫助了我理解維根斯坦的《哲學邏輯論》中語言命題與世界共有的邏輯形式的概念，因為有關的邏輯形式其實即語言繙譯變換群下的不變量；就如投影變換群下的不變量。

至此，我又記起黎老師對我們一班同學所講的一段話。他說，除了非常少數留在數學學術圈子的同學外，大部分同學的職業都會與數學無關。而最能令他感到滿足的將會是——雖然他應不會知道——「若干年之後，你們偶然仍會拿起一本數學書來看叁數頁，依然會感到有趣，並且能夠看得明白。」（大意）今天，二十多年之後，我偶然會拿起一本數學書，翻閱數頁，仍然感到趣味盎然，並且看得明白。

借此機會，感謝數學系各位老師的教導。學生銘記心內。



張錦青教授

# 尋真路上 劉紹昌

七月剛到哈佛，我和太太手牽手漫步查理士河畔，仍覺身在夢中。兩年前，我正在中大為博士論文奮鬥。兩年後，尋真之路把我帶到了地球的彼端。在這裡，我將有幸和許多出色的數學家交流，還能手執教鞭把自己的所思所想傳授給頂尖的學生。真是令人振奮啊！

科學家的情意結，在小學時爸爸帶我去圖書館看名人傳記時就種下了。外星人、恐龍、黑洞...小小的我對這一切充滿興趣，心裡想：能當科學家就好了！漸漸長大後，學得越多，就越覺得「萬物皆數」：所有科學定律，歸根究底竟都由看似簡單，實則包羅萬有的數學結構組成。到了中七，心中也曾有過一點點猶疑：選數學，能找到工作嗎？不過，年少氣盛的我很快就說服自己了：大不了當個補習老師，還能餓死不成？就這樣，不顧家人的勸告，也沒有了解數學是怎樣的一個「行業」，我進了中大數學系。學士、碩士、博士...晃眼間，在中大竟過了九年，恐怕進中大前絕沒有想過！



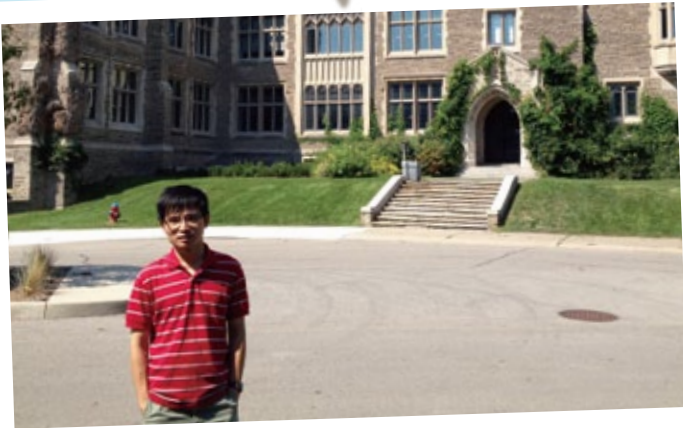
學士和碩士，是最愜意逍遙的時光。我享受思考數學時帶來的迷惑和想通後帶來的滿足，也享受和同學們唱K看戲的日子。到了博士畢業前一兩年，絕大部份朋友都在各行業工作了，身邊的戰友越來越少，寫論文的壓力越來越大，人也漸漸感到彷徨：能畢業嗎？畢業後，能找到工作嗎？這個問題，即使美國的博士畢業生也要面對，更不用說在香港這個商業至上的社會了。這時候，我想起爸爸曾經的勸告：「這條路，很難走！」也想起自己中七時豁出去的「豪情壯語」：大不了當個補習老師，還能餓死不成？其實，這些問題多想無益：患得患失，現實並不會因此有絲毫改變。努力按自己心之所願而為，坦然面對前路的得失。我對自己說，要「勇於尋真」！

在研究生路上，最感謝的，是恩師梁迪聰教授。進研究院前，我對Morse theory、Lie theory茫然不知，更不用說Calabi-Yau、mirror symmetry等等了。他帶著我們一班研究生思考大量問題，大大開闊了我學術以至生活上的視野。他更安排我到美國威斯康生辛大學做研究，並到多所大學講演自己的研究成果。他和丘成桐教授的大力幫忙，令我在找工作上出人意料地順利：我先得到了肯薩斯州立大學的tenure track聘書，然後再相繼得到哈佛大學、日本IPMU研究所、威斯康生大學等等聘書，絕對是天大的驚喜！最後我決定先到IPMU研究一年，再到哈佛開展我的教研工作。感謝恩師和丘成桐教授，也感謝吳恭孚教授、溫有恆教授、區國強教授和鄒軍教授在我念本科時給予的悉心教導和支持。

九月，開學了！寫文章、想問題、備課、上研討會...我前所未有地忙，也前所未有地享受工作。學生一句衷心的讚賞，就能令我開心上幾天，努力教得更好。更重要的，是太太無條件的支持和陪伴，令我的心更踏實，更滿足。儘管每晚大部份時間都要思考問題和備課，太太仍無怨無悔地陪伴我工作。而我母親，儘管她更希望我成為一位醫生，儘管她對我的工作毫不了解，卻仍支持我自由地選擇自己的未來。謝謝妳們！

# New Page of Life

Lai Chun Kit



It is my great pleasure to be a post-doctoral research fellow in McMaster University in Canada after almost 25 years of studies in Hong Kong, of which eight years were spent in CUHK. This new job turns a new page of my life and I am glad to share my new experience with you all.

Located at Hamilton, which is a hundred miles away from Toronto, McMaster University is free from all the hustle and bustle. It allows me to live a simple life. The sky is clear and open while the meadow is wide and green. All these provide a pleasant and quiet environment for me to sit down and think of

new research problems and I enjoy it a lot. Although people say Canada will be -30 Degree Celsius in winter, which I haven't yet experienced, I am ready to take this temperature challenge and hope my brain will not get cold and numb.

Inside the historic building of Hamilton Hall, where the Department of Mathematics and Statistics lies, there are a variety of research groups including financial mathematics, fluid dynamics, harmonic analysis, geometric group theory, number theory, mathematical logics, etc. Professors and students come from all over the world. Although they are of different academic and cultural backgrounds and employ different thinking methods, they share the same passion for mathematics, keen to exchange ideas with one another. In particular, students take the initiative to organize seminars, often inviting professors to attend. Indeed, students at McMaster enjoy a close bonding with their teachers. There was a warm welcome party for new staff and students on the first day of school, in which we took delight in both the food and the informal but fruitful discussions with all faculty members.

Pursuing a PhD is never an easy task, no matter you choose to study at home or abroad. Students from Hong Kong bear heavy family responsibilities and have to live up to high social expectations. It is undoubtedly true that they have talent for mathematics that is not inferior to students from any other places. I believe as long as you show a strong interest in mathematics and are ready to be independent in asking questions, furthering your studies can surely open new and bright avenues to your future.

McMaster University

## 最佳助教獎

本屆的得獎者為劉梓濠、李子豪和劉可伋。



劉梓濠



李子豪



劉可伋

Title: Optimal Transport

Speaker: Prof. Paul Lee

Date: To be announced

## Visitor 2011-12

Every year, scholars from all over the world come to our Department and the Institute of Mathematical Sciences. Their active participation and provision of expertise in our seminars, courses and other academic events have contributed substantially to our Department's research and academic programmes. Due to space limitation, we present here a partial list of our visitors in 2011-12

- ◆ Julien BARRAL, University Paris 13
- ◆ Emmanuel CANDÈS, Stanford University
- ◆ Louis CHEN, National University of Singapore
- ◆ I-Liang CHERN, National Taiwan University
- ◆ Man-Duen CHOI, University of Toronto
- ◆ Patrick CIARLET, ENSTA ParisTech
- ◆ Maarten V. DE HOOP, Purdue University
- ◆ Manuel DEL PINO, University of Chile
- ◆ Qiang DU, Penn State University
- ◆ Weinan E, Princeton University
- ◆ Yalchin EFENDIEV, Texas A&M University
- ◆ Björn ENGQUIST, The University of Texas
- ◆ Roland GLOWINSKI, University of Houston
- ◆ Alexander GRIGORIAN, Universitaet Bielefeld
- ◆ Yizhao Thomas HOU, California Inst. of Technology
- ◆ Kazufumi ITO, North Carolina State University
- ◆ Antti KAENMAKI, University of Jyväskylä, Finland
- ◆ Grigory MIKHALKIN, University of Geneva
- ◆ Esmond G. NG, Lawrence Berkeley National Lab.
- ◆ Lei NI, University of California, San Diego
- ◆ Stanley OSHER, University of California, Los Angeles
- ◆ George PAPANICOLAOU, Stanford University
- ◆ Yousef SAAD, University of Minnesota
- ◆ Zouwei SHEN, National University of Singapore
- ◆ Eitan TADMOR, University of Maryland
- ◆ Justin W.L. WAN, University of Waterloo



**Professor Yu Jiu-Kang**

Lee Hysan Professor of Mathematics

**Professor Lee Yi-Jen**

Si Yuan Professor of Mathematics

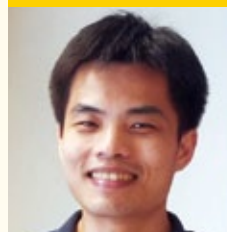


**Professor Duan Renjun**

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