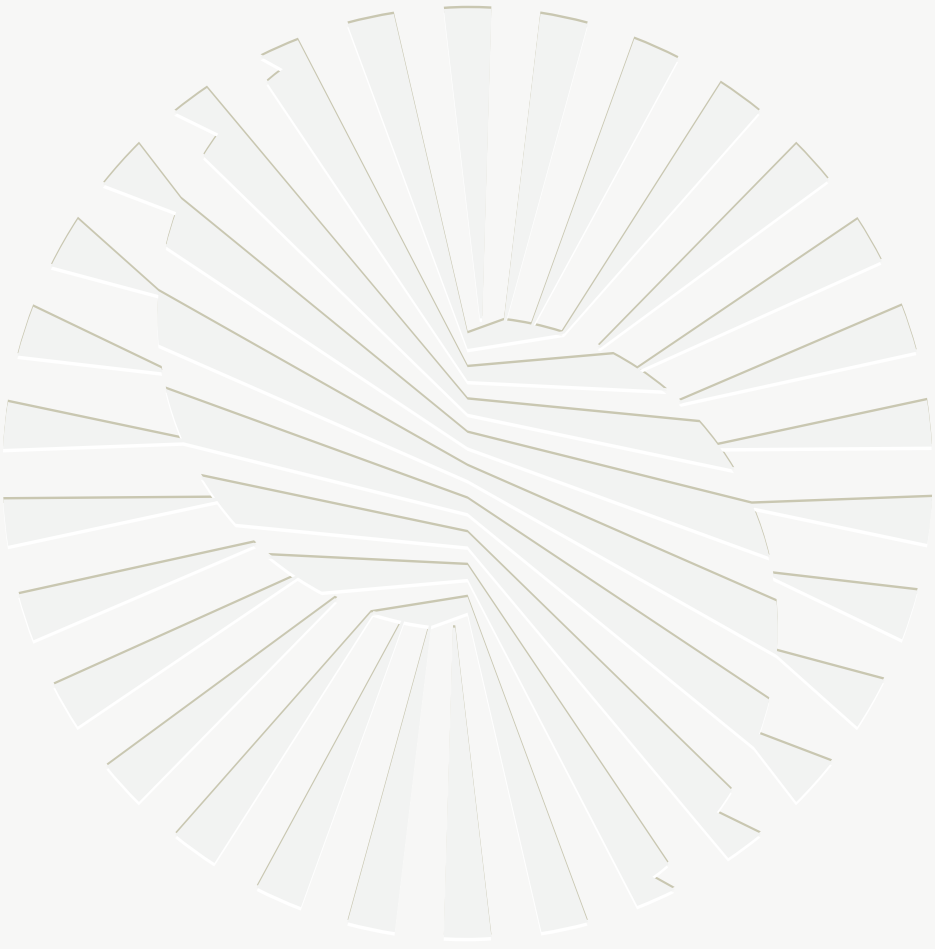
THE SHAW PRIZE 2023 AWARD PRESENTATION



For the Benefit of Humankind

The Shaw Prize is an international award to honour individuals, regardless of race, nationality, gender and religious belief, who are currently active in their respective fields and who have recently achieved distinguished and significant advances, who have made outstanding contributions in academic and scientific research or applications, or who in other domains have achieved excellence. The award is dedicated to furthering societal progress, enhancing quality of life, and enriching humanity's spiritual civilisation.

Preference is to be given to individuals whose significant works were recently achieved and who are currently active in their respective fields.

THE
SHAW
PRIZE
邵逸夫獎

Founder

MR RUN RUN SHAW
(1907–2014)

Mr Shaw, born in China in 1907, was a native of Ningbo County, Zhejiang Province. He joined his brother's film company in China in the 1920s. During the 1950s he founded the film company Shaw Brothers (HK) Limited in Hong Kong. He was one of the founding members of Television Broadcasts Limited (TVB) launched in Hong Kong in 1967. As an established figure in the film and media industry, Mr Shaw gained insight into the needs of the people, and as a visionary he saw how, in addition to the fleeting escapism of entertainment, the more substantial benefits of education and healthcare would greatly impact lives for the better. He established two charities: The Shaw Foundation Hong Kong and The Sir Run Run Shaw Charitable Trust, both dedicated to the promotion of education, scientific and technological research, medical and welfare services, and culture and the arts.

The Shaw Foundation quickly gained momentum in a wide range of philanthropic work: supporting educational institutions as well as hospitals and clinics in Hong Kong, the rest of China and beyond. Expanding his vision into new areas convinced him that the quest for knowledge is key to sustaining the advancement of civilisation, and strengthened his belief that scientists focussed on unmasking the mysteries of nature are pivotal to the well-being of humankind. He decided to use his influence, and with the unfailing support of his wife Mrs Mona Shaw, established The Shaw Prize to inspire and recognise imaginative individuals committed to scientific research and to highlight their discoveries.

The Award continues to gain in stature, casting a beam of recognition on outstanding scientific achievements, and firing the imagination of pioneers who follow him in spirit and in deed, sustaining the continued success of the Shaw Foundation and the Shaw Prize Foundation as lasting tributes to his wisdom and generosity.

Message from the Chief Executive

THE HONOURABLE
JOHN KC LEE

I am pleased and honoured to congratulate the seven Laureates of the Shaw Prize 2023 for their groundbreaking advances in the fields of astronomy, life science and medicine, and mathematical sciences.

This year marks the landmark 20th anniversary of the Shaw Prize, which was created to acknowledge and celebrate exceptional contributions to the advancement of academic and scientific research and applications. Over the past two decades, more than 100 Shaw Laureates from all over the world have been honoured for their trailblazing work, for helping to build a brighter future for us all.

For that, I am deeply grateful to Mr Run Run Shaw, who established the Shaw Prize Foundation in Hong Kong in 2002 and initiated the annual Shaw Prize Awards two years later. The government is equally committed to promoting scientific research and nurturing young scientists, to ensuring that Hong Kong and our nation remains at the forefront of progress in science, technology and research.

My thanks, as well, to the Council Members of the Shaw Prize Foundation and the members of the Board of Adjudicators and Shaw Prize Selection Committees for ensuring that the highest international standards of science and research excellence are recognised, and rewarded, year after year.

JOHN KC LEE

Chief Executive
Hong Kong Special Administrative Region

Message from the Chair of the Board of Adjudicators

REINHARD
GENZEL

Welcome to the twentieth Annual Shaw Prize Award Presentation Ceremony. In 2002 Sir Run Run Shaw and Mrs Mona Shaw established the Shaw Prize to honour scientists in the fields of Astronomy, Life Science and Medicine, and Mathematical Sciences. The inaugural Award Ceremony took place in 2004. In the ensuing years, the Shaws' entrepreneurship and philanthropy inspired the quest for new knowledge, highlighted outstanding achievements, and became a major force for progress in the world.

We are proud to be able to continue the founding vision of Mr and Mrs Shaw in promoting scientific discoveries whose beacons of truth and long-term contributions to society only shine brighter in these difficult times. This year marks the twentieth anniversary of the Shaw Prize, and we are happy to see the return of physical Award Presentation Ceremony, after various special arrangements in the past three years.

This year, we honour seven scientists in the three designated fields for their distinguished contributions. They are Professors Matthew Bailes, Duncan Lorimer and Maura McLaughlin in Astronomy, Professors Patrick Cramer and Eva Nogales in Life Science and Medicine, and Professors Vladimir Drinfeld and Shing-Tung Yau in Mathematical Sciences. In the name of the Shaw Prize Council and the three respective Selection Committees, I would like to convey our warmest congratulations to all laureates for their fantastic achievements.

REINHARD GENZEL

Chair, Board of Adjudicators
Shaw Prize 2023

The Shaw Prize Medal

The front of the medal displays a portrait of Mr Run Run Shaw, next to which are the words and Chinese characters for the title of "The Shaw Prize".

On the reverse side, the medal shows the award category and year, the name of the laureate, and in the upper right corner, the logo mark of the Shaw Prize.


THE
SHAW
PRIZE
邵逸夫獎


2023
THE SHAW PRIZE IN
ASTRONOMY
邵逸夫天文學獎


2023
THE SHAW PRIZE IN
LIFE SCIENCE AND
MEDICINE
邵逸夫生命科學與醫學獎


2023
THE SHAW PRIZE IN
MATHEMATICAL
SCIENCES
邵逸夫獎數學科學獎

Programme

Grand Hall, Hong Kong Convention and Exhibition Centre–12 Nov 2023

OPENING ADDRESS

Dr Wai-Man Chan, Raymond	Chair of the Shaw Prize Foundation Member of the Council
The Honourable John KC Lee	The Chief Executive of HKSAR

TOASTING CEREMONY

SPEECH ON THE PRIZE IN ASTRONOMY

Professor Scott D Tremaine	Member of the Board of Adjudicators Chair of the Selection Committee for the Prize in Astronomy

SPEECH ON THE PRIZE IN LIFE SCIENCE AND MEDICINE

Professor Randy W Schekman	Former Chair of the Selection Committee for the Prize in Life Science and Medicine

SPEECH ON THE PRIZE IN MATHEMATICAL SCIENCES

Professor Hélène Esnault	Member of the Board of Adjudicators Chair of the Selection Committee for the Prize in Mathematical Sciences

AWARD PRESENTATION–2023

Professor Matthew Bailes	The Prize in Astronomy
Professor Duncan Lorimer	The Prize in Astronomy
Professor Maura McLaughlin	The Prize in Astronomy
Professor Patrick Cramer	The Prize in Life Science and Medicine
Professor Eva Nogales	The Prize in Life Science and Medicine
Professor Vladimir Drinfeld	The Prize in Mathematical Sciences
Professor Shing-Tung Yau	The Prize in Mathematical Sciences

AWARD PRESENTATION–2020

Professor Roger D Blanford	The Prize in Astronomy
Professor Gero Miesenböck	The Prize in Life Science and Medicine
Professor Peter Hegemann	The Prize in Life Science and Medicine
Professor Georg Nagel	The Prize in Life Science and Medicine

AWARD PRESENTATION–2021

Professor Victoria M Kaspi	The Prize in Astronomy
Professor Chryssa Kouveliotou	The Prize in Astronomy
Professor Jeff Cheeger	The Prize in Mathematical Sciences
Professor Jean-Michel Bismut	The Prize in Mathematical Sciences

AWARD PRESENTATION–2022

Professor Lennart Lindegren	The Prize in Astronomy
Professor Michael Perryman	The Prize in Astronomy
Dr Paul A Negulescu	The Prize in Life Science and Medicine
Professor Michael J Welsh	The Prize in Life Science and Medicine
Professor Noga Alon	The Prize in Mathematical Sciences
Professor Ehud Hrushovski	The Prize in Mathematical Sciences

ACCEPTANCE SPEECHES BY SHAW LAUREATES 2023

	The Prize in Astronomy
	The Prize in Life Science and Medicine
	The Prize in Mathematical Sciences

The Shaw Prize 2023

Astronomy

PROFESSOR SCOTT D TREMAINE

Member of the Board of Adjudicators
Chair of the Selection
Committee for the Prize in Astronomy

Professor Scott D Tremaine received his undergraduate degree from McMaster University in Canada and his PhD in Physics from Princeton University. He has held faculty positions at MIT, the University of Toronto, and Princeton University.

At the University of Toronto he was the first Director of the Canadian Institute for Theoretical Astrophysics, from 1985 to 1996, and at the Princeton University he chaired the Department of Astrophysical Sciences from 1998 to 2006. He was the Richard Black Professor at the Institute for Advanced Study in Princeton from 2007 to 2020. He is currently an Emeritus Professor at Princeton University and the Institute for Advanced Study and a Professor at the University of Toronto.

He is a Fellow of the Royal Societies of London and of Canada and a Member of the US National Academy of Sciences. His awards include the Dannie Heinemann Prize for Astrophysics, the Tomalla Foundation Prize for Gravity Research, the Dirk Brouwer Award, the Henry Norris Russell Lectureship of the American Astronomical Society, and honorary doctorates from McMaster, Toronto, and St Mary's University.

His research has been focused on the dynamics of astrophysical systems, including planet formation and evolution, planetary rings, comets, supermassive black holes, star clusters, galaxies, and galaxy systems.

Matthew Bailes
Duncan Lorimer
Maura McLaughlin

For the discovery of
fast radio bursts (FRBs).

Pulsars are among the most remarkable and exotic objects in the heavens: rapidly spinning neutron stars with a mass similar to the Sun's, diameters of only a few tens of kilometers and magnetic fields a million million times stronger than the field we experience at the surface of the Earth. Pulsars emit beams of radio waves from their magnetic poles, which sweep across the Earth as the pulsars spin; these periodic pulses can be detected by Earth-based telescopes. On August 24 2001, during a search for pulsars in nearby galaxies, a telescope at the Parkes Observatory in Australia recorded a brief but unusually strong burst of radio emission. This event lay undetected in the archives of that search for more than half a decade, until it was found by David Narkevic, a student working with Duncan Lorimer and Maura McLaughlin at West Virginia University on a search for single pulses from pulsars with strongly variable radio emission. The arrival time of the burst was dispersed, that is, it changed with frequency, a characteristic of astrophysical signals such as those from pulsars that have propagated through the plasma of ionised gas that fills much of our Milky Way and other galaxies. However, the dependence of arrival time on frequency was far larger than for any known pulsar. Lorimer, McLaughlin, Bailes and their collaborators recognised that this dependence implied that the mysterious source — now known as the "Lorimer burst" — lay far outside our own Milky Way, roughly 100,000 times further than the typical pulsar and so far away that the burst was emitted over a billion years ago. They also showed that despite this enormous distance and the correspondingly huge energy requirements, the object emitting the burst had to be very small — the finite speed of light and the short duration of the signal implied that the burst must have come from a region smaller than the Earth.

The properties of the Lorimer burst were so extreme that many astronomers suspected that it was caused by Earth-based radio interference. It was only five years later, as more such fast radio bursts (FRBs) were discovered on different telescopes, that they were recognised to be a real cosmic phenomenon. By now almost a thousand FRBs have been detected, still only a small fraction of the estimated rate of over a thousand per day across the whole sky. Most of these detections have been made by new telescopes and instruments designed specifically to look for FRBs, and an armada of even more ambitious instruments are being designed or under construction.

FRBs are the only extragalactic sources that have short enough timescales to be used to measure dispersion in the arrival time. This dispersion contains a large contribution from plasma in the intergalactic medium along the line of sight to the burst. As Lorimer and his collaborators pointed out, FRBs that are found *in* galaxies with measured distances offer a unique probe of the spatial distribution of ionised matter in the diffuse intergalactic medium *outside* galaxies, which contains most

of the baryonic or normal matter in the Universe and is one of the major remaining unknowns in our inventory of the contents of the Universe. Recent preliminary estimates, which should improve rapidly in the future, suggest that the density of matter in intergalactic space is consistent with values estimated indirectly from the cosmic microwave background and the primordial abundances of the elements.

With future FRB discoveries we may be able to probe issues in fundamental physics, such as the validity of Einstein's equivalence principle, possible new forms of exotic matter, the expansion rate of the Universe, and the origin of intergalactic magnetic fields.

The nature of FRBs remains unknown. Probably, like pulsars, they are associated with neutron stars, whose large rotational energies and strong magnetic fields make them plausible candidates for the progenitors of FRBs. The diversity of FRBs — some repeat but most do not, some are associated with young stellar populations and others with old, some but not all show polarised light, etc. — suggests that more than one mechanism may be responsible. Even more exotic possibilities involving evaporating black holes or new forms of matter have been discussed. A much larger sample of FRBs, with well characterized burst properties and robustly identified galaxy hosts, is needed to differentiate between the dozens of proposed progenitor theories.

The award of the Shaw Prize is also intended to recognise the other collaborators in this research, David Narkevic and Fronefield Crawford, as well as the investigators who collected the original data for other purposes and the team who developed the novel wide-field multibeam receiver for the Parkes Telescope that made the discovery possible. The story of the discovery of FRBs highlights the importance of the stewardship of archived astronomical databases and of supporting archival research that exploits these databases.

THE DISCOVERY PAPER IS

D. R. LORIMER, M. BAILES, M. A. MCLAUGHLIN, D. J. NARKEVIC, F. CRAWFORD, "A BRIGHT MILLISECOND RADIO BURST OF EXTRAGALACTIC ORIGIN", SCIENCE, VOLUME 318, P. 777–780, 2 NOVEMBER 2007

Matthew Bailes

LAUREATE IN ASTRONOMY 2023

‘The pulse seemed
a bit too good to be true.’

I was born on March 16, 1963 in the central Australian desert town of Alice Springs. It was the same day that the discovery of the first quasar 3C273 was published. 3C273 was over a billion light years distant, and its luminosity was incomprehensible unless it was caused by an accreting supermassive black hole, an object of unimaginable gravity that featured in Einstein's General Theory of Relativity. The new 64-metre Parkes telescope (Murriyang) had played an important role in its identification and was later to become my "home away from home".

My mother tells me that I was delivered by "a wonderful Aboriginal midwife who was the matron of the maternity ward" on the same day that Queen Elizabeth II was departing Alice Springs. My father was a public servant and had been ensuring her visit went smoothly. His father and uncle were artesian well-borers in the area many decades prior.

From a very early age, I loved mathematics and science, and I marvelled at the Moon landing as a six-year-old, flying my cardboard lunar module around our living room before watching the transmission of the signal being relayed by the Parkes telescope. My classmates at primary school decided that my nickname should be "the Professor".

At high school, my interests migrated from mathematics to physics, and I loved reading about the history of science, especially Einstein's thought experiments. Although I yearned to be a scientist, neither of my parents had attended University, and I was quite ignorant about career paths. When my father remarried, my step-brother was studying physics at University. This opened up that scientific career option to me, and the inspiring TV series "Cosmos" by Carl Sagan sealed the deal.

I was a competitive and somewhat outspoken student, but revelled in my first research project on a unique binary pulsar, two neutron stars in a tight 7.75 hour orbit at the University of Adelaide. I enrolled at the ANU to continue this work. My advisor, the esteemed galactic dynamist Ken Freeman, recalls that although they did their best to point me in other scientific directions, nothing could prise me away from pulsars. I discovered that the famous pulsar astronomer Dick Manchester worked at the CSIRO in Sydney, and he agreed to remotely supervise my PhD on the origin of pulsar velocities.

After a brief stint at NASA's Goddard Space Flight Center, I commenced a Royal Society Endeavour Fellowship at the University of Manchester in 1990. There, I experienced a series of academic highs in the form of many new pulsar discoveries with the exceptional Professor Andrew Lyne and my first student (and future Shaw Prize winner), Duncan Lorimer.

At one point in the early 1990s, I erroneously thought I had helped discover the first extra-solar planet, and led a Nature paper that had to be embarrassingly retracted. This was an important, and probably much-needed lesson in humility. I briefly contemplated leaving science, but

came to realise that I still loved my research career.

I returned to Australia on a 5-year QEII Fellowship and decided to begin empire-building, having been recruited to create the Centre for Astrophysics and Supercomputing at Swinburne University of Technology. Our mission statement declared that we were "dedicated to inspiring a fascination in the Universe through research and education". We pioneered online astronomy education and the use of virtual reality for public outreach with the aid of many great academic recruits and students. In 2013 we made Australia's first 3D IMAX movie.

Whilst observing at the Parkes telescope with Duncan Lorimer in 2007, we explored a new 5-millisecond burst of radio waves that he and his student had detected in an old survey of the southern sky. To our great surprise, this burst had originated a billion light years away from Earth, and was a trillion times brighter than our galaxy's neutron stars that emit pulses. The pulse seemed a bit too good to be true, and I found it hard to get to sleep the night after we had first computed its almost incomprehensible distance. The subsequent detective work to decipher it had many parallels to the quasars.

Other burst examples proved extremely difficult to find, but after six long years my colleagues and I undertook a new survey at Parkes that finally discovered another 4, which we dubbed "Fast Radio Bursts" ('FRBs'). Now over 5000 FRBs have been discovered and they have helped constrain the number of atoms in the Universe. Most FRBs probably originate from magnetars, highly-magnetic neutron stars.

I currently lead the Australian Research Council's Centre of Excellence for Gravitational Wave Discovery (OzGrav). I am delighted that our FRB discovery has been recognised with the Shaw Prize, and owe much to my (patient) mentors, pulsar and FRB colleagues in our discovery teams and wider community, and to my wife and family.

Duncan Lorimer

LAUREATE IN ASTRONOMY 2023

‘It has been the thrill of a lifetime to play a key role in finding and establishing fast radio bursts as a scientific phenomenon.’

I was born in 1969 in Darlington, County Durham, UK and grew up in the village of Cotherstone some 20 miles further up the river Tees. Both my parents were podiatrists and I'm the youngest of three brothers. Cotherstone was a lovely place to spend my formative years. In 1983 our family moved to Darlington. Near the end of my schooling, at Queen Elizabeth Sixth form College in Darlington, I got interested in astronomy thanks to a great physics teacher, John Charney, who trusted me and some fellow students with the keys to the telescope so that we could observe a lunar eclipse. Inspired by that, and "The Sky At Night" on the BBC, I went on to study Astrophysics at the University of Wales College of Cardiff from 1987 to 1990.

While at Cardiff, I had the great fortune to learn from a number of excellent faculty, including Prof Bernard Schutz who nurtured my interest in neutron stars. Despite knowing barely anything about radio astronomy, following Schutz's recommendation, I applied to graduate study at the University of Manchester and was at the Jodrell Bank Observatory from 1990 to 1994. I quickly became enchanted by the wide array of radio dishes in the muddy fields of the observatory and carried out research with Dr Matthew Bailes (fellow 2023 Shaw Astronomy Laureate) for my master's degree, and continued to a PhD under the guidance of Prof Andrew Lyne. The infectious enthusiasm of Bailes and Lyne for pulsars had me hooked; those projects took me on several extended research trips to the Australia Telescope National Facility (ATNF) in Sydney. This began a career-long association with the Parkes Radio Telescope (Murriyang) as part of a survey of the Southern Sky led by Lyne and Prof Dick Manchester at the ATNF.

Those observing runs at Parkes, often carried out under the guidance of Dr Simon Johnston at the ATNF, cemented my interest in research primarily using radio dishes to search for pulsars and in particular characterize their underlying population in a wide variety of environments. This field of "pulsar statistics" has been a driving force in my research ever since. After graduating from Manchester and a short stint (1994–1995) as a lecturer, I took postdoctoral appointments at the Max Planck Institute for Radio Astronomy in Bonn, Germany (1995–1998) and the Arecibo Observatory in Puerto Rico (1998–2001) which was at that time managed by Cornell University. It was at Arecibo that I met the love of my life Maura McLaughlin (fellow 2023 Shaw Astronomy Laureate) while she was working on her PhD at Cornell. Maura and I moved to Jodrell in 2001 where I was a Royal Society University Research Fellow, and she was awarded a National Science Foundation postdoctoral fellow.

Being back at Jodrell working on pulsar projects with Maura was a very exciting period. Maura led the discovery of the Rotating Radio Transients and she and I worked on the Double Pulsar System. With long-

time collaborator Michael Kramer from Bonn, I co-wrote "Handbook of Pulsar Astronomy" in 2004. Maura and I had a wonderful time exploring the UK and Europe and got married in 2003. After five years at Jodrell, we received an offer to start an astrophysics group at West Virginia University (WVU). Inspired by the collaborations that we had worked in, we moved to WVU in 2006 with our son Callum who was born in 2005. We've since expanded the family with two more boys in Morgantown, Finlay (2007) and Owen (2011). Raising these three amazing humans with Maura continues to be the highlight of my life.

At WVU we have had the opportunity to build many partnerships at the state, national and international level as we have built an astrophysics program with strong ties to the Green Bank Observatory in southern WV. Currently, the faculty at WVU includes seven astronomers with a speciality in compact objects, radio astronomy, and gravitational wave astrophysics. The discovery of fast radio bursts (FRBs) by our team at WVU in 2007 helped us to grow and flourish over the years. I've since led the Department of Physics and Astronomy at WVU three times as Chair and, since 2019, serve the Eberly College of Arts and Sciences as its Associate Dean for Research.

It has been the thrill of a lifetime to play a key role in finding and establishing FRBs as a scientific phenomenon. The people highlighted above have been essential mentors and dear friends to me throughout the journey. I continue to work with and be inspired by them and many other brilliant minds in the community. The promise of FRBs as probes of the large-scale structure of the Universe is now just being realized. An exciting future lies ahead as researchers from around the world enter a rich phase of discovery into the origin and evolution of FRBs.

Maura McLaughlin

LAUREATE IN ASTRONOMY 2023

‘I am grateful for the opportunity to work in a rich scientific field with a vast discovery space along with so many brilliant colleagues.’

I was born in Philadelphia, Pennsylvania in 1972. My mother Susan taught elementary school and my father John was a salesman. My childhood was filled with lots of love from my parents and sisters, Tara and Monica, who are two and five years younger. I was also very lucky to grow up with many close cousins, grandparents, aunts, and uncles.

I inherited my mother's love of academics and my father's passion for reading and frequently changing and intense interests, including the orange-winged amazon parrot named Noel I received at age 11 and still have today! I was considering careers as either a veterinarian or oboist when I happened upon Steven Hawking's "A Brief History of Time" in 1988. The concepts of black holes, compact objects, and space-time completely captivated me, and my all-girls Catholic high school provided freedom to study "nerdy" subjects without worrying about gender norms.

I joined Penn State University as an astronomy and astrophysics major in 1990. Soon after, Prof Alex Wolszczan discovered the first extrasolar planets through high-precision timing of a rapidly rotating, highly magnetized compact object known as a pulsar using the world's largest radio telescope, the Arecibo Observatory in Puerto Rico. I became fascinated with pulsars and was overjoyed to work with him on data analysis on this "planet pulsar" and to travel to Arecibo to carry out observations. Coincidentally, one of my most encouraging and memorable moments as an undergraduate was when Alex said that I reminded him of Vicky Kaspi, an astronomer a few years older than me and who I have always admired greatly (who won the Shaw Prize a few years ago!)

After visiting Arecibo, I was determined to study these unique astronomical physics laboratories in graduate school. At Cornell University, I had the excellent fortune to work with Prof Jim Cordes, one of the most versatile and brilliant scientists I know. Like all of Jim's students, my research spanned many topics, ranging from gamma-ray pulsar populations and searches, radio pulsar searches and timing, and interstellar scintillation, in collaboration with another influential mentor, Dan Stinebring at Oberlin College. One central goal for Jim and I was to discover pulsars in other galaxies. To achieve this, we developed algorithms and code to search for individual, bright pulses that could be detected at much larger distances than the time-averaged, periodic emission to which traditional pulsar searches were sensitive.

During graduate school, I met Duncan Lorimer at Arecibo, and I subsequently joined him at Jodrell Bank Observatory in the UK as an NSF-funded postdoc. My first project was a search for single pulses in the Parkes Multibeam Pulsar Survey, resulting in the unexpected discovery of a class of pulsars we called Rotating Radio Transients, only detectable through their sporadic individual pulses and not through traditional methods. I also worked on many other projects, including studies of the double pulsar system, a fantastic testbed for general relativity and

pulsar physics. Prof Andrew Lyne was an important mentor to me during that time, and I learned a lot from his thoughtful, careful, and creative approach to problem solving.

Duncan and I loved working at Jodrell, but I wanted to be closer to family. An opportunity to do that while building our own astronomy group brought us to West Virginia University in 2006. A bonus was proximity to the largest radio telescope in the continental US, the Green Bank Telescope. The first few years in West Virginia were a personal and professional whirlwind. We arrived with a baby (Callum, now 17) and soon had two more (Finlay and Owen, now 16 and 12). Duncan and I also built a new graduate program in astronomy and more than tripled the number of astronomy faculty over the next decade.

Soon after our arrival at WVU, we co-founded the Pulsar Search Collaboratory, with Sue Ann Heatherly at Green Bank, which has involved thousands of high-school students in pulsar searches. I have continued to work on radio transients, carrying out single-pulse searches such as the one leading to the first Fast Radio Burst, and studying the mysterious diversity of pulsar emission behaviors. My primary current research interest, however, is using high-precision pulsar timing for low-frequency gravitational-wave detection through the NANOGrav collaboration. I co-founded the collaboration in 2007 and have served as Co-Director of the NANOGrav Physics Frontiers Center since 2015.

I am grateful for the opportunity to work in a rich scientific field with a vast discovery space along with so many brilliant colleagues. I have also been fortunate to work with the most incredible students and postdocs, who are the reason that I am excited to come to work each day. I am also immeasurably thankful for my wonderful family and children, and a husband who is a supportive and inspiring partner both in life and in science.

The Shaw Prize 2023

Life Science & Medicine

PROFESSOR BONNIE L BASSLER

Member of the Board of Adjudicators
Chair of the Selection Committee
for the Prize in Life Science and Medicine

Professor Bonnie L Bassler is a Member of the US National Academy of Sciences, the National Academy of Medicine, and the American Academy of Arts and Sciences. She is a Howard Hughes Medical Institute Investigator and the Squibb Professor and Chair of the Department of Molecular Biology at Princeton University. Her research focuses on the molecular mechanisms bacteria use for intercellular communication. This process is called quorum sensing. Professor Bassler's discoveries are paving the way to the development of novel therapies for combating bacteria by disrupting quorum-sensing-mediated communication. She received the Shaw Prize in Life Science and Medicine in 2015. Professor Bassler is a Member of the Royal Society and the American Philosophical Society. She served on the National Science Board from 2010–2016 and was nominated to that position by President Barack Obama. The Board oversees the NSF and prioritises the nation's research and educational activities in science, math and engineering.

Patrick Cramer
Eva Nogales

For pioneering structural biology that enabled visualisation, at the level of individual atoms, of the protein machines responsible for gene transcription, one of life's fundamental processes. They revealed the mechanism underlying each step in gene transcription, how proper gene transcription promotes health, and how dysregulation causes disease.

The Central Dogma, a theory put forward in 1958 by Francis Crick, is the fundamental concept of life. Three crucial molecules are involved: DNA houses an organism's genetic blueprint. The DNA genome contains the information required to produce all of an organism's proteins. Proteins endow cells, tissues, and organisms with their forms and capabilities. Messenger RNA (mRNA) is the intermediate molecule that links DNA to proteins. Particular DNA instructions are converted into individual mRNA molecules to produce specific proteins by a process called gene transcription. Crucially, transcription of specific genes must occur at the correct times and in the correct cellular locations so that the subsets of proteins required for function are only produced when and where they are needed. The gene transcription process has four steps: (1) Initiation; (2) Pausing/Promoter Clearance; (3) Elongation; (4) Termination. In 2006, Roger Kornberg won the Nobel Prize for discoveries concerning how the enzyme called RNA Polymerase converts DNA into mRNA. The work of this year's Shaw Prize recipients, Eva Nogales and Patrick Cramer, represents the next major leap in our understanding of gene transcription. They pioneered structural biology approaches to enable visualization, at the level of the individual atoms, of the protein machines responsible for gene transcription. They revealed the molecular mechanism underlying each step in gene transcription, and the importance of proper gene transcription to promote health and prevent disease.

Visualising biology at the atomic level requires determining the structures of the tiny but highly complicated machines that catalyse life processes. Two major approaches are used: x-ray crystallography and the more recently developed technology, cryo-electron microscopy. X-ray crystallography delivers structures of single proteins or small protein complexes that can be crystalised. A familiar crystal is table salt (NaCl) that consists of many microscopic cubes tightly bound together to yield the crystalline form of salt in a shaker. In the case of proteins and small protein complexes, the protein crystals are exposed to an x-ray beam that diffracts in different directions. The diffraction pattern provides precise information about where every atom in the protein or protein complex resides and its relation to every other atom in the protein or protein complex. Thus, the diffraction pattern can be computed into the 3-dimensional structure of the protein or small protein complex. Cryo-electron microscopy is, in essence, a form of molecular photography. Cryo-electron microscopy enables the shapes of flash-frozen protein complexes to be visualised by shooting electrons at the protein complexes and recording the resulting projected images. Thousands of such projections are collected and combined, and the structure of the protein complex is determined by reconstructing its 3-dimensional shape. Cryo-electron microscopy is especially powerful because it enables atomic-resolution structures of complexes that are too large for

x-ray crystallography.

Both of this year's Shaw Prize winners are giants in the structural biology field and both have, for the first time, solved structures of biology's most central molecular machines: the protein complexes required for gene transcription that make life possible across all organisms, from bacteria to humans. Indeed, in their monumental work, Nogales and Cramer have solved the structures of protein complexes long deemed experimentally intractable. Moreover, their delivery of the structures of complete multi-protein complexes, not the individual protein components in isolation, has driven a transformation in our understanding of gene transcription in health and disease.

Shaw Prize recipient Eva Nogales pioneered cryo-electron microscopy to transform our understanding of the earliest steps in gene transcription. These studies involved the human TFIID recognition and binding of core promoter DNA and the consequent assembly of the transcription pre-initiation complex (PIC). This large and complex molecular machinery, which is required for the launch of the gene transcription process, is scarce, fragile, and extremely flexible, all of which made the structures Nogales captured a Herculean accomplishment. Nogales revealed how TFIID keeps the TATA binding protein (TBP) sequestered until the rest of the complex engages with the promoter sequences and only then deploys TBP for PIC assembly. She showed the stepwise assembly of the PIC, how the PIC is stabilised on the DNA, and how coupling occurs between PIC states to allow transcription initiation.

Shaw Prize recipient Patrick Cramer used x-ray crystallography and cryo-electron microscopy to determine many breathtaking structures capturing the sequential steps of gene transcription. Cramer's array of structures includes the full PIC, a 46-protein machine that contains crucial players called Mediator and TFIIH. Cramer also solved structures of RNA polymerase II after it initiates synthesis of an mRNA messenger. These structures include the paused elongation complex, the elongation complex in action, the elongation complex together with the nucleosome (nucleosomes are proteins with DNA wrapped around them and the elongation complex must clear them to proceed), the elongation complex with the nucleosome and remodeling factors, and the elongation complex with the pre-mRNA splicing complex (the splicing complex stitches mRNAs together following elongation). Combined, Cramer's extraordinary structures provide the world's first "movie" of gene transcription.

Nogales' and Cramer's landmark discoveries drove a paradigm shift in our understanding of one of life's most central processes: gene transcription. They showed how transcription can initiate and proceed, and how transcription is regulated to enable cells to differentiate so that organisms can properly develop and function.

Patrick Cramer

LAUREATE IN LIFE SCIENCE & MEDICINE 2023

PHOTO CREDIT: CH MUKHERJEE

‘Science has so far and in many ways opened up an exciting life journey for me.’

I was born on February 3, 1969 in Stuttgart, Germany, and grew up a little to the north of it in the countryside. When I was ten years old, I saw the TV programme "Hobbythek" with famous Jean Pütz. He carried out little chemical experiments and from then on, I started doing experiments myself. My parents have always been supportive of me and my two brothers. One Christmas they gave me a chemistry experiment kit as a present.

During my teenage years, my interest in the natural sciences expanded further. I had a great teacher, Mr Schnell, who encouraged me a lot. Also, I was a passionate guitar player, but never took many lessons.

At the end of the 1980s, I started studying chemistry, first in Stuttgart and then in Heidelberg. From the beginning, it was clear to me that I was particularly interested in biochemistry and molecular biology. But at that time, there were hardly any undergraduate programmes in that field in Germany, so you had to find your own way into it. Thanks to the Erasmus programme, I could spend time at the University of Bristol. Later, I also went to the University of Cambridge as a research student. Coming to the UK was one of the most inspiring experiences in my life: Cambridge is the birthplace of molecular biology and provided me with incredible insights and possibilities.

I received my Diploma in chemistry in 1995 at the University of Heidelberg. For my doctorate I went to the European Molecular Biology Laboratory (EMBL) in Grenoble. Although my first year was very difficult and experiments would constantly fail, I enjoyed my time in France very much. A new synchrotron had just been built at Grenoble and I was able to learn cutting-edge X-ray crystallography and could solve the three-dimensional structures of transcription factors of the so-called NF-kappaB family, which are important for organism development and the immune response. France also has a special place in my heart because my wife and I started our family here: our daughter was born in 1997.

After my doctorate in 1998, I became a postdoctoral fellow at Stanford University with Nobel Laureate Roger Kornberg. Between 1999 and 2001 I worked there on the subject that was to fascinate me for the rest of my life: The structural analysis of RNA polymerase complexes. We could determine the first structure of an eukaryotic RNA polymerase, Pol II, the central enzyme that produces messenger-RNA (mRNA) in our cells. Working with Roger and then actually being able to achieve the goal we set ourselves was a very special experience. My results were important for gaining him the Nobel Prize in Chemistry "for the structural basis of transcription" in 2006. Without the support of my wife, I would not have been able to be as productive during this intensive research period at Stanford. Our second child, our son, was born in the US; he still has an American passport.

Our next stop, for the next 13 years, was to be Munich. I took a

tenure-track professorship of biochemistry at the University of Munich (LMU) in 2001 and became Full Professor of biochemistry at the University of Munich from 2004 to 2013 as well as Director of LMU's Gene Center. Our lab developed integrated structural biology methods to determine structures of Pol II in many functional complexes. We were particularly proud to prepare the first "molecular movie" of transcription. Now we could see how a gene is transcribed, how DNA is used as a template to make mRNA. Also, we were keen on finding methods to estimate cellular rates of RNA synthesis, splicing and degradation; in other words: we were monitoring RNA metabolism.

In Munich I got more involved in science management and became Dean of the Faculty of Chemistry and Pharmacy. It is my conviction that those who have already made good progress in science have a duty to also take the time and work towards ideal conditions for the young scientists, and help the next generation to get started with their own research programmes.

In 2014, I was recruited as Director to the Max Planck Institute for Biophysical Chemistry at Göttingen. My lab resolved many mechanistic aspects of gene transcription, from initiation to elongation and transcription-coupled events such as DNA repair or RNA processing. During the Corona pandemic we focused on SARS-CoV-2 for some time and worked out the structure of the polymerase with bound RNA template and RNA product. Based on these results, we clarified the mechanisms of the polymerase-targeting antiviral drugs remdesivir and molnupiravir. In 2022, I organised the merger of two Max Planck Institutes and my "home institute" is now called Max Planck Institute for Multidisciplinary Sciences. I left it this summer to start my job as President of the Max Planck Society in Munich for the term 2023–2029.

Science has so far, and in many ways, opened up an exciting life journey for me. I have given over 600 talks, been to many places around the world and have always felt at home, thanks to inspiring people of the scientific community and beyond whom I've had the privilege to work with. I am indebted to many people: of course all the coworkers over the decades, and not least, my family. In my home village near Stuttgart, surrounded by vineyards, my curiosity was sparked to discover the world and the adventures science has to offer.

Eva Nogales

LAUREATE IN LIFE SCIENCE & MEDICINE 2023

‘Science is a large community effort. Within it, we continue to visualize complex and flexible molecular players in gene regulation.’

I was born in Colmenar Viejo, then a small town 20 miles north of Madrid. My parents, who grew up in post-civil war Spain and did not have a chance to finish even secondary school, were obsessed with giving my brother and me a college education and made any sacrifice needed to make it possible. High school was a glorious time. I loved learning, whether history, literature, science, or philosophy. Importantly, my math, biology, and physics teachers were amazing women, each with a passion for their jobs, who have been my role models till today (there were no women faculty in the department where I carried out my studies at the Universidad Autónoma de Madrid). I decided to study physics. I always loved how mathematical formulation can explain and predict natural phenomena, and the great communicator Carl Sagan also influenced that decision. From then on, I grabbed the opportunities that came my way.

I changed my scientific direction to biophysics when I met the director of the UK Synchrotron X-ray source SRS, Joan Bordas, at a summer course in Santander. Joan, a physicist who had moved into biology, was inspirational. After his talk, I asked to join his lab and a few months later (and some accelerated English courses), I moved to England. There, I studied tubulin polymerization when exposed to anti-mitotic drugs using time-resolved small angle X-ray scattering. I also started to use cryo-electron microscopy (cryo-EM), then a budding technology practiced by few. When my boyfriend (now husband) and I were considering moving to Berkeley, I was able to interview with Robert Glaeser, the father of cryo-EM. I was intimidated, but Bob was incredibly kind and helpful, as he has been for many years as my colleague and mentor at Berkeley. When I mentioned my work on tubulin, he walked me right to the office of Kenneth Downing. It was like winning the lottery. Ken was an expert in electron crystallography, a modality of cryo-EM that uses 2D crystals. Tubulin can form a 2D polymer in the presence of zinc that is both similar and distinct from the microtubule, the natural assembly of tubulin in cells. We stabilized those with Taxol, a major anti-cancer agent, and, after overcoming major technical hurdles, obtained the first structure of this critical cellular component. This success helped me land a faculty position at UC Berkeley. In my own lab I have continued to study microtubules till today.

Once at UC Berkeley, my scientific horizons quickly expanded. I was introduced to transcription by my colleague and long-time collaborator, Robert Tjian, an international leader in this field. I decided to use electron microscopy to visualize the large human transcription factor TFIID. The size, scarcity, and flexibility of this complex, which is required to determine where transcription starts and then to assemble the transcription pre-initiation complex (PIC), made structural characterization daunting. For years, our painstaking progress had to push the limits of what cryo-EM allowed at the time, but we ultimately

were able to describe the structure of TFIID and its molecular acrobatics to bind DNA and subsequently assemble the PIC. This work, started by posdocs Frank Andel and Patricia Grob, culminated with the work of three sequential graduate students: Michael Cianfrocco, Robert Louder, and Avinash Patel, all of them fearless. In parallel, we worked building up the human PIC, one step at a time in order to facilitate interpretation of our limited-resolution structures obtained before new detector and software technology revolutionized cryo-EM. This extremely challenging task, which had to be done with miniscule amounts of sample, was carried out by a truly brilliant postdoc, Yuan He. Once better technology became available, he pushed the resolution and visualized the human PIC in three sequential steps through transcription initiation. Postdoc Basil Greber later obtained an atomic model of the multifunctional component TFIIH by itself and was able to describe the conformational changes that it undergoes as it joins the rest of the PIC to open the DNA. These studies built on the heroic work of lab manager Jie Fang, who purified samples of these human complexes over the years. It was a privilege working with them and all those that have come to my lab, made their own scientific contributions, and made my professional life so enjoyable and adventurous. Many of this group of amazing scientists are now running very successful labs of their own. I am immensely thankful for all their efforts, intelligence and drive. I also would like to thank the National Institutes of Health and the Howard Medical Institute for funding our research and allowing us to take risks. And thanks to all those that lighted the path before us. Science is a large community effort. Within it, we continue to visualize complex and flexible molecular players in gene regulation.

The Shaw Prize 2023

Mathematical Sciences

PROFESSOR HÉLÈNE ESNAULT

Member of the Board of Adjudicators
Chair of the Selection Committee
for the Prize in Mathematical Sciences

Professor Hélène Esnault is a French and German mathematician working in Algebraic-Arithmetic Geometry. She studied at the École Normale Supérieure, got a PhD and a Doctorat d'État from the University Paris VII, and a Habilitation from the University of Bonn. She held a Chair at the University of Essen (1990–2012), then became an Einstein Professor at the Freie Universität Berlin, Germany until 2019. She is a part-time Professor at the University of Copenhagen and an Associate Faculty at Harvard University.

She received the Paul Doisteau–Emile Blutet Prize of the Academy of Sciences in Paris (2001), the Leibniz Prize of the German Research Council DFG (2003), an ERC Advanced Grant (2009), a Chaire d'Excellence de la Fondation Mathématique de Paris (2011), the Cantor Medal (2019), honorary Doctorate degrees of the Vietnam Academy of Sciences and Technology (2009), University of Rennes (2013), and the University of Chicago (2023). She was an invited speaker at the ICM Beijing 2002 and the ECM Krakow 2012. She was a Chern Professor at MSRI (Berkeley) (2019), a guest Professor at the Institute for Advanced Studies, Princeton (2019/20).

She is a Member of the Academies of North Rhine-Westphalia since 2005, of the German National Academy (Leopoldina) since 2008, of Berlin–Brandenburg since 2010, of the European Academy (Academia Europaea) since 2014.

Vladimir Drinfeld
Shing-Tung Yau

For their contributions
related to mathematical physics,
to arithmetic geometry,
to differential geometry and to
Kähler geometry.

Vladimir Drinfeld and Shing-Tung Yau share the 2023 Shaw Prize in Mathematical Sciences.

They share an interest in mathematical physics. Drinfeld launched with Beilinson the geometric Langlands program, which, to quote Witten, has some common features with aspects of quantum field theory, and yet stems from number theory. Yau worked on mathematical problems arising from general relativity and string theory.

Drinfeld invented at an early age the shtukas (coming from *Stück* in German, meaning "piece") in resonance with the Korteweg–de Vries equation in physics. With it, he solved the arithmetic Langlands program over a function field in rank two, for which he was awarded the Fields Medal in 1990. It was then already noticed that his solution proved at the same time a conjecture of Deligne on the existence of compatible l-adic systems in rank two. Remarkably, after the Langlands program over a function field was proven in any rank in 2002 by L Lafforgue, following Drinfeld's method, Drinfeld could extend the existence of compatible l-adic systems in any rank from function fields to higher-dimensional varieties. This complete solution to the Deligne conjecture has multiple consequences, even in complex geometry, for example to rigid local systems.

In today's p-adic Hodge theory, and in the dreamed Langlands program over a number field, it is expected that Drinfeld's shtukas should be a key concept, as suggested by Scholze's general conjectures exposed in his ICM 2018 plenary address. This is surely a future vision. Closer to us, Drinfeld's "prismatization" sheds a new light on the prismatic cohomology theory of Bhatt–Scholze, and of its coefficients.

Drinfeld's work is a pillar of arithmetic geometry. His ideas permeate the whole area. They are also at the core of the new developments.

Yau developed systematically partial differential equation methods in differential geometry. With these, he solved the Calabi conjecture, for which he was awarded the Fields Medal in 1982, the existence of Hermitian Yang–Mills connections (with Uhlenbeck), and the positive mass conjecture (with Schoen) for which they used the theory of minimal surfaces. He introduced geometric methods to important problems in general relativity, which led for example to Schoen–Yau's black-hole existence theorem and to an intrinsic definition of quasi-local mass in general relativity.

Yau's work on the existence of a Kähler–Einstein metric led to the solution to the Calabi conjecture, and to the concept of Calabi–Yau manifolds, which are cornerstones both in string theory and in complex geometry. The Strominger–Yau–Zaslow construction has had a major impact on mirror symmetry.

His work (with P Li) on heat kernel estimates and differential

Harnack inequalities has changed the analysis of geometric equations on manifolds. It has influenced the development of optimal transportation and Hamilton's work on Ricci flow.

Yau contributed to the fusion of geometry and analysis, now known as geometric analysis. His work has had a deep and lasting impact on both mathematics and theoretical physics.

Vladimir Drinfeld

LAUREATE IN
MATHEMATICAL SCIENCES 2023

‘Mathematics was a natural choice for me, and I invested as much energy as possible into studying it.’

I was born in 1954 in Kharkov (now Kharkiv, Ukraine, formerly a part of the USSR). My mother was a professor of Latin, my father a professor of mathematics. When I was a child, he saw that I had some mathematical abilities, and started teaching me mathematics; importantly, he did it in a way which was pleasurable to me.

As I grew up, I realized that I had to find a field in which I could excel. Mathematics was a natural choice for me, and I invested as much energy as possible into studying it. During 1965–1969 I attended School 27 in Kharkiv (this is a physico-mathematical school founded by N I Akhiezer, a renowned mathematician). In 1969 I took part in the International Mathematics Olympiad and won a gold medal.

During 1969–1977 I studied at the Mathematical Department of Moscow University (first as an undergraduate student and then as a graduate one). In 1971 I became a student of Yu I Manin. During 1971/72 Manin, jointly with I I Piatetskii-Shapiro, organized a seminar on modular and automorphic forms. I was strongly influenced by that seminar and by Piatetskii-Shapiro's course on automorphic forms on GL(2). Informally, Piatetskii-Shapiro became my second scientific advisor. During 1974/75 I was mentored by D Kazhdan (before he emigrated to the US).

During my student years I mostly worked on the Langlands program for function fields. My main result during this period was a proof of the global Langlands conjecture for GL(2) over a global function field. The proof used a new notion of "shtuka" and was based on the study of the moduli varieties of shtukas. Later the moduli varieties of more general shtukas were used by L Lafforgue and V Lafforgue in their works on the global Langlands conjecture for reductive groups over global function fields.

From 1978 to 1980 I worked as an assistant professor at Bashkir State University in Ufa, a city near the Ural mountains. In Ufa I met my future wife. We have a son, Andrey.

In 1980 I returned to Kharkiv. During 1981–1998 I worked there at the Institute for Low Temperature Physics and Engineering. This was a good place to do research in mathematics.

During 1980–1989 most of my research was devoted to algebraic questions of mathematical physics. One of the challenges was to understand the algebraic mechanism underlying the theory of quantum integrable systems. While studying a paper by E K Sklyanin (a student and collaborator of L D Faddeev), I realized that the key algebraic structure is that of Hopf algebra and that the Hopf algebras relevant for the theory of quantum integrable systems are neither commutative nor cocommutative. Such Hopf algebras are now often called quantum groups, and they have Poisson–Lie groups as their classical limits. It turned out that the universal enveloping algebras of semi-simple Lie

algebras (and more generally, of Kac–Moody algebras) have canonical quantizations; they were constructed independently by M Jimbo and me. These quantizations turned out to be very important for representation theory, as demonstrated later in the works of G Lusztig, M Kashiwara, and many others.

On the other hand, in the early 1980's I wrote a paper, which became a starting point of the Geometric Langlands program (a series of works by G Laumon was another starting point). The main idea of this program is as follows: given a local system E of rank n on a smooth projective curve X over any field k, one should try to construct a complex of sheaves on the stack of rank n vector bundles on X, which is related to E in a certain way. In the 1990's Beilinson and I developed such a construction in the de Rham context for a certain class of local systems assuming that k has characteristic 0; the main idea was to quantize a certain Hamiltonian integrable systems discovered by Hitchin in 1987.

In 1999 I moved with my family to the USA. Since then I have been working at the University of Chicago.

In 2012 I proved that for any smooth variety X over a finite field, the set of isomorphism classes of irreducible l-adic local systems whose determinant has finite order does not depend on the prime number l. In the case of curves, this had been deduced by L Lafforgue from the Langlands conjecture proved by him; my contribution was to deduce the general case from his result. It is still unknown whether the smoothness assumption can be replaced by normality (as conjectured by P Deligne).

Since 2018 I have been working on prismatic cohomology. This is a new cohomology theory for p-adic formal schemes introduced by B Bhatt and P Scholze and developed further by Bhatt and J Lurie.

Shing-Tung Yau

LAUREATE IN
MATHEMATICAL SCIENCES 2023

‘Among the many awards and honors I have received, the Shaw Prize is a special one, for it is from the city I grew up in and my alma mater.’

I was born in Shantou, a small town in southern China in 1949. Before long, my father Chiu Chin Yin brought the family to Hong Kong to flee the civil war, where I grew up in the farming villages in the New Territories.

My father earned his living by lecturing in several colleges simultaneously. The income was meagre and life was hard. Being a traditional scholar, he had high expectations for his children. From an early age I was taught literature and history. I was asked to recite poems and practise calligraphy regularly. This early training sparked my interest in literature and history lasting for a lifetime. My father would gather students at home to discuss various issues on Chinese and Greek philosophy. Although their discussions were far beyond my grasp, those abstract notions deeply impressed me, and had a direct bearing on my future interest in mathematics.

I went to Pui Ching Middle School, a secondary school famous for science subjects. In Grade 8 we learned Euclidean geometry. I was amazed to find that so many beautiful and ingenious results on triangles and circles can be deduced rigorously from five axioms. I indulged myself in the subject and even started my own research on it.

Life was peaceful until my father became sick and died suddenly in 1963. My family ran into financial crisis. However, due to my mother's persistence, I was able to continue my education. I was admitted to the Chung Chi College, CUHK in 1966 majoring in math. My performance in class caught the attention of Dr Stephen Salaff from Berkeley. Upon his recommendation, I was admitted to the Graduate School in UC Berkeley in 1969.

My first achievement in mathematics, carried out in my first year at Berkeley, was to extend a theorem of Preissman on negatively curved manifolds to non-positive ones. My supervisor, Professor S S Chern later suggested it to be my PhD thesis. I graduated in 1971.

In 1954, Eugene Calabi proposed to find Kähler manifolds within a Chern class. Although his motivation was purely geometric, I realized that it had important implications in general relativity. Calabi's conjecture boils down to solving a fully nonlinear partial differential equation (PDE). With much effort, I finally solved the conjecture in 1976. Subsequently, I solved the positive mass conjecture in general relativity with my student R Schoen using minimal surfaces. Mainly due to these works, I was awarded the Fields Medal in 1982.

Geometric analysis is a new branch of mathematics in which nonlinear PDE's are employed to solve problems in geometry and physics. I am considered to be one of its creators. A remarkable achievement in this area is the Ricci-flow proof of the Poincaré conjecture by R Hamilton and G Perelman in 2002. Today, geometric analysis remains as an active research area.

String theory was developed in the 1980's to unite quantum mechanics and general relativity. It turned out that the Kähler manifolds found in my resolution of the Calabi's conjecture is precisely the "universe" that physicists were looking for. The "Calabi–Yau space" has become the setting for string theory and its extension. Calabi posted his conjecture purely for its beauty in mathematics, and eventually it has found application in physics. This was a most fulfilling experience for me.

In 1990 my postdoc Brian Greene, and Ronen Plesser, discovered a way to construct a Calabi–Yau space out of a given one so that they both share a hidden kinship. This phenomenon is called "mirror symmetry". Next P Candelas et al exploited mirror symmetry to solve a century-old problem in enumerative geometry. To explain mirror symmetry, A Strominger, E Zaslow and I proposed the SYZ conjecture.

I held permanent positions at Stanford, IAS Princeton, UC San Diego, and settled at Harvard in 1987. I joined Tsinghua University full time in 2022. When I was a child, my father told me that one should do something for his own people. I have a long association with the math community in China. Several research institutes were founded through years by me in Beijing, Hangzhou, Nanjing, Hong Kong and Taipei. A most recent endeavour is the establishment of Qiuzhen College at Tsinghua where gifted high school students are admitted and trained to be leaders in mathematics and basic sciences. I am deeply indebted to the authority and Tsinghua for their enthusiastic support.

I am honored to be awarded the Shaw Prize. Among many awards and honors I have received, the Shaw Prize is a special one, for it is from the city I grew up in and my alma mater. I would like to thank my father for setting a goal of high standards for me, and my mother for showing me how to handle hardship in life. I thank my wife and my two sons for their love and support. I treasure the joy of growing up together with my siblings and childhood friends S T Chui and S Y Cheng. I am indebted to my teachers S S Chern, Charles B Morrey, Louis Nirenberg and I M Singer who taught me ways of thinking mathematics. I thank Richard Schoen, Leon Simon, Karen Uhlenbeck, Nigel Hitchin, Richard Hamilton, David Mumford, Blaine Lawson, Peter Li, Clifford Taubes, Wilfried Schmid, Simon Donaldson, Dimitris Christodoulou, Robert Bartnik, Andy Strominger and Cumrun Vafa, all of whom have influenced my work.

Organisation Preparatory Committee 2003

FIRST ROW, FROM RIGHT TO LEFT

Professor Kwok-Pui Fung Member	Head, United College, The Chinese University of Hong Kong
The late Professor Ma Lin (1924– 2017) Promoter	Chairman, Board of Trustees, Shaw College, The Chinese University of Hong Kong
Professor Chen-Ning Yang Chairman, Board of Adjudicators	
The late Mr Run Run Shaw (1907– 2014) Founder of The Shaw Prize	
Professor Yue-Man Yeung Chairman	Director, Hong Kong Institute of Asia-Pacific Studies, The Chinese University of Hong Kong
The late Mrs Mona Shaw (1934– 2017) Member	Chairperson, The Shaw Prize Foundation

TITLES OF MEMBERS WERE THEN AS OF JULY 2003

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Professor Pak-Chung Ching Member	Dean of Engineering, The Chinese University of Hong Kong
Professor Samuel Sai-Ming Sun Member	Chairman, Department of Biology, Faculty of Science, The Chinese University of Hong Kong
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Mr Charles Cheuk-Kai Cheung	
Mr Koon-Fai Chor Secretary	

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Professor James Peebles	Laureate in Astronomy
Professor Stanley Cohen	Laureate in Life Science and Medicine
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FROM RIGHT TO LEFT

Professor Peter Goldreich	Laureate in Astronomy
Professor Robert Lefkowitz	Laureate in Life Science and Medicine
The late Mr Run Run Shaw (1907–2014)	Founder of The Shaw Prize
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FROM RIGHT TO LEFT

Professor Reinhard Genzel	Laureate in Astronomy
The late Sir Ian Wilmut (1944–2023)	Laureate in Life Science and Medicine
The late Professor Keith H S Campbell (1954–2012)	Laureate in Life Science and Medicine
The late Mr Run Run Shaw (1907–2014)	Founder of The Shaw Prize
Mr Donald Tsang	The then Chief Executive of HKSAR
Professor Shinya Yamanaka	Laureate in Life Science and Medicine
The late Professor Vladimir Arnold (1937–2010)	Laureate in Mathematical Sciences
The late Professor Ludwig Faddeev (1934–2017)	Laureate in Mathematical Sciences

FROM RIGHT TO LEFT

The late Professor Frank H Shu (1943–2023)	Laureate in Astronomy
The late Professor Douglas L Coleman (1931–2014)	Laureate in Life Science and Medicine
The late Mr Run Run Shaw (1907–2014)	Founder of The Shaw Prize
Mr Donald Tsang	The then Chief Executive of HKSAR
Professor Jeffrey M Friedman	Laureate in Life Science and Medicine
Professor Simon K Donaldson	Laureate in Mathematical Sciences
Professor Clifford H Taubes	Laureate in Mathematical Sciences

FROM RIGHT TO LEFT

Professor Charles L Bennett	Laureate in Astronomy
Professor Lyman A Page Jr	Laureate in Astronomy
Professor David N Spergel	Laureate in Astronomy
The late Mr Run Run Shaw (1907–2014)	Founder of The Shaw Prize
Mr Donald Tsang	The then Chief Executive of HKSAR
Professor David Julius	Laureate in Life Science and Medicine
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FROM RIGHT TO LEFT

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Dr Gerald J Fishman	Laureate in Astronomy
Professor Jules A Hoffmann	Laureate in Life Science and Medicine
Professor Ruslan M Medzhitov	Laureate in Life Science and Medicine
The late Mr Run Run Shaw (1907–2014)	Founder of The Shaw Prize
Mr Donald Tsang	The then Chief Executive of HKSAR
Professor Bruce A Beutler	Laureate in Life Science and Medicine
Professor Demetrios Christodoulou	Laureate in Mathematical Sciences
Professor Richard S Hamilton	Laureate in Mathematical Sciences

FROM RIGHT TO LEFT

Professor Arthur L Horwich	Laureate in Life Science and Medicine
Professor Franz-Ulrich Hartl	Laureate in Life Science and Medicine
Mr C Y Leung	The then Chief Executive of HKSAR
Professor David C Jewitt	Laureate in Astronomy
Professor Jane Luu	Laureate in Astronomy
Professor Maxim Kontsevich	Laureate in Mathematical Sciences

FROM RIGHT TO LEFT

Professor Michael W Young	Laureate in Life Science and Medicine
Professor Michael Rosbash	Laureate in Life Science and Medicine
Professor Jeffery C Hall	Laureate in Life Science and Medicine
Mr C Y Leung	The then Chief Executive of HKSAR
Professor David L Donoho	Laureate in Mathematical Sciences
Professor Steven A Balbus	Laureate in Astronomy
The late Professor John F Hawley (1958–2021)	Laureate in Astronomy

FROM RIGHT TO LEFT

Professor Daniel Eisenstein	Laureate in Astronomy
Professor Shaun Cole	Laureate in Astronomy
Professor John A Peacock	Laureate in Astronomy
Mr C Y Leung	The then Chief Executive of HKSAR
Professor Kazutoshi Mori	Laureate in Life Science and Medicine
Professor Peter Walter	Laureate in Life Science and Medicine
Professor George Lusztig	Laureate in Mathematical Sciences

FROM RIGHT TO LEFT

Mr William J Borucki	Laureate in Astronomy
Professor Bonnie L Bassler	Laureate in Life Science and Medicine
Professor E Peter Greenberg	Laureate in Life Science and Medicine
Mr C Y Leung	The then Chief Executive of HKSAR
Professor Gerd Faltings	Laureate in Mathematical Sciences
Professor Henryk Iwaniec	Laureate in Mathematical Sciences

FROM RIGHT TO LEFT

Professor Kip S Thorne	Laureate in Astronomy
Professor Rainer Weiss	Laureate in Astronomy
Mr C Y Leung	The then Chief Executive of HKSAR
Professor Adrian P Bird	Laureate in Life Science and Medicine
Professor Huda Y Zoghbi	Laureate in Life Science and Medicine
Professor Nigel Hitchin	Laureate in Mathematical Sciences

REMARKS

The late Professor Ronald W P Drever (1931–2017)	Laureate in Astronomy was unable to participate in the ceremony

FROM RIGHT TO LEFT

Professor Simon D M White	Laureate in Astronomy
Professor Ronald D Vale	Laureate in Life Science and Medicine
Mrs Carrie Lam Cheng Yuet-ngor	The then Chief Executive of HKSAR
Professor János Kollár	Laureate in Mathematical Sciences
Professor Claire Voisin	Laureate in Mathematical Sciences

REMARKS

The late Professor Ian R Gibbons (1931–2018)	Laureate in Life Science and Medicine was unable to participate in the ceremony

FROM RIGHT TO LEFT

Dr Jean-Loup Puget	Laureate in Astronomy
Mrs Carrie Lam Cheng Yuet-ngor	The then Chief Executive of HKSAR
Professor Mary-Claire King	Laureate in Life Science and Medicine
Professor Luis A Caffarelli	Laureate in Mathematical Sciences

FROM RIGHT TO LEFT

Professor Edward C Stone	Laureate in Astronomy
Mrs Carrie Lam Cheng Yuet-ngor	The then Chief Executive of HKSAR
Professor Maria Jasin	Laureate in Life Science and Medicine
Dr Michel Talagrand	Laureate in Mathematical Sciences

FROM RIGHT TO LEFT

Professor Roger D Blandford	Laureate in Astronomy
Professor Gero Miesenböck	Laureate in Life Science and Medicine
Professor Peter Hegemann	Laureate in Life Science and Medicine
Professor Georg Nagel	Laureate in Life Science and Medicine
Professor Alexander Beilinson	Laureate in Mathematical Sciences
Professor David Kazhdan	Laureate in Mathematical Sciences

FROM RIGHT TO LEFT

Professor Jeff Cheeger	Laureate in Mathematical Sciences
Professor Jean-Michel Bismut	Laureate in Mathematical Sciences
Professor Scott D Emr	Laureate in Life Science and Medicine
Professor Victoria M Kaspi	Laureate in Astronomy
Professor Chryssa Kouveliotou	Laureate in Astronomy

FROM RIGHT TO LEFT

Professor Lennart Lindegren	Laureate in Astronomy
Professor Michael Perryman	Laureate in Astronomy
Dr Paul A Negulescu	Laureate in Life Science and Medicine
Professor Michael J Welsh	Laureate in Life Science and Medicine
Professor Noga Alon	Laureate in Mathematical Sciences
Professor Ehud Hrushovski	Laureate in Mathematical Sciences

The Shaw Prize Council
Founding Members

MRS MONA SHAW (1934–2017)

Mrs Mona Shaw uplifted her husband's idea of creating an award to honour and highlight international scientific achievements and together with Mr Run Run Shaw and esteemed academics, brought the concept to fruition with the founding of the Shaw Prize. Advancing the Shaw focus on education, and in the firm belief that the sharing of knowledge is key to discovery, the Prize aims to inform the world's budding scientists of major breakthroughs in diverse scientific fields, and through widely disseminated Shaw Laureate lectures, inspire them to be future trailblazers. Herself a highly respected leader in business, advancing the arts and philanthropy, Mrs Mona Shaw orchestrated the format of the annual Awards Ceremony and her remembered presence is warmly cherished.

PROFESSOR MA LIN (1924–2017)

A founding member of the Shaw Prize, Professor Ma's ideals have indelibly marked the Prize, and together with his legacy of love for the creation and application of knowledge, continue to fuel its advancement. An internationally acclaimed biochemist and gifted leader, on his watch the Chinese University of Hong Kong established the Department of Biochemistry, the Faculty of Medicine, and later the founding of Shaw College. As a scientist and educator his expertise melded well with Mr Run Run Shaw's quest to inspire scientific research and expand discovery. The founding of the Shaw Prize embodied their shared vision of societal progress through the advancement of knowledge.

PROFESSOR CHEN-NING YANG

Professor Chen-Ning Yang, an eminent physicist, was Albert Einstein Professor of Physics at the State University of New York at Stony Brook until his retirement in 1999. He has been Distinguished Professor-at-large at The Chinese University of Hong Kong since 1986 and Professor at Tsinghua University, Beijing, since 1998.

Professor Yang has received many awards: Nobel Prize in Physics (1957), Rumford Prize (1980), US National Medal of Science (1986), Benjamin Franklin Medal (1993), Bower Award (1994) and King Faisal Prize (2001). He is a Member of the Chinese Academy of Sciences, the Academia Sinica in Taiwan, the US Academy of Sciences, the Royal Society of London, the Russian Academy of Sciences and the Japan Academy.

Since receiving his PhD from the University of Chicago in 1948, he has made great impacts in both abstract theory and phenomenological analysis in modern physics.

The Shaw Prize Council

Council Members

PROFESSOR KENNETH YOUNG

Chair of the Council
Vice Chair of the Board of Adjudicators

Professor Kenneth Young is a theoretical physicist, and is Emeritus Professor of Physics at The Chinese University of Hong Kong. He pursued studies at the California Institute of Technology, USA, 1965–1972, and obtained a BS in Physics (1969) and a PhD in Physics and Mathematics (1972). He joined The Chinese University of Hong Kong in 1973, where he has held the position of Chairman, Department of Physics and later Dean, Faculty of Science, Dean of the Graduate School and Pro-Vice-Chancellor.

He was elected a Fellow of the American Physical Society in 1999 and a Member of the International Eurasian Academy of Sciences in 2004. He was also a Member of the University Grants Committee, HKSAR and Chairman of its Research Grants Council. He served as Secretary and then Vice-President of the Association of Asia Pacific Physical Societies. He is a Director of the Council of the Hong Kong Laureate Forum. His research interests include elementary particles, field theory, high energy phenomenology, dissipative systems and especially their eigenfunction representation and application to optics, gravitational waves and other open systems.

DR WAI-MAN CHAN RAYMOND

Dr Raymond Chan joined the Shaw Brothers (Hong Kong) Ltd in January 1994. He was invited to join the Preparatory Committee of the Shaw Prize in 2002. Since 2012, he has been a Member on the Board of Advisors of Sir Run Run Shaw Charitable Trust. In 2017, he was successively appointed Managing Director of the Shaw Group of Companies, Chairman of the Shaw Foundation and the Shaw Prize Foundation.

Dr Chan studied in the United Kingdom gaining BA (Hons) and B Arch (Hons) and became a Member of the Royal Institute of British Architects and Hong Kong Institute of Architects. He is also a registered architect under the Architect Registration Board in both UK and Hong Kong. In 2022, he received an Honorary Degree of Doctor of Laws from the University of Liverpool, UK.

He is on the Board of Trustee of Shaw College, The Chinese University of Hong Kong, an Honorary Trustee of Peking University and the Honorary Chairman of Board of Directors of Nanjing Medical University, PRC. Dr Chan is also a Member of the Council of the Hong Kong Laureate Forum. In June and October 2021, he was awarded an Honorary Fellowship by The Chinese University of Hong Kong and The Hong Kong University of Science and Technology respectively.

PROFESSOR WAI-YEE CHAN

Professor Wai-Yee Chan is Pro-Vice-Chancellor/Vice-President, Li Ka Shing Professor of Biomedical Sciences and Director of the Institute for Tissue Engineering and Regenerative Medicine, The Chinese University of Hong Kong (CUHK). Professor Chan obtained his BSc (First Class Honours) in Chemistry from CUHK in 1974 and PhD in Biochemistry from the University of Florida, Gainesville, Florida, USA in 1977. Prior to joining CUHK in June of 2009, he was Professor of Pediatrics, Georgetown University Medical Center, Washington, DC, and Head and Principal Investigator, Section on Developmental Genomics, Eunice Kennedy Shriver National Institute of Child Health and Human Development, National Institutes of Health, Bethesda, Maryland, USA.

His expertise is in developmental genomics and molecular genetics of endocrine disorders. He received the 1988 Merrick Award for Outstanding Biomedical Research and the 2008 Presidential Award from the Association of Chinese Geneticists in America. He serves on the editorial boards of a number of international scientific journals and on review panels of regional and international research funding agencies.

PROFESSOR
PAK-CHUNG CHING

Professor Pak-Chung Ching is Director of Shun Hing Institute of Advanced Engineering and Research Professor of Electronic Engineering of The Chinese University of Hong Kong. He received his Bachelor in Engineering (First Class Honours) and PhD from the University of Liverpool, UK, in 1977 and 1981 respectively. Professor Ching is a Fellow of IEEE, IET, HKIE and HKAES. He is Chairman of the Veterinary Surgeons Board of Hong Kong and Chairman of the Board of Directors of the Nano and Advanced Materials Institute. Professor Ching was awarded the IEEE Third Millennium Award (2000) and the Bronze Bauhinia Star (2010) and Silver Bauhinia Star (2017) of the HKSAR; he was admitted to the HKIE Hall of Fame (2010). His research interests include adaptive digital signal processing, time delay estimation and target localization, blind signal estimation and separation, automatic speech recognition, speaker identification/verification and speech synthesis, and advanced signal processing techniques for wireless communications.

PROFESSOR REINHARD GENZEL

Chair of the Board of Adjudicators

Professor Reinhard Genzel, born in 1952 in Germany, is the Director at the Max Planck Institute for Extraterrestrial Physics, Garching, Germany, Honorary Professor at the Ludwig Maximilian University, Munich since 1988 and Professor in the Graduate School, UC Berkeley since 2017.

He received his PhD from the University of Bonn in 1978. He was a Postdoctoral Fellow at Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts, an Associate Professor of Physics and Associate Research Astronomer at Space Sciences Laboratory and a Full Professor of Physics at UC Berkeley.

Professor Genzel has received many awards, including Balzan Prize (2003), Stern-Gerlach Medal (2003), Petrie Prize (2005), The Shaw Prize in Astronomy (2008), Jansky Prize (2010), Karl Schwarzschild Medal (2011), Crafoord Prize in Astronomy (2012), Tycho Brahe Prize (2012), Herschel Medal (2014), Great Cross of Merit (with Star) of Germany (2014), Harvey Prize in Science and Technology (2014) and the Bavarian Maximilian Order for Science and Art (2021). In 2020, he received the Nobel Prize in Physics, jointly with Andrea Ghez, for the discovery of a supermassive compact object at the centre of our galaxy.

PROFESSOR
YUET-WAI KAN

Professor Yuet-Wai Kan, the Louis K Diamond Professor of Hematology at the University of California, San Francisco, USA, is a world-leading expert on the use of gene and cell therapy to treat sickle cell anemia and thalassemia. Professor Kan was born in Hong Kong, graduated from the Faculty of Medicine at the University of Hong Kong and trained at Queen Mary Hospital, Hong Kong, before going to the United States for further studies.

Professor Kan's contributions to DNA diagnosis and his discovery of human DNA polymorphism have found wide application in genetics and human diseases. For his work, he has received many national and international awards including the Albert Lasker Clinical Medical Research Award, the Gairdner Foundation International Award and the Shaw Prize. He is the first Chinese elected to the Royal Society, London, and is a Member of the US National Academy of Sciences, Academia Sinica, the Third World Academy of Sciences and the Chinese Academy of Sciences. He has received honorary degrees from The University of Caglieri, Italy, The Chinese University of Hong Kong, The University of Hong Kong and The Hong Kong Metropolitan University (formerly the Open University of Hong Kong).

The Shaw Prize
Board of Adjudicators

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Professor Reinhard Genzel	Director and Scientific Member Max Planck Institute of Extraterrestrial Physics, Garching, Germany

VICE CHAIR

Professor Kenneth Young	Emeritus Professor of Physics, The Chinese University of Hong Kong, Hong Kong

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Professor Hélène Esnault	Chair of the Selection Committee in Mathematical Sciences Einstein Professor of Mathematics, Emeritus, Mathematisches Institut, Freie Universität Berlin, Germany

The Shaw Prize
Selection Committees

ASTRONOMY SELECTION COMMITTEE

Professor Gilles Chabrier	Professor, Centre de Recherche Astrophysique de Lyon, France and Professor of Astronomy, University of Exeter, UK
Professor Sandra M Faber	Professor Emerita, Department of Astronomy & Astrophysics, University of California, Santa Cruz, USA
Professor Eiichiro Komatsu	Director, Department of Physical Cosmology, Max Planck Institute for Astrophysics, Germany
Professor Elaine M Sadler	Professor of Astrophysics, School of Physics, The University of Sydney, Australia

LIFE SCIENCE AND MEDICINE SELECTION COMMITTEE

Professor Michael N Hall	Professor, Biozentrum, University of Basel, Switzerland
Professor Marina V Rodnina	Director and Scientific Member, Max Planck Institute for Multidisciplinary Sciences, Germany
Professor Joan A Steitz	Sterling Professor of Molecular Biophysics and Biochemistry, School of Medicine, Yale University, USA
Professor Marc Tessier-Lavigne	President Emeritus and Professor of Biology, Stanford University, USA
Professor Fiona M Watt	Professor of Regenerative Medicine and Director of Centre for Stem Cells & Regenerative Medicine, King's College London, UK
Professor Huda Y Zoghbi	HHMI Investigator, Professor of Pediatrics, Molecular and Human Genetics, Neurology and Neuroscience, Baylor College of Medicine, USA

MATHEMATICAL SCIENCES SELECTION COMMITTEE

Professor Gerd Faltings	Retired Director and Scientific Member, Max Planck Institute for Mathematics, Germany
Professor Takashi Kumagai	Professor, Department of Mathematics, Faculty of Science and Engineering, Waseda University, Tokyo, Japan
Professor Ngaiming Mok	Edmund and Peggy Tse Professor and Chair of Mathematics, Department of Mathematics, The University of Hong Kong, Hong Kong
Professor Horng-Tzer Yau	Merton Professor of Mathematics, Department of Mathematics, Harvard University, USA

PROFESSOR GILLES CHABRIER

Astronomy Committee

Professor Gilles Chabrier graduated in theoretical physics. He did his PhD at the International Center for Theoretical Physics, in Trieste, Italy, and in Paris. He switched to astrophysics as a postdoctoral fellow at the University of Rochester, USA. He is the Foundator and the Head of the astrophysics group of Ecole Normale Supérieure de Lyo, France, and a professor at the University of Exeter, UK.

Professor Chabrier received several national and international awards, Johann Wempe Prize (2004), Silver Medal of CNRS (2006), Grand Prix Jean Ricard of the French Physical Society (2010), Eddington Medal of the Royal Astronomical Society (2011), Grand Prix Ampère of the Académie des Sciences (2014), Fred Hoyle Medal and Prize of the Institute of Physics (IOP) (2019). He has been elected Fellow of the Institute of Physics (FInstP).

His research ranges from dense matter physics to stellar and planetary physics, star formation and galactic astronomy.

PROFESSOR SANDRA M FABER

Astronomy Committee

Professor Sandra M Faber is University Professor Emerita at the University of California Santa Cruz and a staff member of the UCO/Lick Observatory. She is an observational astronomer with research interests in cosmology and galaxy formation. Discoveries include the first structural scaling law for galaxies, large-scale flow perturbations in the expansion of the Universe, supermassive black holes at the centres of galaxies, and the first detailed description of galaxy formation based on "cold dark matter."

Professor Faber assembled the scientific case for the Keck 10 m telescopes, helped to diagnose the optical flaw in the Hubble Space Telescope, led the construction of the DEIMOS spectrograph on Keck, and co-led the CANDELS survey on Hubble, which extended our view of galaxy formation back nearly to the Big Bang.

Professor Faber received her BA degree in Physics from Swarthmore College and her PhD in Astronomy from Harvard. She is a Member of the US National Academy of Sciences, the American Academy of Arts and Sciences, and the American Philosophical Society. She serves on the boards of several organizations including the Carnegie Institution of Science, Annual Reviews, and (formerly) the Harvard Board of Overseers. She has received the Bruce Medal of the Astronomical Society of the Pacific, the Russell Prize of the American Astronomical Society, the Gruber Cosmology Prize, the Gold Medal of the Royal Astronomical Society, and the National Medal of Science from President Obama.

PHOTO CREDIT: STEVE KURTZ

PROFESSOR EIICHIRO KOMATSU

Astronomy Committee

Professor Eiichiro Komatsu uses theoretical physics and observational data to study the origin, evolution, and constituents of our Universe. He has been Director of the Department of Physical Cosmology at the Max Planck Institute for Astrophysics in Garching, Germany, since 2012. Prior to this he was a postdoctoral fellow at Princeton University and a professor in the Department of Astronomy and Director of Texas Cosmology Center at the University of Texas at Austin. He obtained his PhD from Tohoku University in Sendai, Japan, in 2001.

He is a Fellow of American Physical Society. He received awards for his work including Alfred P Sloan Fellow, the Nishinomiya-Yukawa Memorial Prize, the Gruber Cosmology Prize, the Lancelot M Berkeley Prize of the American Astronomical Society, the Chushiro Hayashi Prize of the Astronomical Society of Japan, the Breakthrough Prize in Fundamental Physics, the Inoue Prize for Science, and the Nishina Memorial Prize.

His scientific achievements include the most stringent test of the physics of the very early Universe known as “cosmic inflation”, innovative explorations of dark matter, dark energy and neutrinos in cosmology, and astrophysics of galaxy clusters.

PROFESSOR
ELAINE M SADLER

Astronomy Committee

Professor Elaine M Sadler received her PhD in Astronomy from the Australian National University and held postdoctoral positions in Germany and the USA before returning to Australia, where she is currently a Professor of Astrophysics at the University of Sydney. From 2014–18 she was Director of the ARC Centre of Excellence for Allsky Astrophysics (CAASTRO) and since 2018 she has also been affiliated with the Australia Telescope National Facility at the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia's national science agency.

Her research area is observational astronomy and astrophysics, with a particular focus on galaxy evolution, active galaxies, stellar populations and transient objects. Much of her research is based on the analysis of data from large-area optical and radio surveys, and she has designed and carried out several major radio surveys of the southern sky. She regularly serves on national and international advisory committees, and is actively involved in planning for next-generation telescopes and facilities.

Professor Sadler was elected to the Australian Academy of Science in 2010 and served as the Academy's Foreign Secretary from 2018 to 2022.

PROFESSOR MICHAEL N HALL

Life Science and
Medicine Committee

Professor Michael N Hall received his PhD from Harvard University and was a postdoctoral fellow at the Pasteur Institute, France, and the University of California, San Francisco. He joined the Biozentrum of the University of Basel, Switzerland, in 1987 where he is currently Professor and former Chair of Biochemistry. Professor Hall is a pioneer in the fields of TOR signaling and cell growth control. In 1991, Professor Hall and colleagues discovered TOR (Target of Rapamycin) and subsequently elucidated its role as a central controller of cell growth and metabolism. The discovery of TOR led to a fundamental change in how one thinks of cell growth. It is not a spontaneous process that just happens when building blocks (nutrients) are available, but rather a highly regulated, plastic process controlled by TOR-dependent signaling pathways. As a central controller of cell growth and metabolism, TOR plays a key role in development, aging, and disease. Professor Hall is a Member of the US National Academy of Sciences and has received numerous awards, including the Breakthrough Prize in Life Sciences (2014) and the Albert Lasker Award for Basic Medical Research (2017).

PROFESSOR
MARINA V RODNINA

Life Science and
Medicine Committee

Professor Marina V Rodnina is the Director and Scientific Member at the Max Planck Institute for Multidisciplinary Sciences in Goettingen, Germany. Her research focuses on the function of the ribosome as a macromolecular machine. Her group pioneered the use of kinetic and fluorescence methods in conjunction with quantitative biochemistry to solve the mechanisms of translation. Her current interests focus on the dynamics of the ribosome and translation factors, and the mechanisms of translational recoding and co-translational protein folding.

Professor Rodnina is a Member of the German Academy of Sciences Leopoldina, Academia Europaea, US National Academy of Sciences, and the European Molecular Biology Organization. She received the Hans Neurath Award of the Protein Society in 2015, the Gottfried Wilhelm Leibniz Prize in 2016, the Otto Warburg Medal in 2019, and the Albrecht Kossel Prize in 2020. She is a holder of an ERC Advanced Investigator Grant 2018.

PROFESSOR JOAN A STEITZ

Life Science and Medicine Committee

Professor Joan A Steitz earned her BS in chemistry from Antioch College in 1963. Significant findings from her work emerged as early as 1967, when her Harvard PhD thesis with Jim Watson examined the test-tube assembly of a ribonucleic acid (RNA) bacteriophage (antibacterial virus) known as R17.

Professor Steitz spent the next three years in postdoctoral studies at the Medical Research Council Laboratory of Molecular Biology in Cambridge, England, where she used early methods for determining the biochemical sequence of RNA to study how ribosomes know where to initiate protein synthesis on bacterial mRNAs. In 1970, she was appointed assistant professor of Molecular Biophysics and Biochemistry at Yale, becoming full professor in 1978. At Yale, she established a laboratory dedicated to the study of RNA structure and function. In 1979, Steitz and her colleagues described a group of cellular particles called small nuclear ribonucleoproteins (snRNPs), a breakthrough in understanding how RNA is spliced. Subsequently, her laboratory has defined the structures and functions of other noncoding RNPs, such as those that guide the modification of ribosomal RNAs, microRNAs and several produced by transforming herpesviruses.

Professor Steitz, a former investigator of the Howard Hughes Medical Institute, is a member of the American Academy of Arts and Sciences, National Academy of Sciences, Institute of Medicine, and the Royal Society of London. Her many honors include: National Medal of Science (1986); RNA Society Lifetime Achievement Award (2004); Gairdner Foundation International Award (2006); Lasker-Koshland Special Achievement Award in Medical Science (2018); and 21 honorary degrees.

PROFESSOR MARC TESSIER-LAVIGNE

Life Science and
Medicine Committee

Professor Marc Tessier-Lavigne is President Emeritus and Professor of Biology at Stanford University and was the university's 11th president (2016–2023). He returned to Stanford, where he had been a faculty member, after serving as president of The Rockefeller University in New York. He also previously held a faculty position at the University of California, San Francisco, and executive positions at biotechnology company Genentech.

Professor Tessier-L avigne has been a leader in understanding the mechanisms that direct the wiring up of the brain during embryonic development. He has also helped elucidate mechanisms of neurodegeneration. He is the recipient of numerous scientific awards, including the 2020 Gruber Neuroscience Prize, and has been elected to multiple learned societies, including the US National Academy of Sciences, the National Academy of Medicine, the American Academy of Arts and Sciences and the American Philosophical Society. In 2020 he was named an Officer of the Order of Canada.

PHOTO CREDIT: LINDA A CICERO, STANFORD NEWS SERVICE

PROFESSOR FIONA M WATT

Life Science and Medicine Committee

Professor Fiona M Watt obtained her first degree from Cambridge University and her DPhil, in cell biology, from the University of Oxford. She was a postdoc at MIT, where she first began studying differentiation and tissue organisation in mammalian epidermis. She established her first research group at the Kennedy Institute for Rheumatology in London and then spent 20 years at the CRUK London Research Institute. She helped to establish the CRUK Cambridge Research Institute and the Wellcome Trust Centre for Stem Cell Research and in 2012 she moved to King's College London to found the Centre for Stem Cells and Regenerative Medicine. From 2018 to 2022 she was on secondment as Executive Chair of the UK Medical Research Council. She is currently EMBO Director.

Professor Watt has received numerous awards and honours. She is a Fellow of the UK Royal Society and Academy of Medical Sciences, a Member of the European Molecular Biology Organisation and an International Member of the US National Academy of Sciences.

PROFESSOR HUDA Y ZOGHBI

Life Science and
Medicine Committee

Professor Huda Y Zoghbi is the Ralph D Feigin Professor of Pediatrics at Baylor College of Medicine, where she is also Professor of Molecular and Human Genetics, Neurology and Neuroscience. She has been an Investigator with the Howard Hughes Medical Institute since 1996. She is also the Founding Director of the Jan and Dan Duncan Neurological Research Institute at Texas Children's Hospital.

Professor Zoghbi's interest is in understanding healthy brain development as well as what goes awry in specific neurological conditions. She has published seminal work on the cause and pathogenesis of Rett syndrome and late-onset neurodegenerative diseases, and has trained many scientists and physician-scientists. In 2000 she was elected to the Institute of Medicine, and in 2004 she was elected to the US National Academy of Sciences. Among Professor Zoghbi's recent honours are the Shaw Prize, the Breakthrough Prize, Canada's Gairdner Prize, the Brain Prize and the Kavli Prize.

PROFESSOR GERD FALTINGS

Mathematical Sciences Committee

Professor Gerd Faltings was Director and Scientific Member at the Max Planck Institute for Mathematics in Bonn, Germany from 1994 to 2022. He studied mathematics and physics at the University of Münster and obtained his PhD in Mathematics there in 1978. He then spent a year doing postdoctoral work as a Research Fellow at Harvard University. He held faculty positions at the University of Münster, Wuppertal University and Princeton University.

His research interests lie at Commutative algebra, arithmetics geometry, p-adic Hodge theory, vector bundles on curves.

Professor Faltings has received many prizes, including the Fields Medal (1986), Guggenheim Fellowship (1988), Leibniz Preis (1996), von Staudt Preis (2008), Gumin Preis (2010), King Faisal Prize (2014), The Shaw Prize (2015) and the Cantor Medal (2017). He is a Member of the Academies in Berlin, Duesseldorf, Goettingen, Halle (Leopoldina), European Academy, Foreign Associate of the Royal Society of London and the US National Academy of Sciences.

PROFESSOR TAKASHI KUMAGAI

Mathematical Sciences Committee

Professor Takashi Kumagai is a Japanese mathematician, currently a professor at the Department of Mathematics, Faculty of Science and Engineering, Waseda University, Tokyo, Japan. He received his PhD from Kyoto University in 1994. After working at Osaka University, Nagoya University and Kyoto University, he accepted a position at Waseda University in 2022.

Kumagai's research focuses on probability theory. In particular, he has been working in the field of stochastic processes and analysis on disordered media such as fractals, and he has obtained anomalous properties of the heat transfer on the media. He was an invited speaker at the 2014 ICM in Seoul, and gave a Medallion Lecture at the Conference on Stochastic Processes and their Applications in Moscow in 2017. His awards include the Spring Prize of the Mathematical Society of Japan (2004), JSPS Prize (2012), Inoue Prize for Science (2017), and Humboldt Research Award (2017).

PROFESSOR NAGIMING MOK

Mathematical Sciences Committee

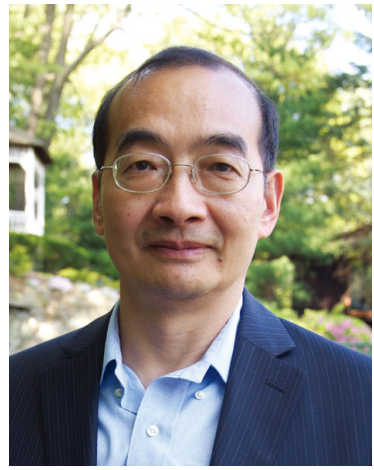
Professor Ngaiming Mok obtained his MA from Yale University and his PhD from Stanford University, and started his career at Princeton University. He then taught at Columbia University and Université de Paris-Sud, Orsay, and had been Full Professor at both universities, before taking up a Chaired Professorship at the University of Hong Kong (HKU) in 1994. Currently he is the Edmund and Peggy Tse Professor in Mathematics, Chair of Mathematics and Director of the Institute of Mathematical Research of HKU.

Professor Mok is a world-renowned mathematician dedicated to solving analytic and geometric problems on the interface of complex analysis, differential geometry, algebraic geometry and number theory. He has served on the editorial board of *Inventiones Mathematicae* and on the Fields Medal Committee in the International Congress of Mathematicians.

Professor Mok's outstanding achievements have earned him many international honours including the Sloan Fellowship, the Presidential Young Investigator Award of the US, the Croucher Senior Fellowship Award of Hong Kong, the State Natural Science Award (Class II) of China and the Bergman Prize of the American Mathematical Society. He was elected Academician of the Chinese Academy of Sciences in 2015, and Fellow of the Hong Kong Academy of Sciences in 2017. In 2022 Professor Mok was recipient of the Future Science Prize in Mathematics and Computer Science, and the Tan Kah Kee Science Award in Mathematics and Physics of the Chinese Academy of Sciences.

PROFESSOR HORNG-TZER YAU

Mathematical Sciences Committee



Professor Horng-Tzer Yau is currently the Merton Professor of Mathematics at Harvard University. He received his BS in Mathematics from Taiwan University and PhD in Mathematical Physics from Princeton University (1987). Before joining Harvard University, he was a faculty member at New York University and Stanford University. In 2013–2014, he was a distinguished visiting professor at the Institute for Advanced Study in Princeton.

Professor Yau worked on a wide range of problems in mathematical physics and probability theory. The topics include quantum many-body systems, quantum dynamics, interacting particle systems and random matrix theory.

He delivered the Marston Morse Lecture at the Institute for Advanced Study in 2022. Professor Yau received various honours, including the Packard Fellowship (1991), MacArthur Fellowship (2000), Henri Poincare Prize (2000), Simons Investigator Award (2012), and American Mathematical Society Eisenbud Prize (2017). He is a member of the Academia Sinica and the US National Academy of Sciences.

The Shaw Prize 2023
Award Presentation Presenters

MS ASTRID CHAN

Project Producer and Corporate Trainer

Ms Astrid Chan is a highly accomplished professional with a remarkable 30-year career in the performing arts industry. She has excelled as a versatile performer, corporate trainer, and emcee for prominent events.

Her hosting expertise spans diverse occasions such as the "New Year's Eve Countdown", "Miss Chinese International Pageant" and the opening ceremony of the "Hong Kong Palace Museum". She has also showcased her acting talent in classic dramas like "Healing Hands" and "When Heaven Burns".

In 2016, Ms Chan received the prestigious "Outstanding Women Award" in recognition of her remarkable achievements.

MR LEON KO

Theatre and Film Composer

Mr Leon Ko received a Richard Rodgers Development Award in the US for his musical "Heading East", as well as an ASCAP screen award for the movie "Monster Hunt 2". His musical "Takeaway" premiered in London in 2011. In Hong Kong, he won ten awards for his stage musicals, the latest one being "The Impossible Trial". Mr. Ko was the musical director of Jacky Cheung's world tour of "Snow, Wolf, Lake". His film music has garnered him a Golden Horse Award in Taiwan and two Hong Kong Film Awards. Mr Ko launched "Time In A Bottle" in 2010, showcasing the artistry of vintage perfume bottles in the context of theatre.

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Celebrating the work of
Matthew Bailes,
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Maura McLaughlin
in Astronomy,
Patrick Cramer
and Eva Nogales in
Life Science and Medicine,
Vladimir Drinfeld
and Shing-Tung Yau in
Mathematical Sciences

THE SHAW PRIZE 邵逸夫獎

20th Anniversary