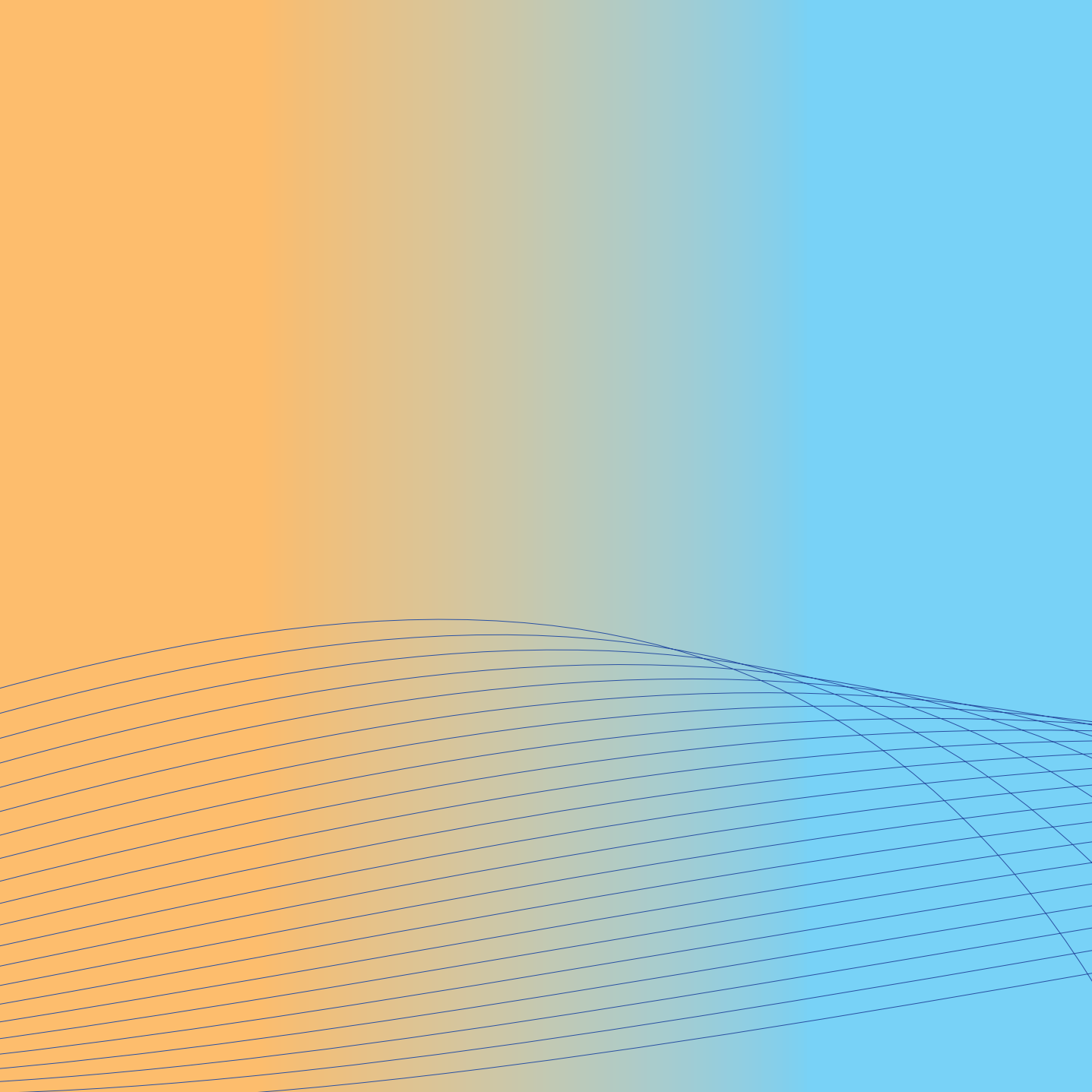

恒隆
數學獎
HANG LUNG
MATHEMATICS AWARDS



# 2025 Hang Lung Mathematics Awards Announcement and Awards Presentation

December 17, 2025
Conrad Hong Kong
Pacific Place, 88 Queensway, Hong Kong

Digital Version

# Program

**Welcome Remarks**

| | |
|---|---|
| Mr. Adriel Chan | Chair<br>Hang Lung Properties Limited |
| Professor Nancy Ip,<br>SBS, BBS, MH, JP | President and The Morningside Professor of Science<br>The Hong Kong University of Science and Technology |

**Opening Remarks**

| | |
|---|---|
| Dr. Choi Yuk Lin,<br>JP | Secretary for Education<br>The Government of the Hong Kong Special Administrative Region |

**Dinner**

**Memorial Tribute**

| | |
|---|---|
| Mr. Ronnie C. Chan | Honorary Chair<br>Hang Lung Properties Limited |

**Panel Discussion**

| | |
|---|---|
| Professor Richard Schoen | Chair, Scientific Committee<br>2025 Hang Lung Mathematics Awards |
| Professor Ngaiming Mok | Chair, Steering Committee<br>2025 Hang Lung Mathematics Awards |
| Ms. Jennifer Zhu Scott (moderator) | Co-founder and CEO<br>Power Dynamics |

**Vote of Thanks**

| | |
|---|---|
| Mr. Weber Lo | Chief Executive Officer<br>Hang Lung Properties Limited |

**2025 Hang Lung Mathematics Awards Announcement and Awards Presentation**

**Group Photos**

Dear Friends,

Welcome to the announcement and celebration of the 2025 Hang Lung Mathematics Awards held in conjunction with The Hong Kong University of Science and Technology. HLMA continues to serve not only as a premier arena for mathematics excellence but also as a catalyst for innovation and intellectual engagement in our society. This year, we are honored to have Dr. Choi Yuk Lin, JP, Secretary for Education of Hong Kong, joining us again as our Guest of Honor.

Since our last edition, we have launched HLMA Talks, a high-level public talk series that transcends disciplinary boundaries, sparks meaningful dialogue, inspires innovative ideas, and connects leading experts with our local communities to showcase thought leadership on global challenges and opportunities. To date, the series has convened six talks that span scientific research, medical science, fundamental science, higher education, and AI, featuring Nobel Laureates and eminent speakers from leading institutions both locally and internationally.

HLMA has engaged over 200 secondary schools across Hong Kong, fostering a vibrant culture of inquiry and innovation while supporting the city's development as a global hub for talent and ideas. Over the years, students have produced more than 500 research reports, many attaining undergraduate level and beyond, which reflects the remarkable quality of their scholarly achievements. These outstanding contributions, together with their active participation in our HLMA Talks, demonstrate the value of nurturing analytical thinking and broad perspectives from a young age, shaping future leaders ready to tackle scientific problems and societal challenges.

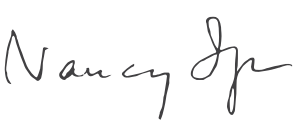
This year, we pause to pay tribute to Professor George Smoot, 2006 Nobel Laureate in Physics, who served as Chair of our Steering Committee. Professor Smoot was an extraordinary scientist whose pioneering work in probing the origins of the universe earned him global acclaim and inspired countless students and colleagues. His passion for discovery and commitment to public understanding of science had left an indelible mark on HLMA and the world. He will be deeply missed by all who had the privilege of working with him and learning from his wisdom.

We are grateful to have Professor Richard Schoen continuing his exceptional leadership of our Scientific Committee, and are honored to have Prof. Ngaiming Mok, a world-renowned mathematician and longstanding supporter of HLMA, to chair our Steering Committee.

As we celebrate this year's achievements, we extend our deepest gratitude to all those who have supported HLMA, and we look forward to creating greater impact together in the years ahead.



**Mr. Adriel Chan**
Chair
Hang Lung Properties Limited



**Professor Nancy Ip**
President and The Morningside Professor of Science
The Hong Kong University of Science and Technology

Dear Students, Teachers, and Honored Guests,

Mathematics is not only a pursuit of truth but also a powerful language that connects people across cultures through creativity, curiosity, and shared progress. HLMA stands as a symbol of this spirit, uniting students, teachers, and distinguished scholars across borders in celebration of mathematical achievement.

This year, we received a record number of research reports from an expanding network of HLMA veteran schools as well as new joiners, reflecting the growing passion for mathematics exploration and the shared belief that discovery thrives where curiosity meets opportunity. Our heartfelt thanks go to the entire HLMA community of students, teachers, schools, and supporters, whose commitment and enthusiasm continue to drive this remarkable journey forward.

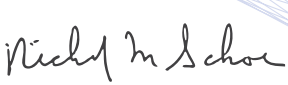
We extend our heartfelt gratitude to our partner, The Hong Kong University of Science and Technology, whose support has been instrumental to our success. Through a series of tailored online workshops and informative in-person sessions, they offered invaluable guidance to students and teachers in preparing for the competition. We are also immensely grateful to the Scientific Committee, many of whom flew to Hong Kong especially for this competition. Our thanks also extend to our Steering Committee members, as well as our Executive Committee and Screening Panel members for their unwavering dedication.

To our young scholars: let your participation remind you that many innovations begin with a simple question and a steadfast determination to seek for answers. May this experience inspire you to explore not only the world of mathematics, but also your own limitless potential.

Together, we share a commitment to a future where excellence, collaboration, and creativity flourish. We thank you for being a part of today's celebration, and for shaping the next chapter of excellence with us at HLMA.



**Mr. Weber Lo**
Chief Executive Officer
Hang Lung Properties Limited



**Professor Richard Schoen**
Chair, Scientific Committee
2025 Hang Lung Mathematics Awards



**Professor Ngaiming Mok**
Chair, Steering Committee
2025 Hang Lung Mathematics Awards


2023
恒隆數學獎
Hang Lung
Mathematics
Awards

Hang Lung Mathematics Awards (HLMA) is a biennial mathematics research competition that inspires secondary school students in Hong Kong to achieve excellence in mathematics through original thinking, rigorous scholarship, and creative problem-solving.

A close collaboration between Hang Lung Properties and The Hong Kong University of Science and Technology, and supported by many leading universities in Hong Kong, HLMA honors those who push the boundaries of knowledge while upholding the highest standards of academic rigor and integrity. Since 2004, it has played a pivotal role in nurturing Hong Kong's brightest mathematical minds, propelling many towards fulfilling journeys at universities and beyond, where they make meaningful contributions to society and spearhead innovations across diverse fields including academia, industry, and the broader community.

HLMA has two key committees. The Scientific Committee, chaired by 2017 Wolf Prize laureate Professor Richard Schoen and comprises renowned mathematicians from around the world, upholds the highest standards of academic rigor and integrity. The Steering Committee, chaired by 2022 Future Science Prize laureate Professor Ngaiming Mok, serves as the advisory body and provides support, guidance, and oversight, and includes leaders from academia and experts in various professional sectors.

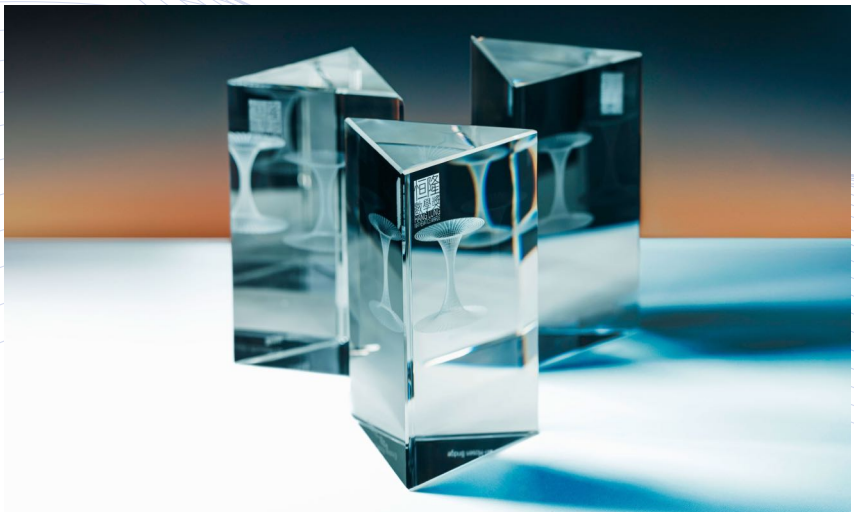
Schools form teams of up to five students supervised by a teacher. Each team selects a mathematics topic, conducts research, and submits a detailed research report. The Scientific Committee rigorously evaluates these reports through a multi-stage review akin to academic publishing. Selected teams then present their research at an oral defense modeled on doctoral dissertation defenses, involving public presentation and in-depth questioning. Winners are announced at an awards ceremony the following day.

Hang Lung Properties contributes HK$2.5 million to each competition, with HK$1 million allocated for monetary prizes, and HK$1.5 million supporting academic consultancy, meticulous assessment process, and mathematics education promotion.

About 100 teams from over 50 secondary schools in Hong Kong participated in the 2025 HLMA. Up to eight awards are presented at each competition, including one Gold Award, one Silver Award, one Bronze Award, and up to five Honorable Mentions. Each award is a recognition of excellence and has four components: a Student Education Award for team members' university studies; a Teacher Leadership Award for the supervising teacher; a School Development Award for the winning school; and an Educator Scholarship for a teacher nominated by the winning school to pursue a Master of Science Program in Mathematics for Educators at The Hong Kong University of Science and Technology.

Besides monetary prizes, each winning student and teacher receives a crystal trophy and certificate, while each winning school is awarded a crystal trophy. The crystal trophy features an Einstein-Rosen bridge, or "wormhole", symbolizing a theoretical connection between spacetime regions. It plays a prominent role in mathematics and physics, with implications for geometry, gravity, information, and quantum physics.

Participating students who have submitted a research report that meets a reasonable academic standard will receive a certificate of participation.



| Hang Lung Mathematics Awards | | | | | |
|---|---|---|---|---|---|
| **in HK$** | **Student Education Award** | **Teacher Leadership Award** | **School Development Award** | **Educator Scholarship** | **Amount of each Award** |
| **1 x Gold Award** | $250,000 | $50,000 | $100,000 | Full program fee | $400,000 + Educator Scholarship |
| **1 x Silver Award** | $120,000 | $20,000 | $60,000 | Full program fee | $200,000 + Educator Scholarship |
| **1 x Bronze Award** | $60,000 | $10,000 | $30,000 | Full program fee | $100,000 + Educator Scholarship |
| **5 x Honorable Mentions** | $32,000 | $8,000 | $20,000 | Half program fee | $60,000 + Educator Scholarship |
| Total | **HK$1,000,000 + Educator Scholarships** | | | | |

Launched in January 2024, HLMA Talks has emerged as a signature platform for thought leadership and scientific exploration. Six high-impact events have brought together Nobel Laureates, world-class scientists, and leading experts from top institutions, fostering meaningful dialogues that inspire young talent, inform the public, and strengthen support for scientific research.

In collaboration with the Asia Society Hong Kong Center, each full-house event has drawn a broad and diverse audience, including leaders in the government, academia, and business, as well as teachers and school students.

HLMA Talks ignites curiosity and empowers the next generation to shape our future through science. Register here for our next event!




## What is Good Research?

Two leading scientists in life science and materials physics, Prof. Nancy Ip (President, HKUST) and Prof. Xiang Zhang (President, HKU), joined Dr. Gerald Chan, a visionary in science, investment, and philanthropy, in a compelling conversation on the balance between curiosity-driven research and mission-oriented research, and how universities foster innovation and critical thinking to generate new knowledge rather than simply transmit it.




## Nobel Insights: Fundamental Science and the Age of AI

Two Nobel Laureates, Prof. David Gross (Physics, 2004) and Prof. Arieh Warshel (Chemistry, 2013), shared the stage for the first time in a wide-ranging discussion, exploring the holy grail in physics and chemistry, the promises and perils of AI, and the legacy of Prof. Chen-Ning Yang. The session was moderated by award-winning HKUST Chair Professor in Physics Prof. Kam Tuen Law.




## From Lab to Life: How Science Rewrites the World

Bringing together two medical titans from East and West — Prof. Dennis Lo (President, CUHK) and Prof. David Ho (Director, Aaron Diamond AIDS Research Center, Columbia University) — for their first public dialogue in medical science. Moderated by Prof. Stephanie Ma (Associate VP, HKU), they shared insights on breakthroughs in cancer detection, and highlighted the passion, curiosity, and transformative potential of neuroscience in improving lives.

Prof. Lap-Chee Tsui and Prof. Nancy Rothwell, respectively at the helm of HKU and the University of Manchester for more than a decade, joined Prof. Nick Rawlins (former Pro-Vice-Chancellor, CUHK) to discuss how universities can adapt to change while staying true to their mission — fostering intellectual growth, inspiring students, and serving society.

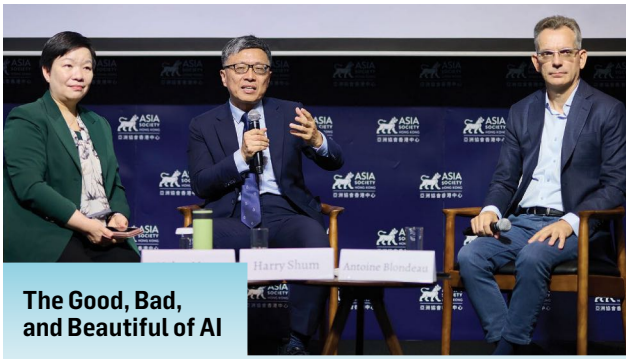
## The Future of Universities




MIT Chancellor Prof. Eric Grimson championed the integration of computational thinking across disciplines. A computer scientist for over four decades, he urges students to understand the fundamentals of machine learning, ethical use of AI, and computational experimentation to thrive in an AI-driven future.

## AI's Next Frontiers: Insights from MIT






## The Good, Bad, and Beautiful of AI

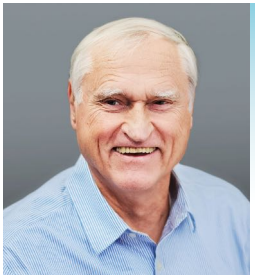
Prof. Harry Shum (Council Chair, HKUST), an AI and robotics scientist and tech entrepreneur, joined leading AI investor Mr. Antoine Blondeau (Co-founder, Alpha Intelligence) in a thought-provoking discussion moderated by Prof. Helen Meng (Professor, SEEM, CUHK), exploring AI's transformative impact on creativity and productivity, while cautioning against bias and misinformation.

## Panel Discussion: Ubiquity of Mathematics: the Language of Discovery

HLMA's two key Committee Chairs, Professor Richard Schoen and Professor Ngaiming Mok, will explore the profound significance and far-reaching impact of mathematics. This conversation, moderated by technology expert Ms. Jennifer Zhu Scott, will highlight how mathematics serves as a universal language, transcending cultural and disciplinary boundaries to deepen our understanding of both the natural world and the synthetic realities we create. The discussion will delve into the evolving landscape of mathematics research and education, underscoring the vital importance of fostering curiosity, adaptability, and critical thinking among young people. It will also discuss the transformative power of mentorship in nurturing future generations of innovators and leaders.

This thought-provoking exploration weaves together personal journeys, cosmic mysteries, and forward-looking perspectives on how mathematics continues to shape science, technology, and society, particularly as we prepare for an increasingly AI-driven future. We invite curious minds to join us in reimagining the role of mathematics in unlocking the mysteries of our existence and charting the path forward.

## Speakers



### Professor Richard Schoen

2017 Wolf Prize Laureate in Mathematics
Anne T. and Robert M. Bass Professor in the School of Humanities and Sciences, Emeritus, Stanford University
Emeritus Professor, University of California, Irvine
Chair, HLMA Scientific Committee

Professor Richard Schoen is known for his groundbreaking contributions in the fields of differential geometry and general relativity. He has made seminal advances in topics such as the positive mass conjecture, scalar curvature, and minimal surfaces. Collaborating with his doctoral advisor Professor Shing Tung Yau, he proved the fundamental positive mass theorem in 1979. He solved the Yamabe problem on compact manifolds in 1984, and, with Professor Simon Brendle, proved the differentiable sphere theorem in 2007. He holds the distinguished Anne T. and Robert M. Bass Professorship in Humanities and Sciences at Stanford University, where he has also served as department chair. His accolades include the Wolf Prize in Mathematics, the Heinz Hopf Prize, the Rolf Schock Prize, election to the National Academy of Sciences, and the WLA Prize in Computer Science or Mathematics.



### Professor Ngaiming Mok

2022 Future Science Prize Laureate in Mathematics and Computer Science
Edmund and Peggy Tse Professor in Mathematics, The University of Hong Kong
Chair, HLMA Steering Committee

Professor Ngaiming Mok specializes in several complex variables, complex differential geometry and algebraic geometry. His groundbreaking research includes the development of the theory of Varieties of Minimal Rational Tangents (VMRT) to solve several long-standing problems and the proof of the Ax-Schanuel conjecture on Shimura varieties. Currently the Edmund and Peggy Tse Professor in Mathematics and Chair of Mathematics at the University of Hong Kong, Professor Mok is an Academician of the Chinese Academy of Sciences and a Fellow of the Hong Kong Academy of Sciences. His international career spans leading institutions such as Princeton, Columbia, and Université de Paris (Orsay), and he has earned prestigious honors including the State Natural Science Award, the Stefan Bergman Prize, the Future Science Prize in Mathematical Sciences, and the Tan Kah Kee Science Award of the Chinese Academy of Sciences. He was an Invited Speaker at the International Congress of Mathematicians (ICM) in 1994 (Zurich) and has been invited to give a Plenary Lecture at ICM 2026 (Philadelphia).

## Moderator



### Ms. Jennifer Zhu Scott

Co-founder and CEO, Power Dynamics

Jennifer Zhu Scott is the Co-founder and CEO of Power Dynamics, specializing in next-generation digital infrastructure. She previously served as Executive Chairman of The Commons Project, co-creating the SMART Health Cards utilized by Apple and Google. Jen is on the Investment Committee of the Investcorp eLydian Fund and a board member of Mysten Labs' SUI Foundation. Recognized by Forbes as a Top 50 Women in Tech and by Fortune as one of China's Most Influential Businesswomen, she is also a China Fellow at The Aspen Institute and cofounded the Tech Fellowship. Jen holds degrees in applied mathematics and finance and has completed leadership programs at Yale, Harvard, Oxford, and Princeton. She is a published author and speaker on AI, data ownership, and digital assets, with a TED Talk viewed over 3 million times.

# A Memorial Tribute to Professor George Smoot

HLMA pays tribute to Professor George Smoot (1945-2025), 2006 Nobel Laureate in Physics and Chair of the HLMA Steering Committee, for his profound impact and enduring legacy in advancing scientific discoveries.

Recognizing the importance of nurturing research minds from a young age, Professor Smoot accepted our invitation to chair the HLMA Steering Committee in 2021, a position he had held until his passing. Through his steadfast commitment to fostering scientific curiosity, Professor Smoot had been an inspirational figure to many scientific talents in Hong Kong and the world.

Amid his extensive responsibilities and demanding schedule, Professor Smoot always prioritized HLMA during his visits to Hong Kong, spending time with HLMA winners and engaging with the HLMA community at large.

Professor Smoot's career was distinguished by his seminal contributions to cosmology, including the discovery of the cosmic microwave background radiation anisotropy – the work for which he was awarded the Nobel Prize in Physics in 2006 jointly with Professor John C. Mather. He published over 500 influential academic papers, and continued to delve into new scientific ideas and discoveries throughout his life.

We are deeply saddened by Professor Smoot's passing and would like to extend our sincere gratitude for his invaluable leadership, inspiration, and dedication to HLMA. He would be remembered fondly for his academic contributions, his warmth, and his generosity.


恒隆
數學獎
SHAPING
OUR FUTURE
2023
恒隆數學獎
Hang Lung
Mathematics
Awards



# 2025 Hang Lung Mathematics Awards Committees and Panel

## SCIENTIFIC COMMITTEE

### Chair

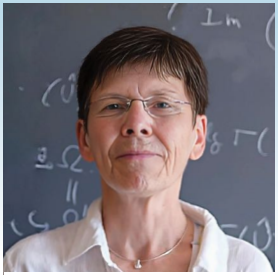


**Richard Schoen**
2017 Wolf Prize Laureate in Mathematics
Stanford University
University of California, Irvine

### Members



**Raymond Hon Fu Chan**
Lingnan University



**Hélène Esnault**
Freie Universität Berlin



**Jun Kigami**
Kyoto University



**Andrew G. Cohen**
The Hong Kong University of Science and Technology



**Frederick Tsz-Ho Fong**
The Hong Kong University of Science and Technology



**Wei-Ping Li**
The Hong Kong University of Science and Technology



**Ngaiming Mok**
2022 Future Science Prize Laureate in Mathematics and Computer Science
The University of Hong Kong



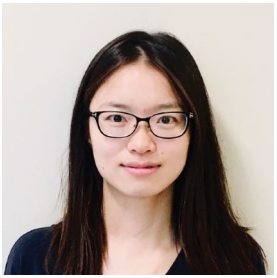
**Tom Yau Heng Wan**
The Chinese University of Hong Kong



**Ya-xiang Yuan**
Chinese Academy of Sciences



**Kenneth A. Ribet**
University of California, Berkeley



**Hong Wang**
Institut des Hautes Études Scientifiques (IHÉS)



**Shou-Wu Zhang**
Princeton University

# 2025 Hang Lung Mathematics Awards Committees and Panel

## STEERING COMMITTEE

### Chair



**Ngaiming Mok**
2022 Future Science Prize Laureate in Mathematics and Computer Science
The University of Hong Kong

### Members



**Thomas Kwok Keung Au**
The Chinese University of Hong Kong



**Alfred Cheung**
NeoUnion ESC Organization



**Owen H. Ko**
The Chinese University of Hong Kong



**Tony F. Chan, JP**
The Hong Kong University of Science and Technology



**Guangyue Han**
The University of Hong Kong



**Shing Yu Leung**
The Hong Kong University of Science and Technology



**Leevan Ling**
Hong Kong Baptist University



**Siu Leung Ma, BBS, MH**
Fung Kai Public School



**Yang Wang**
The University of Hong Kong



**Chee Tim Yip**
Princeton Skylake International School (Shenzhen)



**Ya Yan Lu**
City University of Hong Kong



**Michael Kwok Po Ng**
Hong Kong Baptist University



**Susan Wong**
Hang Lung Properties Limited

# 2025 Hang Lung Mathematics Awards Committees and Panel

## SCREENING PANEL

### Chair



**Frederick Tsz-Ho Fong**
The Hong Kong University of Science and Technology

### Members



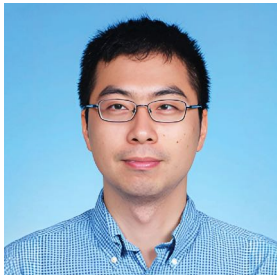
**Ivan Chi Ho Ip**
The Hong Kong University of Science and Technology



**Eric Marberg**
The Hong Kong University of Science and Technology



**Maosheng Xiong**
The Hong Kong University of Science and Technology



**Tianling Jin**
The Hong Kong University of Science and Technology



**Dong Xia**
The Hong Kong University of Science and Technology

## EXECUTIVE COMMITTEE

### Chair



**Shing Yu Leung**
The Hong Kong University of Science and Technology

### Members



**Jimmy Chi Hung Fung**
The Hong Kong University of Science and Technology



**Albert Yin-Bon Ku**
The Hong Kong University of Science and Technology



**Chi Wai Yu**
The Hong Kong University of Science and Technology



**Stanley Hon-Ming Ho**
The Hong Kong University of Science and Technology



**Chi Man Leung**
The Hong Kong University of Science and Technology

### Secretariat



**Niki Hiu Yan Chan**
The Hong Kong University of Science and Technology

1. Topic : **A Study on Elements of Order $p$ in the Outer Automorphism Group of Extraspecial $p$-Groups**

School : Helen Liang Memorial Secondary School (Shatin)
學校名稱 : 梁文燕紀念中學（沙田）
Teacher : Mr. Chun Hei Leung
領導老師 : 梁頌晞先生
Team Member : Hang Li
成員同學 : 李恒

This paper investigates the elements of order $p$ in the outer automorphism group of extraspecial $p$-groups for odd primes $p$. Leveraging the isomorphism between the outer automorphism group and the finite symplectic group $\mathrm{Sp}(2m, p)$, we classify these elements as regular unipotent elements and derive a closed-form formula for their weighted sum based on the dimension of the kernel of $(s - I)^{p-1}$, under the condition $p \geq 2m$. The main result is $\sum_{s \in S} p^{\dim \ker((s-I)^{p-1})} = p^{2m}(p^{2m}-1)$, where $S$ is the set of non-identity elements of order $p$. Proofs draw from Carter's Jordan block classification, Spaltenstein's theory of regular unipotents, and Borel's centralizer order formula. Computational verification using GAP confirms the results for parameters satisfying $p \geq 2m$, and applications to computational group theory, representation theory, cryptography, and physics are discussed.

2. Topic : **Asymptotically Efficient Numerical Approximation of Mean Cross-Sectional Area of 3D Convex Hulls**

School : Yew Chung International School
學校名稱 : 香港耀中國際學校
Teacher : Mr. Daniel Owusu Nyantakyi
Team Members : Yat Hong Chan, Pok Man Chiang, Ho Ka Fu, Bok Yin Kwan
成員同學 : 陳逸康、蔣博文、符皓嘉、關博彥

In this paper, we derive a deterministic algorithm to approximate the mean cross-sectional area of the convex hull of any 3-dimensional polyhedron using linear algebra. The principle behind this algorithm is that the cross-sectional area can be treated as a bounded 2-variable function with the inputs representing direction in 3-dimensional space, so numerical integration can be used for approximating the mean using a small sample of data of cross-sectional area in different directions. We also showed that the algorithm derived has a bounded maximum relative error, and the bound for error can be adjusted based on the number of approximations taken, using numerical analysis. We also found optimal grid-based distributions of directions of cross-sectional areas to calculate for different bounds of maximum relative error while minimising computational cost. The algorithm we derived is designed for efficient computation in computer aided design (CAD) software for choosing an appropriate scale when rendering technical drawings.

3. Topic : **Incentric Subdivisions of Triangles and Iterated Function Systems**

School : St. Paul's Co-Educational College
學校名稱 : 聖保羅男女中學
Teacher : Mr. Pak Leong Cheung
領導老師 : 張伯亮先生
Team Members : Angus Kui Lam Huang, Inna Belle Lee, Chun Lam Lo, Lok Hei Qiao, Cheuk Lok Wong
成員同學 : 黃鉅霖、李欣霖、盧晉林、喬樂熙、黃卓樂

In this paper, we have introduced and studied two new subdivision rules of triangles using incenter, namely, inward and outward binary incentric subdivisions, alongside the existing senary and ternary incentric subdivisions. To this end, we have used iterated function systems to establish approximation, convergence and denseness theorems in metric spaces as the main tools to study how diverse the shapes of the descendant triangles are upon repeated subdivisions of triangles using these old and new rules.

In the inward binary case, we have proved that the descendant triangles are dense in the space of triangles, similar to the senary case. We have also proved the distinctive behavior of the inward binary descendants that, in contrast to the senary case, they are spread over the space of triangle more and more evenly as subdivision keeps going, which is characterized by the weak convergence of their empirical measures to the uniform probability measure on the closure of the space of triangles.

In the outward binary case, we have proved that the descendant triangle branches all converge to a rather limited choice of triangles, similar to the ternary case. We have also followed up on connections between the ternary case and the Sierpiński triangle through formulating an old observation in precise terms and proved it.

We have also generalized both inward and outward binary incentric subdivisions to quasi-incentric subdivisions, and discovered that they preserve well the behaviors of the descendant triangles in their incentric counterparts.

4. Topic : **Investigating Wordle and its Variants from an Information Theory Perspective**

School : Diocesan Boys' School
學校名稱 : 拔萃男書院
Teacher : Mr. Long Tin Chan
領導老師 : 陳朗天先生
Team Members : Cary Sirui Chan, Pak Yu Hui, Chi Sum Lok, Pui Ho Wong
成員同學 : 陳思睿、許岶羽、駱志森、黃培浩

We investigate Wordle and two of its generalizations, the multi-board $n$-Wordle variant and the "Any Valid String" variant from an information theory perspective. We first analyze the case of playing simultaneously on one or two boards, where both the worst case and average case are considered. We then generalize to the case of $n$ concurrent boards, proving asymptotics and establishing worst-case bounds for sufficiently large $n$ through the construction of strategies. Finally, we extend to arbitrary strings beyond the standard word list, proving the optimality of a strategy which uses at most 9 attempts to guess a five-letter string of uppercase English letters, by trying to maximize the information entropy of each guess. Obtaining these results from an information theory perspective helps us understand the design of word-based puzzles and their generalizations.

5. Topic : **Markov Chains Associated with Ultraspherical Polynomials: an Analysis of Weak Convergence and First Passage Time Functionals**

School : Hong Kong Chinese Women's Club College
學校名稱 : 香港中國婦女會中學
Teacher : Mr. On Ping Chung
領導老師 : 鍾安平先生
Team Member : Siu Man Li
成員同學 : 李兆旻

This paper investigates discrete-time Markov chains on non-negative integers whose transition probabilities are derived from the recurrence relation of ultraspherical polynomials. Generalizing prior single-time convergence results, our first main result is to establish the full weak convergence of the diffusively rescaled chains to a Bessel process of dimension $d = 2\alpha+2$. The proof shows the tightness of the process sequence and the convergence of its finite-dimensional distributions. As a key application of this process-level convergence, our second main result shows that the rescaled first exit time of the chain from an interval converges in law to the corresponding exit time of the limiting Bessel process.

6. Topic : **On 6-Free Extraordinary Numbers**

School : Pui Ching Middle School
學校名稱 : 香港培正中學
Teacher : Mr. Yan Lam Fan
領導老師 : 樊昕霖先生
Team Member : Xi Yue Chen
成員同學 : 陳曦悅

A positive integer $n$ is said to be ordinary if the smallest integer with $n$ divisors is $p_1^{q_1-1} p_2^{q_2-1} \cdots p_s^{q_s-1}$, where $n = q_1 q_2 \cdots q_s$ is the prime factorization, $q_1 \geq q_2 \geq \cdots \geq q_s$ and $p_i$ denotes the $i$th prime. In 2014, Y. G. Chen found all 5-free extraordinary numbers. Based on its research methods, and with the aid of self-written programs, this paper gives rigorous and detailed proofs to find all 6-free extraordinary numbers.

7. Topic : **On the 3D Sofa Problem**

School : Baptist Lui Ming Choi Secondary School
學校名稱 : 浸信會呂明才中學
Teacher : Mr. Pak Hei Chan
領導老師 : 陳栢希先生
Team Members : Yin Ching Chiu, Nicole Hon, Jason Ka Chun Tse, Kai Yang Zheng
成員同學 : 趙彥程、韓采桐、謝珈晉、鄭開陽

The Moving Sofa Problem is a famous problem that aims to find the shape with the maximum area that can pass through a L-shaped planar region. Since the problem is in a 2-dimensional setting, and the investigated shapes with large areas are not commonly seen in real life, we noticed that most of the work on this topic may not facilitate real-life moving sofa problems, contrary to the name of the problem.

This paper aims to provide a more realistic perspective on the problem: we aim to extend the 2D problem to 3D, and focus our investigation on cuboids. We construct a 3D staircase structure with two infinite-length hallways and one corner, and investigate the largest possible dimensions a cuboid can reach such that it can pass through the structure. Next, to make our work more applicable, we investigated on finite-length staircases. In the end, we have made a Python program which can determine if a cuboid can pass through a staircase. We believe this approach can be helpful for real-life sofa transportation problems.

8. Topic : **On the Generalisations of the No-Three-in-Line Problem**

School : Queen's College
學校名稱 : 皇仁書院
Teacher : Mr. Hang Chun Chan
領導老師 : 陳恆進先生
Team Members : Edison Sze Ho Fu, Yun Tung Ko, Hoi Chun Puk, Wai Kwan Yeung
成員同學 : 傅思皓、高潤彤、濮愷俊、楊懷堃

The No-Three-in-Line problem asks how many points can be placed on an $n \times n$ integer grid so that no three are collinear. In this paper, we first generalise the problem to an $m \times n$ rectangular grid, establishing a construction method which we prove places the largest possible number of points on the grid for certain constraints on $m$ and $n$. Then, using probabilistic heuristics, we estimate the maximum number of points that can be placed on the grid. Finally, we extend our analysis to the 3D No-Three-in-Line problem, deriving an asymptotic expression for the total number of collinear triples in an $n \times n \times n$ grid as $n \to \infty$. We demonstrate why the heuristic approach cannot be extended directly to 3D.

9. Topic : **On the Images of Rational Numbers under a Certain Type of Fractal Interpolation Function**

School : St. Joseph's College
學校名稱 : 聖若瑟書院
Teacher : Dr. Wai Shan Cheung
領導老師 : 張慧珊博士
Team Members : Tsz Hei Chiu, Alex Sheung Fai Lam, Hin Chun Lee, Jamie Chun Hin Ng, Ka Lam Tang
成員同學 : 招梓晞、林尚暉、李衍俊、吳振軒、鄧嘉琳

Fractal interpolation functions were first introduced by Barnsley. In this paper, we investigate the fractal interpolation functions joining the points (0, 0), ($x_1$, $y_1$), (1, 1) for rational $x_1$, $y_1$ in the closed unit interval, and show that, when $x_1 = 1/2$, the function will always map rationals to rationals, but will not map any rational to 1/2 when $y_1$ has odd denominator. Moreover, we derive by similar considerations a result about a dynamical system on the closed unit interval.

10. Topic : **On the Number of Multiplicative Type $E_n$ Friezes**

School : HKUGA College
學校名稱 : 港大同學會書院
Teacher : Mr. Yuk Lun Fong
領導老師 : 方鈺倫先生
Team Members : Lok Him Chan, David Kai Hei Gu, Sui Ping Tang, Ho Wong
成員同學 : 陳樂謙、顧楷熙、唐瑞平、黃浩

As a complementary development of the nature of frieze structures, we partially solve the Fontaine-Plamondon conjecture on the enumeration of multiplicative $\mathbf{E}_n$ friezes through an elementary combinatorial approach. Incorporating the concept of quiddity sequences, we explicitly show the number of distinct $\mathbf{E}_6$ friezes are 70, with substantial evidence to support the number of $\mathbf{E}_7$ and $\mathbf{E}_8$ friezes to be 440 and 1694, respectively.

11. Topic : **Producing Annoying Sounds with Chalk by Varying Angle of Contact**

School : Victoria Shanghai Academy
學校名稱 : 滬江維多利亞學校
Teacher : Mr. David Bian
領導老師 : 邊偉先生
Team Members : Joshua Cheung, Haoyang Dong, Jizheng Li, Ming Ze Li, Maximilian Ng
成員同學 : 張倬華、董浩揚、李濟正、李銘澤、吳廷芳

This paper investigates how varying the angle of contact $\alpha$ between a chalk and blackboard affects how annoying the sound produced is after drawing some distance $d$. Annoyance is quantified through Zwicker's psychoacoustic annoyance model. Chalk is modeled as a cylinder and its crumbling is modeled by a downward translation "into" a chalkboard rotated at an angle $\alpha$. This model is used to calculate the chalk's area of contact with the board at any $d$ and $\alpha$. Next, the relationship between contact area and psychoacoustic annoyance is determined experimentally. The set of angles that minimize and maximize annoyance are then found, measured using two annoyance metrics: instantaneous and accumulated annoyance.

12. Topic : **SEIR Modeling the COVID-19 Pandemic in Hong Kong**

School : FDBWA Szeto Ho Secondary School
學校名稱 : 五邑司徒浩中學
Teacher : Mr. Yu Tin Wong
領導老師 : 黃裕田先生
Team Members : Kwok Leong Choi, Wai Leung Lao, Chun Tak Sun, Kwan Ho Wong
成員同學 : 蔡國亮、勞韋樑、孫振德、黃均浩

This research applies a compartmental SEIR model to study the spread of COVID-19 in Hong Kong. The model divides the population into susceptible, exposed, infectious, and recovered, and incorporates factors such as waning immunity, imported cases, and government interventions. The model was validated and parameters were estimated using official case reports and policy records from 2020 to 2023. Strong non-pharmaceutical measures, such as mask requirements and mobility limitations, significantly decreased transmission in the early waves, according to simulation results. Scenario analysis suggests that sustained moderate restrictions would have prevented higher waves observed in late 2022. Sensitivity analysis shows that the most important factors influencing the course of the epidemic were variations in contact rate. In order to control future outbreaks, these results emphasize the importance of prompt interventions and ongoing monitoring. In densely populated urban areas like Hong Kong, the study shows how mathematical modeling can offer insightful information that can guide public health initiatives.

13. Topic : **The Game of Math: Making Decisions in Games**

School / 學校名稱 : Ying Wa College / 英華書院
Teacher / 領導老師 : Dr. Chiu Chak Tang / 鄧超澤博士
Team Members / 成員同學 : Yu-Yan Kan, Yue-Hin Li, Freddy Shing-Hon Lin / 簡宇仁、李雨軒、林承瀚

This paper explores a combined mathematical analysis of two distinct strategic games using game theory and Markov chains. The first part examines decision-making in the Lowest Unique Number Game (LUNG) through game-theoretic methods, identifying its mixed-strategy symmetric Nash equilibrium. The second part focuses on the board game RISK, modeling territorial conquest probabilities with Markov chain techniques. Together, these examples highlight how mathematical frameworks offer valuable insights into decision-making under uncertainty across diverse gaming scenarios.

14. Topic : **The Mathematics of Riffle Shuffling from Single to Multi-Deck Card Games**

School / 學校名稱 : King George V School / 英皇佐治五世學校
Teacher : Ms. Alexandra Streeter
Team Members / 成員同學 : Daniel Haifeng Wang, Justin Haisong Wang / 汪海峰、汪海嵩

While significant progress has been made on the question "How many shuffles are required to sufficiently randomize a deck of cards?", the most influential work on the subject remains the 1992 paper by Bayer and Diaconis, which provided an answer for a standard 52-card deck, proving that seven shuffles suffice. However, many variations of this problem have yet to be extensively explored. In particular, multiple decks of cards are commonly used in various card games, such as the popular Chinese game GuanDan (2 decks), making the randomness of a deck after shuffling highly relevant in both recreational and professional settings. In this paper, we provide a mathematical analysis on the randomness of riffle shuffling multiple decks of cards, extending the result of Bayer and Diaconis to the multi-deck setting. A key contribution of ours is the investigation of the randomness of a player's hand after riffle shuffling in a deck, a question that has not been investigated at all previously, from which we are able to give explicit formulae for the separation distance for a player's hand after riffle shuffling for both the single deck and double deck setting.

15. Topic **: What Can You Split and Draw?**

School : HKUGA College
學校名稱 : 港大同學會書院
Teacher : Mr. Yuk Lun Fong
領導老師 : 方鈺倫先生
Team Members : Triton Cheuk Lok Kho, Eron Ching Long Kwok, Man Hei Tung
成員同學 : 許卓樂、郭澄朗、董旻熙

Building on 'What Can You Draw (2023)' by Florian Frick and Fei Peng, this paper generalises 'drawability', a topological framework combining unions and exclusions of regions, to arbitrary brush shapes and infinite drawing sequences, enabling the study of more complex figures. '$n$-layer drawability' is introduced as a new metric to quantify the complexity of undrawable sets. Our central theoretical result establishes that a figure is undrawable if and only if its boundary contains 'containment loops' ($\in$-loops). To analyse these loops, we developed the layer drawability graph and prove its chromatic number provides a lower bound on $n$-layer drawability. Finally, we prove this complexity metric is unbounded. Case studies of practical drawing are also discussed.

Hang Lung Properties Limited (SEHK stock code: 00101) creates compelling spaces that enrich lives. Headquartered in Hong Kong and Shanghai, the Company manages a portfolio of over 3.5 million square meters of retail, office, residential, and hotel properties across Hong Kong and mainland China.

The Company's diverse portfolio in Hong Kong includes office towers and malls in prime districts, as well as luxury residential developments in prestigious areas. In mainland China, under the signature "66" brand, the Company's mixed-use and retail developments are regarded as premium landmarks, strategically located in the hearts of key cities of Shanghai, Shenyang, Jinan, Wuxi, Tianjin, Dalian, Kunming, Wuhan, and Hangzhou.

The Company is recognized for pioneering sustainability in the real estate industry, with an MSCI ESG rating of AA and inclusion on CDP "A List" for Climate Change. The Company powers 80% of its operating properties on the Mainland with renewable energy, with a net zero commitment by 2050.

At Hang Lung Properties – **We Do It Well**.

For more information, please visit *https://www.hanglung.com*

## The Hong Kong University of Science and Technology

The Hong Kong University of Science and Technology (HKUST) (https://hkust.edu.hk/) is a world-class university that excels in driving innovative education, research excellence, and impactful knowledge transfer. With a holistic and interdisciplinary pedagogy approach, HKUST was ranked 3rd in the Times Higher Education's Young University Rankings 2024, 19th Worldwide, and No.1 in Hong Kong in Times Higher Education's Impact Rankings 2025. Thirteen HKUST subjects were ranked among the world's top 50 in the QS World University Rankings by Subject 2025, with "Data Science and Artificial Intelligence" holding the 17th place, maintaining its position as first in Hong Kong. Our graduates are highly competitive, consistently ranking among the world's top 30 most sought-after employees. In terms of research and entrepreneurship, over 80% of our work was rated "internationally excellent" or "world leading" in the latest Research Assessment Exercise 2020 of Hong Kong's University Grants Committee. As of May 2025, HKUST members have founded over 1,800 active start-ups, including 10 Unicorns and 17 exits (IPO or M&A).

To learn more about HLMA,
please visit our website and follow us on Facebook and Instagram.

