

THE
SHAW
PRIZE
邵逸夫獎

Life science & Medicine

Astronomy

Mathematical Sciences

THE SHAW PRIZE 2022
AWARD CEREMONY

The Shaw Prize

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 civilization.

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

Founder of The Shaw Prize

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



Mr Run Run Shaw
(1907 – 2014)

for knowledge is key to sustaining the advancement of civilization, and strengthened his belief that scientists focussed on unmasking the mysteries of nature are pivotal to the well-being of mankind. He decided to use his influence, and with the unfailing support of his wife Mrs Mona Shaw, established The Shaw Prize to inspire and recognize 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

I am delighted to congratulate this year's Shaw Laureates on their momentous contributions to academic development, as well as scientific research and applications.

This year, six brilliant individuals, each of them a trailblazer in their own right, are being honoured for their pioneering work in astronomy, life science and medicine, and mathematical sciences. They are defined as much by their abiding passion to conquer the unknown as by their singular focus to enrich every aspect of human existence. Their discoveries have lifted the veil on the universe and opened our eyes to new and exciting possibilities.

Over the past two decades, the Shaw Prize has established itself as one of the most prestigious international awards celebrating and recognising scientific accomplishments. I am pleased to see the Shaw Prize Foundation continue to build its reputation as a herald and patron of scientific endeavour and advancement. Motivated by the same beliefs that underpin the Foundation's exemplary work, the government is equally devoted to promoting scientific research and nurturing young scientists who can serve the long-term development needs not only of Hong Kong, but



**The Honourable
John KC Lee**

also of the Guangdong–Hong Kong–Macao Greater Bay Area as well as the nation as a whole.

Only by pushing the frontiers of science can we bring about true progress and innovation. I am confident that the 2022 Shaw Laureates will continue to do that and expand our horizons far beyond the boundaries of our imagination.

A handwritten signature in black ink, appearing to read 'John KC Lee', written on a white background.

John KC LEE
Chief Executive
Hong Kong Special Administrative Region

Message from the Chair of the Board of Adjudicators

Welcome to the nineteenth 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. Unfortunately travel restrictions during the pandemic again forced this year's Shaw Prize presentations to be a virtual ceremony.

This year, we honour six scientists in the three designated fields for their distinguished contributions. They are Professors Lennart Lindegren and Michael Perryman in Astronomy, Professor Michael J Welsh and Dr Paul A Negulescu in Life Science and Medicine, and Professors Noga Alon and Ehud Hrushovski in Mathematical Sciences. In the name of the Shaw Council and the three respective Selection Committees I would like to convey our warmest congratulations to all laureates for their fantastic achievements.

A handwritten signature in black ink that reads "Reinhard Genzel". The signature is written in a cursive, flowing style.

Reinhard Genzel
Chair, Board of Adjudicators
Shaw Prize 2022

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, the medal shows the award category and year, the name of the laureate, and in the upper right corner, an imprint of a saying due to Xun Zi (313 – 238 BCE), a thinker in the Warring States period of Chinese history: “制天命而用之”, meaning “Grasp the law of nature and make use of it”.

PROGRAMME

(Virtual Ceremony – 29 September 2022)

Music Performance by Hong Kong Philharmonic Orchestra

Welcome Speech by

Professor Reinhard Genzel

Member of the Council

Chair of the Board of Adjudicators, The Shaw Prize

Congratulatory Speech by

The Honourable John KC Lee

The Chief Executive of HKSAR

Dialogue with

Professor Scott D Tremaine

Member of the Board of Adjudicators

Chair of the Selection Committee for

the Prize in Astronomy

Speech by

Professor Lennart Lindegren

Laureate in Astronomy

Speech by

Professor Michael Perryman

Laureate in Astronomy

Dialogue with
Professor Bonnie L Bassler
Member of the Board of Adjudicators
Chair of the Selection Committee for
the Prize in Life Science and Medicine

Speech by
Dr Paul A Negulescu
Laureate in Life Science and Medicine

Speech by
Professor Michael J Welsh
Laureate in Life Science and Medicine

Dialogue with
Professor H el ene Esnault
Member of the Board of Adjudicators
Chair of the Selection Committee for
the Prize in Mathematical Sciences

Speech by
Professor Noga Alon
Laureate in Mathematical Sciences

Speech by
Professor Ehud Hrushovski
Laureate in Mathematical Sciences

Closing Performance by Hong Kong Philharmonic Orchestra



**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.

The Prize in Astronomy 2022

Lennart Lindegren

and

Michael Perryman

**for their lifetime contributions to
space astrometry, and in particular for
their role in the conception and design of
the European Space Agency's
Hipparcos and Gaia missions.**

An Essay on the Prize in Astronomy 2022

Astrometry, the first scientific discipline, is the measurement of the positions and motions of planets and stars. The early naked-eye star catalogues of Ptolemy (ca. 100–170 CE), Ulugh Beg (1394–1449), and Tycho Brahe (1546–1601) were supplanted in the last two centuries by telescopic catalogues of ever-increasing size and accuracy. However, by the late twentieth century, astrometry from ground-based optical telescopes encountered insurmountable barriers to further improvements, arising from atmospheric distortions, thermal and gravitational distortions of the telescopes, and the difficulties of stitching together data from telescopes in different continents.

The concepts of precision space astrometry date back to the 1960s, and these were first realized with the launch of the European Space Agency's Hipparcos mission in 1989. Hipparcos measured the positions and motions of over 100,000 stars with accuracies 100 times better than ground-based observatories. By measuring small variations in stellar positions as the Earth traveled around its orbit (parallax), Hipparcos also determined distances to over 20,000 stars with uncertainties of less than 10%.

The successor to Hipparcos was the Gaia mission, launched in 2013 and planned to operate at least until 2025. Gaia is based on the same design principles as Hipparcos but has vastly greater capabilities. It has measured 10,000 times as many stars as the Hipparcos catalogue, and the positions and motions of these stars are measured 100 times more accurately. Gaia can measure changes in the position of stars on the sky as small as the width of a human hair in Beijing as viewed from Hong Kong. This remarkable performance is achieved by a unique architecture consisting of two telescopes pointing in very different directions, whose images are combined on a single detector. The telescope spins once every six hours, and sends back to Earth precise measurements of the times at which the stars cross a fixed point on the detector.

Accurate astrometry provides fundamental data — positions, velocities, and distances — that underpin almost every aspect of modern astronomy and astrophysics. Parallax-based distances are used to calibrate all distances in astronomy and thus are the foundation for measuring the size of the Universe. Accurate distances to stars allow us to measure their intrinsic luminosities, and this in turn is a sensitive probe of their internal physical processes, such as crystallization in the interior of degenerate stars. Measurements of the velocities of stars allow us to infer their Galactic orbits, which in turn provide insight into the formation history of the Milky Way and the

distribution of the mysterious dark matter within it. Gaia has measured irregularities in the distribution of stars in the Galactic disk that may reflect recent disturbances from surviving satellite galaxies or unseen clumps of dark matter. Gaia measurements have allowed us to determine for the first time the orbits of hundreds of distant star clusters and dwarf galaxies.

Gaia will eventually provide a rich harvest of ancillary astronomical results, including an all-sky survey of the brightnesses and colours of a billion stars; Doppler-shift based velocities of many millions of stars; light curves for hundreds of thousands of variable stars; thousands of newly discovered extrasolar planets; a survey of asteroids and other small Solar System bodies with unprecedented detail; a uniform catalogue of hundreds of thousands of distant quasars; and stringent new tests of Einstein's theory of gravity.

The study of the preliminary catalogues released by the Gaia project, all of which are in the public domain, has already transformed many areas of astronomical understanding, and even richer, larger and more accurate catalogues will be produced before the mission is completed in a few years. Gaia is providing a survey of our Galaxy that will not be surpassed in quantity or quality for decades to come.

Hipparcos and Gaia succeeded because of the sustained collective effort of hundreds of researchers, managers and engineers over the past half century. The 2022 Shaw Prize in Astronomy recognizes two of these individuals for their lifetime contributions to space astrometry, and in particular for their key scientific contributions to these two missions. Lennart Lindegren originated many of the concepts of the Hipparcos mission design and led one of the two independent teams that carried out the data analysis for Hipparcos. He was a member of the Hipparcos science team for two decades and the Gaia science team for two decades after that. Michael Perryman was Project Scientist for Hipparcos from 1981 to 1997, Chair of the Hipparcos Science Team for the same period, and lead author on the 1997 paper describing the Hipparcos catalogue. Perryman was also Project Scientist for the Gaia mission from 1995 to 2008, Chair of the Gaia Science Advisory Group from 1995 to 2000, and Chair of the Gaia Science Team from 2001 to 2008. Lindegren and Perryman proposed the concept for Gaia in the 1990s and were instrumental in its scientific and technical design.

Lennart Lindegren

Laureate in Astronomy



I was born 1950 in Svalöv, a small rural village in the south of Sweden. My parents owned a shop selling stationery, newspapers, toys, and similar. My father was also a portrait photographer and I spent many hours watching him at work in the darkroom. At the age of seven my fascination with space and astronomy was sparked by the news of Sputnik 1, the first artificial satellite, being launched into space. I read everything I could find about space. With my older sister I often spent summer holidays at our grandparents' summer house. My grandfather was a highly skilled craftsman who taught me to use various hand tools. I still enjoy working with my hands, designing and constructing things.

As a teenager my reading interests broadened and I discovered classical music, one of the great passions in my life. But I still spent many late evenings in our backyard observing the planets with a small telescope and hunting for Messier objects, or experimenting with astrophotography.

In 1969 I began studies in mathematics and physics at Lund University. My plan at that point was to become a meteorologist. However, a short optional course in astronomy, given by staff from Lund Observatory, changed my mind. From 1972 to this day I have been associated to Lund Observatory, that is the astronomy department at Lund University. I received my PhD in astronomy in 1980, became a research associate the same year, senior lecturer in 1987, and professor in 2000. Between 1998 and 2004 I was the director of Lund Observatory. I retired in 2017 but am currently employed part-time by the university.

My career in astrometry was inspired by the hundred-year-old Repsold meridian circle at Lund Observatory, which fascinated me from the moment I first saw it. I declared to my professor, Tord Elvius, that I wanted to work with astrometry for my PhD. From today's perspective of strictly regulated postgraduate education, it seems remarkable that such a quaint choice of subject could be approved. The Lund meridian circle had not been used for decades, no-one at the department was actively working in the area, and the whole subject of (optical) astrometry was generally considered old-fashioned and unpromising. A few of my seniors did try to involve me in more fashionable projects, including ultraviolet observations of active galactic nuclei and solar spectroscopy, but none of these seemed very satisfactory to me. In my spare time I tinkered with the old meridian circle, hoping to get it in working order, or at least to better understand the beauty of its design.

At this point my career might have taken a very different direction, had it not

been for an unlikely coincidence in time and place. The Danish astronomer Erik Høg had just returned to his native country after 15 years at the Hamburg Observatory, where he had developed a new technique for meridian observations, photon-counting astrometry. Working at Copenhagen University Observatory, within 100 km of Lund, he was therefore a world-leading expert in precisely the field that I had just chosen for my thesis! Meetings were arranged, and Erik became my de facto PhD supervisor, colleague, and friend. In 1976 he introduced me to the Hipparcos project and the following year I joined him as a member of the space astrometry study team set up by the European Space Agency (ESA). I contributed numerous, mostly unpublished studies of different aspects of the Hipparcos mission, including the optics, scanning law, accuracy estimates, and scientific data processing. The mission was adopted by ESA in 1980, after which I became a member of the new Hipparcos Science Team. This was chaired by the newly-appointed Project Scientist, Michael Perryman.

In parallel with this I completed my PhD thesis in early 1980. It consists of a heterogeneous collection of papers dealing with meridian observations of major planets, atmospheric limitations of narrow-field astrometry, a comparison of methods for precise image location, and the detection and measurement of double stars with an astrometry satellite. The subjects reflect my reorientation towards space astrometry a few years earlier.

The appointment of Michael Perryman as the scientific leader of the pioneering space astrometry project was the beginning of an intense development phase. An increasing number of people across Europe were involved. Over a period of 16 years Michael skilfully navigated us through many difficulties right up to the triumphant conclusion of the project in 1997.

Already by 1993 it was clear that Hipparcos was going to be a great success. Proposals were submitted to ESA for more ambitious astrometry missions, taking advantage of the much more efficient CCD detectors. This eventually became the Gaia project, approved by ESA in 2000 and launched in 2013. From the very beginning of the project I took part in its development as a member of various study teams and by writing technical notes on various issues, in particular related to the astrometric data analysis and astrometric accuracy. During much of this time I collaborated closely with Michael Perryman.

It must be a great satisfaction for any scientist to be able to follow a long and complicated project from its early conception to roaring success. I have had the privilege to follow and work with two immensely successful space astrometry missions, and for this I am extremely grateful.

Michael Perryman Laureate in Astronomy



I was born in Luton in 1954 and, after my parents moved to Norfolk when I was nine years old, educated at King Edward VII school in King's Lynn. I started out on my scientific career with a mother passionate about education, and an inspiring school teacher excited by the beauty of mathematics. I studied mathematics and theoretical physics at Cambridge University between 1973–1976, and received my doctorate from the Cavendish Laboratory, Cambridge University, in 1979, on the subject of the cosmological evolution of extragalactic radio sources.

I joined the European Space Agency (ESA), in The Netherlands, as a research fellow in 1980. A year later, at the age of just 26, I was appointed as Project Scientist for the recently-adopted Hipparcos space astrometry mission, which I subsequently headed as lead scientist between 1981–1997. Leiden, a beautiful city in The Netherlands, would be the home for me and my family — my wonderful wife Julia and our three sons Thomas, James and Richard — for the next 30 years!

Astrometry was a new field for ESA. My work involved overall coordination of the scientific aspects of the satellite design, manufacture and testing, assisting with the parallel preparation of the input catalogue and overall data analysis, and chairing the Hipparcos Science Team. Like all space missions, Hipparcos presented a continuous series of difficult challenges, tackled in collaboration with a wonderful and highly motivated team of scientific colleagues across Europe, project managers in ESA, and talented engineers in European industry. After its launch in 1989, the satellite failed to reach its target geostationary orbit, and I also took over the overall mission management with the numerous associated recovery operations. It was a tense, difficult and protracted period. But, executed by independent data analysis teams, the project eventually recovered all and more of its original scientific objectives, thereby validating the concepts and principles underpinning space astrometry. One of the many high points was our presentation of the final Hipparcos star catalogue to the international scientific community at a major conference in Venice in 1997.

In 1993, together with Lennart Lindegren, I jointly proposed a more ambitious astrometry mission to take advantage of technological advances such as CCDs, large lightweight ceramic mirrors and structures, and micro-Newton gas thrusters. This built on earlier ideas put forward by Erik Høg and Lennart Lindegren. The

mission was approved by ESA's Science Programme Committee in 2000. I was the scientific leader of the Gaia project from its inception until shortly before the Critical Design Review in 2008, establishing the payload concept, its technical feasibility, its operational and data analysis principles, its organization structure, and coordinating its enormous scientific case. This all led to its successful launch in 2013, just one year after the date targeted at the time of its adoption in 2000.

Now eight years into its operational lifetime, Gaia is generating progressively improved catalogues of more than two billion stars in our Galaxy, leading to an exquisitely detailed portrait of our Galaxy and its formation, with impacts on all branches of astronomy and astrophysics. Amongst its expected scientific impacts, I have been a proponent of the discovery potential for exoplanets with Gaia, predicting that many thousands could be detected by the end of this decade. What is of enormous satisfaction to me today is reading the very large numbers of scientific papers that are being published based on the Gaia survey, and admiring their ingenuity, their breadth, and the huge scientific advances that they represent. Gaia is, today, regarded as a revolution in astronomy, and I am delighted to have played my part in its success.

In parallel with my duties in ESA, I held a position as Professor of Astronomy at Leiden University from 1993 to 2009. Post ESA, in 2010, I held a joint position at Heidelberg University and the Max Planck Institute for Astronomy, spending a wonderful year in Heidelberg, where I worked on the first edition of my "Exoplanet Handbook". Since 2012, I have been adjunct professor at University College Dublin. In other memorable and stimulating appointments and scientific interludes, I was Bohdan Paczynski visiting professor at Princeton University in 2013; holder of the Källén Seminar for Breakthrough Discoveries, University of Lund (Sweden) in 2014; visiting fellow at the Kiepenheuer Institute for Solar Physics, Freiburg (Germany) in 2016, and visiting scientist at the Instituto Astrofísica Andalucía (IAA), Granada in 2017. I was most fortunate that my wife, Julia, could join me on all of these adventures.

I am of course most grateful to the Shaw Prize Foundation for their recognition of my contributions to space astrometry, which I am delighted to share with my long-term colleague Lennart Lindegren. And let me also stress the self-evident: that the major scientific advances gained by Hipparcos and Gaia could only have come about through the dedicated and outstanding contributions of many others — scientists, managers, and engineers — over very many years.



**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 Sciences 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 prioritizes the nation's research and educational activities in science, math and engineering.

The Prize in Life Science and Medicine 2022

Paul A Negulescu

and

Michael J Welsh

**for landmark discoveries of the molecular,
biochemical, and functional defects underlying
cystic fibrosis and the identification and development
of medicines that reverse those defects and can treat
most people affected by this disorder.
Together, these discoveries and medicines are
alleviating human suffering and saving lives.**

An Essay on the Prize in Life Science and Medicine 2022

The Shaw Prize in Life Science and Medicine 2022 is awarded in equal shares to Paul A Negulescu and Michael J Welsh for landmark discoveries of the molecular, biochemical, and functional defects underlying cystic fibrosis and the identification and development of medicines that reverse those defects and can treat most people affected by this disorder. Together, these discoveries and medicines are alleviating human suffering and saving lives.

Cystic fibrosis (CF) is one of the most common, severe single-gene disorders, affecting more than 80,000 people globally. The single gene in which the disease-causing mutations fall is called *CFTR* (cystic fibrosis transmembrane conductance regulator). The CFTR protein ensures the proper flow of chloride, a component of salt, that is present in secreted body fluids such as sweat, saliva and mucus. These fluids keep cells lubricated and are thus vital for the proper function of organs. In CF patients, these secretions become thick and sticky and, rather than acting as lubricants, clog passageways, especially in the lungs. The disease is fatal. There are many different mutations in *CFTR* that cause the disease, but a mutation called F508del is particularly important, and is present in about 90% of patients.

Lap-Chee Tsui pinpointed chromosome 7 as harbouring the “CF” gene in 1985. Four years later, in a landmark use of positional cloning for human genetic analysis, Lap-Chee Tsui, Francis Collins, and colleagues cloned the *CFTR* gene and reported that alterations in the protein caused cystic fibrosis. However, the function of the CFTR protein, how mutations affect its function, and whether that knowledge would enable therapeutic development, remained unknown.

Michael Welsh, working at the University of Iowa, broke through all three obstacles. He first discovered, in 1990/1991, that the CFTR protein is a chloride channel and he revealed how its activity can be regulated. He corrected the CF defect in cultured cells by providing a normal *CFTR* gene, thereby showing that correcting the defect was a feasible therapeutic strategy. The most obvious way of achieving this, i.e., by gene therapy (delivery of a functional gene), has unfortunately been unsuccessful to date. Instead, therapeutic development was enabled by additional extraordinary studies (1992–1993) by Welsh. He demonstrated how different CF disease-causing mutations affect the CFTR protein — some eliminated its production, some interfered with its trafficking to the cell membrane, and some prevented the opening or function of its chloride-transporting channel. He showed that the severity of the defects of the CFTR proteins in assays he designed in the laboratory correlated with the severity of the CF disease each caused. Welsh categorized the different human CF mutations according to mechanism and laid out a scheme to correct each type of underlying defect. Importantly, Welsh showed that the CFTR protein with

the common F508del mutation has multiple defects, the protein does not reach the cell membrane and is also defective for chloride transport. In a seminal contribution, Welsh discovered that trafficking of CFTR-F580del to the membrane was temperature sensitive. That is, at low temperature, the protein made it to the cell membrane, but at body temperature, it became stalled in an internal cellular compartment, and it did not reach its final, normal location, the cell membrane. Very crucially, Welsh demonstrated that if the CFTR-F508del protein did make it to the membrane, it functioned. That landmark discovery meant that if a strategy could be developed to get CFTR-F508del to the cell membrane, it would be beneficial in combating the disease.

Welsh's discoveries and his mechanistic insight provided the needed groundwork for Shaw Prize laureate Paul Negulescu to make the leap from mechanism to therapy. Efforts to treat CF with gene therapies had been attempted and failed. Negulescu and his team at Vertex Pharmaceuticals took on the challenge of developing small molecule therapeutics. Doing so was an enormously risky strategy because mutations that cause CF disease are loss-of-function, and so expecting a protein to be "fixed" by the action of small molecule is not standard. Moreover, there are many different mutations that cause disease, so it was not obvious a medicine could be made that is capable of treating many CF patients. Negulescu first discovered a CFTR "potentiator" that stimulated CFTR channel function. This medicine, called Kalydeco, was granted breakthrough designation as a monotherapy for CF. The medicine received regulatory approval exclusively based on laboratory data, not on clinical trial data, a first and a watershed moment for the path to modern clinical development of medicines for rare diseases.

Still, there was a significant hurdle. Kalydeco was useful only for the subset of CF patients with certain rare mutations, not for the vast majority of CF patients with the *CFTR*-F508del mutation. In an even bolder effort, Negulescu then screened for molecules that could correct the trafficking defect of the CFTR-F508del protein. Remarkably, he discovered such a molecule, a "protein-corrector". He combined the new molecule with Kalydeco, now named Orkambi. He then improved on Orkambi twice more, combining two "protein correctors" with a "potentiator" to make Trikafta, approved in 2019. Trikafta helps patients with the *CFTR*-F508del mutation and patients with 177 rare *CFTR* mutations. Currently, 50% of all CF patients take Vertex CF medicines. The FDA described Vertex's CFTR modulators as "unique" and "groundbreaking".

The combined contributions of Welsh and Negulescu represent the complete biomedical arc from basic discovery to application to the saving of lives. They are especially worthy of the Shaw Prize in Life Science and Medicine.

Paul A Negulescu

Laureate in Life Science and Medicine



I was born and raised in San Francisco, California. My parents immigrated to California from Romania following World War II. My father was a general surgeon who loved his work. Mom spoke four languages perfectly and took care of the business side of dad's medical practice. Mom and dad liked to go to auctions and bring back old furniture, which dad would restore beautifully. I inherited a love of reading from my mom and an interest in learning how things worked and fixing them from my dad.

My parents took great interest in the education of my brother and me. Mom insisted we take Latin, which I did not appreciate at first, but later realized it was foundational for my understanding of language and western culture. When I was about six years old, my parents built a house into a hillside with views of the city, the bay and bridges. Perhaps because of these experiences I wanted to be an archeologist or an architect as a child. I have happy memories of growing up in San Francisco.

After high school I attended the University of California at Berkeley and was preparing to graduate with a degree in History. A turning point occurred in my third year when I enrolled in a Physiology class taught by a new faculty member named Roger Tsien. Roger was a brilliant scientist and teacher (and future Nobel Prize Laureate), and his explanation of how the human body worked fascinated me. Roger would have a great influence on my development and career. I obtained degrees in both History and Physiology and applied to graduate school in Physiology.

As a graduate student at Berkeley I studied epithelial cell physiology in Terry Machen's lab which prepared me for later work in cystic fibrosis. Terry was very collaborative with other faculty, including Roger, who would generously provide samples of fluorescent indicators he had designed and access to cell imaging equipment that he developed for my studies of cell ion transport.

As a post-doc in Mike Cahalan's lab at UC Irvine, I tried learning patch-clamp electrophysiology, but did not have the delicate touch needed for this technique. I continued using fluorescent dyes and imaging methods to study cell biology. I met my wife Debbie while at Irvine and I started to look for a job. I planned to accept a faculty position at the University of Connecticut when Roger contacted me unexpectedly to ask me to join a new Company he was forming to industrialize

cell-based assays for pharmaceutical drug discovery. My experience with Roger's dyes gave me faith in the concept and I was drawn to applied research. I moved to San Diego and joined Aurora Biosciences as the 5th employee in 1996, while Debbie completed her graduate work at UC.

Joining a start-up provided a quick education. We had collaborations with many companies, developing assays for different targets in many diseases. I learned about deadlines, and drug discovery and managing more than myself. One approach at Aurora was to use voltage sensing dyes in cells that Roger had invented with Tito Gonzalez to screen chemical libraries for modulators of ion channel targets. Bob Beall, President of the Cystic Fibrosis Foundation (CFF) heard about this and approached us to screen for CFTR modulators to treat cystic fibrosis. In 2000, we proposed a 5-year research project to discover CFTR corrector and potentiators which Bob and the CFF accepted following diligence. Bob was very intense but supportive throughout our collaboration, which extended to over more than a decade. He was a model for me of a focused and demanding, but fair, executive.

When Vertex acquired Aurora in 2001, I was responsible for transitioning Aurora's research to Vertex and we continued both the CF project and a project to inhibit sodium channels to treat pain. In 2003 I was given the opportunity to lead the Vertex research site in San Diego and to build a wonderful team including Fred Van Goor, Sabine Hadida and Peter Grootenhuis and so many others. Although it took us about 5 years to identify the first CFTR modulator, we learned many lessons together and we continued to work together to apply these lessons to each subsequent modulator, resulting in four approved medicines. Drug discovery failures are more common than successes, and I realize how rare it is to lead a team for so long and to contribute to a project from the very beginning to a tangible result.

Looking back on my life and career, I feel fortunate to have been supported by family and teachers early on, and then by teams and organizations to contribute to a positive health outcome for many people with CF. I am grateful to all of those who supported me throughout my life and who shared this journey with me, including talented teammates at Aurora and Vertex, members of the CF community and my family.

Michael J Welsh

Laureate in Life Science and Medicine



I grew up in the rolling hills of rural Iowa, and my parents were the most important influence in shaping my life. They worked hard; after returning wounded from World War II, my father worked in a foundry during the day and a bakery at night, and my mother tended a large garden, canned vegetables and fruit, made my clothes, and raised four children. My parents taught me that I was no better than anyone else and to respect all people.

As a boy, I did chores and milked the cow morning and night. My elementary school had two classrooms; mine was the largest class with five students. My only other scheduled activity was weekly Red Cross swimming lessons during the summer. This gave me the time and freedom to play, read, and pursue my imagination.

I had no specific career goal when I entered college, so I sampled and enjoyed literature, philosophy, ethics, languages, and science. In retrospect, this broad exposure provided a foundation that has enriched my personal and professional life. Although I had no real knowledge of medicine, with time I decided to become a physician for the simple reason that I thought it was a job worth doing. I was heavily influenced by President John Kennedy's exhortation to go beyond oneself and contribute to society.

It was in medical school and internship and residency at Iowa that I had my first taste of research. My attendings were physician-scientists who were caring for patients and also working in the lab, Drs Jack Hoak, Qais Al-Awqati, Don Heistad, and Frank Abboud. I was drawn to the intellectual challenge, problem solving, and goal of improving our patient's lives. These mentors gave me my first experiences in research, and I loved it. I knew this would be my life's work after further training at the University of California San Francisco and the University of Texas Houston. I returned to the University of Iowa as an Assistant Professor seeing patients and setting up my research lab.

I reveled in the joy of discovery. It was thrilling to pore over new data. Understanding something for the first time often filled me with a sense of peace, and then set me to dreaming about the implications and thinking about the next important question and how we might answer it.

Two factors drove my focus on cystic fibrosis (CF). First, I cared for people with CF on the wards. I knew what we could do for them, and importantly, what we could not do — we desperately needed treatments to halt the progressive lung destruction. Second, my research began with curiosity about how salt and water moved across the epithelial sheets lining the lung's airways. When Dr Paul

Quinton found that CF sweat glands were impermeable to chloride, I increasingly focused on elucidating mechanisms by which respiratory epithelia transport chloride. We discovered that CF airway epithelia lack a chloride permeability in their apical membrane, helping establish defective chloride conductance as a unifying abnormality in CF.

In 1989, Drs Lap-Chee Tsui, Francis Collins, and their colleagues identified the gene that is mutated in CF: *CFTR*. I remember the Sunday afternoon when my post-doc came out to my house showing me that she had CFTR protein on a gel. The next day I went to my department chairman, Dr Frank Abboud, telling him that I needed to take a sabbatical. He asked when, and I said “today”, and when he asked where, I said “my lab”. My pulmonary colleagues stepped in, covering my clinical responsibilities in the Intensive Care Unit, freeing me to focus full time on the research.

Thus began what was for me an extremely exciting series of discoveries. We tried to focus on the most important problem and construct the simplest, cleanest hypotheses. Although the questions were simple, we were adapting novel tools and techniques that had been developed for other purposes. We pushed forward, driven by the thrill of discovery and the strong belief that our research would provide the foundation, the enabling approaches, and the roadmap for developing medicines that would change the lives of people suffering from CF. I commend and thank the co-recipient of the Shaw Prize, Dr Paul Negulescu, and his colleagues for their development of those highly effective medicines.

Our progress was always a team effort. I was incredibly fortunate to work with a fantastic group of students, post-docs, staff, and faculty. Dr Alan Smith and his colleagues at Genzyme were splendid collaborators. Our patients with CF inspired us and participated in many of our studies. The University of Iowa provided an exceptional environment for physician-scientists, and Howard Hughes Medical Institute, National Institutes of Health, and Cystic Fibrosis Foundation funding gave us the freedom to pursue problems no matter what direction they took.

I have been fortunate to have married two amazing women. I met Ruth as a college student. We had a wonderful life and raised three children. I am enormously proud of the people they have become. Ruth died 16 years ago from cancer. Nine years ago I met Anne, and luckily, I convinced her to marry me and move to Iowa. None of my research advances would have been possible without the love and support of my family.

I am thankful for the rare privilege to see within a lifetime a field move from the clinic where I cared for young people coughing and struggling to breathe, through an understanding of the responsible cellular and molecular mechanisms, and then back to the clinic with medicines that dramatically improve their lives.



**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.

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) and of the University of Rennes (2013). 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 (IAS, 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.

The Prize in Mathematical Sciences 2022

Noga Alon
and
Ehud Hrushovski

**for their remarkable contributions to
discrete mathematics and model theory
with interaction notably with algebraic geometry,
topology and computer sciences.**

An Essay on the Prize in Mathematical Sciences 2022

Historians consider mathematics as one of the oldest branches of science, if not of all human intellectual activities. They date tally numbers back to 23,000 BCE. Several systems of numerals were developed by the Romans, the Indians, the Chinese, the Mesopotamians ... till we adopted the Hindu–Arabic numeral system in the 14th century. The numbers $\{1, 2, \dots\}$ are part of our everyday life. A collection of objects is called *countable* if we can count it as $\{1, 2, \dots\}$. *Discrete mathematics* is the part of mathematics which studies properties that can be *counted*, in opposition to *continuous mathematics* which studies continuous or differentiable functions on spaces, which was initiated by Leibniz and Newton in the 17th century. These days we often associate discrete mathematics with codes and computer science, e.g., in relation with breaking the German codes in WWII, or more recently in the development of smart phones.

Noga Alon has made profound contributions to discrete mathematics with notable applications to *theoretical computer science*. Remarkably, some of his results also interact with *algebraic geometry*, which started in the 4th century BCE with the Greeks drawing in the sand the different shapes of conics, the intersections of cones with planes, and with *algebraic topology*, which started with Euler realising in the 18th century that a walk through the city of Königsberg that crosses each of its seven bridges once and only once is impossible. We mention two of Alon's many results, but his output also touches other domains such as graph theory, probability theory, and complexity theory.

The *Nullstellensatz* in algebraic geometry, due to Hilbert at the end of the 19th century, describes all polynomial functions that vanish on the zero set of finitely many polynomial functions. It is perhaps the most foundational result in algebraic geometry. Alon's 1999 *combinatorial Nullstellensatz* studies the special case in which the zero set consists of a large box. He is then able to control precisely several invariants attached to Hilbert's solutions. This ingenious formulation has led to powerful results in extremal combinatorics, graph theory, additive number theory and combinatorial geometry.

Helly's theorem at the beginning of the 20th century shows that given an infinite family of compact *convex sets* in the d -dimensional Euclidean space, their intersection is non-empty if all intersections of $d + 1$ among them is non-empty. It is one of the core theorems in convex set theory. The 1957 Hadwiger–Debrunner (p, q) -problem, solved in 1992 by Alon and Kleitman, concerns a difficult generalisation of this theorem where instead one assumes that amongst any p of the sets there are q with a non-empty intersection. The solution was a tour de force and required the development of tools that found additional applications in discrete and computational geometry.

Mathematical logic is the branch of mathematics which is arguably the closest to philosophy. Through the work of Gödel and Gentzen among others, it developed at the beginning of the 20th century the foundations of various areas of mathematics and

shaped their axiomatisation. Within it, *model theory*, starting in the 1950s with the work of Tarski, studies the formal language which underlies a mathematical structure.

Ehud Hrushovski has made profound contributions to model theory with applications to a broad list of topics in algebraic geometry and group theory, as well as in combinatorics and number theory. Among Hrushovski's whole output we mention two results that touch the first two areas mentioned.

The study of Euler's proof on the Königsberg bridges led to the concept of a *topology* on a space as the data of closed sets with certain properties. It goes back to Cauchy in the 18th century and Gauss in the 19th century. The intuition comes from the Euclidean space in which we live, where it is possible to separate points by small neighbourhoods, a property eventually singled out by Hausdorff in the first half of the 20th century. Zariski, at approximately the same time, defined a much coarser topology on algebraic spaces simply by declaring that the zero-sets of polynomial functions are the closed sets. For this topology, nowadays called the *Zariski topology*, the separation property does not hold. Hrushovski and Zilber in 1993 characterised the Zariski topology through a collection of combinatorial and elementary properties based on the notion of dimension. Remarkably, this new vision of algebraic geometry enabled Hrushovski to prove the Mordell–Lang conjecture in positive characteristic: on algebraic spaces defined by polynomial functions with coefficients in generalised Galois congruence fields, and on which it makes sense to add points, one can characterise the subspaces on which it still makes sense to add points.

The notion of a *group*, due to Galois in the first half of the 19th century, is central in all branches of mathematics. It describes the symmetries of a mathematical object. It is a key concept in Galois theory equating the theory of field extensions with the one of their group of symmetries. Group theory is one of the most studied areas in mathematics, for example finite groups, topological groups, algebraic groups, among them linear groups etc. The subsets of a group which respect the symmetries are called subgroups. *Approximate subgroups* are those subsets which miss by very little (in a precise way) the symmetry property. They were defined and studied in additive combinatorics, a new branch of combinatorics, starting in 2012. Hrushovski drew parallels between those approximate subgroups and certain structures in model theory which enabled him to solve a conjecture of Green on the structure of certain approximate subgroups. These results played a crucial role in the proof of a fundamental theorem of Breuillard, Green and Tao on the structure of approximate groups.

Noga Alon and Ehud Hrushovski have made remarkable contributions to discrete mathematics and model theory with interactions with algebraic geometry, topology and computer science. The methods they developed have become the basis of many further developments in the areas of mathematics that they have profoundly shaped.

Noga Alon

Laureate in Mathematical Sciences



I was born in Haifa, Israel in 1956 and studied, together with my older brother Zvika, at the Reali School there. I participated in competitive sports during high school, reaching some regional competitions in high jump, long jump and shot put with modest success, never reaching a national level. I have been more successful in Mathematics. In elementary school, I had already been interested in mathematical puzzles, and I was fascinated by the beauty and elegance of the subject. Reali has been one of the leading schools in the country, and we had an unusual teacher of mathematics in my final years there. His name was Yakov Kaplan, and he came as an immigrant from Ukraine where he had written several textbooks for high school students. Kaplan gave extra classes covering advanced material for interested students, and I participated enthusiastically. This surely helped me win first place in the two main mathematics competitions for high school students we had in Israel at that time: the Mathematics Youth Olympics at the Weizmann Institute and the Grossman Contest in Mathematics at the Technion. During my last year in high school I met Paul Erdős, the legendary Hungarian mathematician who used to visit Israel often, and a question in extremal graph theory he suggested to me in one of these meetings, together with its natural extensions, later became the subject of my first paper and of my Master thesis.

In 1974 I started my compulsory military service. After a year of service I joined the academic reserve and started my BSc studies in Mathematics at the Technion, graduating in 1979. Returning to the army, I served in Intelligence as a research officer. During service I completed my MSc in Mathematics at Tel Aviv University, and my PhD focusing on discrete mathematics at the Hebrew University of Jerusalem under the supervision of Micha Perles. After graduation I spent two years at MIT, hosted by Daniel Kleitman who later became one of my close collaborators. At MIT I kept working in combinatorics but also spent considerable efforts in applications of tools and techniques from the area to theoretical computer science. In 1985 I returned to Israel and joined the School of Mathematical Sciences at Tel Aviv University. During 1989–1990 I spent a sabbatical at IBM Almaden, and in 1993 I accepted an offer from Bombieri to become a long term visitor at the Institute for Advanced Study in Princeton and help organize there a programme in Discrete Mathematics and Theoretical Computer Science. As part of this programme, which is now led by my long-time

friend and collaborator Avi Wigderson, I kept visiting the Institute multiple times as a visiting professor until 2016. Additional universities and research institutes in which I have spent extended periods of time include: Harvard, Bell Laboratories, Bellcore and Microsoft Research (Redmond and Israel). I also served as the head of the School of Mathematical Sciences in Tel Aviv University between 1999 and 2001. In 2018 I moved to Princeton University as a Professor of Mathematics and a member of the programme of Computational and Applied Mathematics.

The main topics I investigated over the years are the following.

- The development of spectral techniques in the study of expander graphs and their applications, establishing discrete analogues of results in differential geometry.
- The foundation, with Matias and Szegedy, of the now active area of streaming algorithms, trying to characterize the properties of a stream of data that can be measured efficiently under space constraints.
- The proof of a discrete variant of Hilbert's Nullstellensatz and its applications in the study of problems in Additive Number Theory, Graph Theory and Combinatorics.
- The solution, with Kleitman, of the Hadwiger Debrunner (p, q) problem raised in 1957, which extends the classical theorem of Helly.
- The solution of a problem of Shannon raised in 1956 about the zero-error capacity of a disjoint union of independent channels.
- The application of probabilistic methods in the study of extremal problems in combinatorics, graph theory and Ramsey theory and in the design of randomized algorithms and the investigation of questions in property testing.

I have been lucky to collaborate with a large number of excellent researchers including many of my superb graduate students, and I wish to thank all of them. I owe much of my success to my students and collaborators and hope to continue collaborating and working on the fascinating aspects of discrete mathematics and its applications for many years to come.

I am married to Nurit, whom I first met in kindergarten when I was 5 years old, and we have three daughters: Nilli, Natalie and Narkis. It is a special pleasure to thank them for their love and support.

Ehud Hrushovski Laureate in Mathematical Sciences



Photo © The Royal Society (CC BY 4.0)

I grew up in West Jerusalem, not a large town in the 1960s, and sharply bordered in space and in time. My mother was a psychologist, my father a theoretician of literature. The apartment was full of books, almost all in languages I could not read; works of literature or the human sciences. In retrospect, I can remember some very meaningful contacts with mathematics in those early years; but I was not conscious of this pattern at the time. Certainly, it did not occur to me that mathematics may exist as a profession.

I finished high school at seventeen; this gave me a year before the compulsory three-year Israeli army service. Influenced by my father, I was excited about the prospects for a theory of the understanding of natural language, for elucidating the mystery of metaphors. I applied to study Mathematics and Philosophy at Oxford, thinking of the mathematical part as merely a sensible preparation. But at Oxford I was overwhelmed by the newness and beauty of the mathematical edifice I was beginning to glimpse. When I went back to school in Berkeley in 1980, I knew it was mathematics that I wanted to study.

As I write this, my youthful dreams about language and metaphor seem far away. But perhaps I did not stray infinitely far! If one had to say today what single category is most closely associated with model theory, the reply would surely be theories in first-order languages, with interpretations — exhibiting hidden similarities of structure — as their connecting morphisms.

In 1982, I began working towards a PhD at Berkeley; Leo Harrington became my supervisor. I completed it in 1985/86 as an exchange student in Paris. Saharon Shelah had recently completed his search for the “main gap”, drawing robust dividing lines of order and disorder among first order theories; I made contributions to the stable part, showing in particular that many theoretical phenomena were governed by definable groups. I spent the next three years in Rutgers and Princeton, deeply influenced by Gregory Cherlin. Totally categorical theories formed the innermost region of Shelah’s classification; there, Zilber had shown that certain specific mathematical theories, originating in linear algebra over a finite field, have a relation to the whole that is not simply illustrative but formative: in some sense they generate that class, and even the simplest general properties cannot be understood without this recognition.

Cherlin had given another proof of Zilber’s theorem, relating it to the newly achieved classification of the finite simple groups into finitely many families. But Zilber’s theorem corresponded to only two of these. Cherlin and I later extended the entire theory of total

categoricity to a class representing all families of simple groups over a given finite field. Stability had seemed the indispensable bedrock for Shelah's theory; only on that basis could one define the deeper notions of regular types, orthogonality, domination, and further concepts of geometric stability. And yet here it turned out that the upper stories of this house could be transferred intact to an unstable setting, with entirely different, group-theoretic derivations of their basic properties. This was to me a revelation, later multiply confirmed, not only about the specific subject but about the nature of mathematics.

Zilber further conjectured that within a wider class of theories, algebraic geometry plays a similarly fundamental role. Since my days in Berkeley and Paris, this conjecture fascinated me; there was nothing I wanted to prove more. But at some point I began to suspect it may not be true, and constructed a counterexample. The dimension-governed method that I used found many applications; a recent one by David Evans resolved a basic question in structural Ramsey theory.

In 1990 I took up my first tenure-track position in MIT, and later alternated between MIT and the Hebrew University in Jerusalem. I met Zilber, who was eventually able to leave the Soviet Union. Together, we proved his conjecture under additional topological assumptions. I used this to show it held true in the world of ordinary differential equations, in any characteristic. That in turn led to the solution of the Mordell–Lang conjecture for function fields; a purely algebro-geometric proof, by Roessler, came twenty years later. It was extraordinary to see to what extent model theory predicts the landscape of algebraic ODE's, starting with nothing more than the Leibniz rule.

I moved fully to Jerusalem around 1994. I married Merav there, and our son David was born in 2005. I engaged in studies of these ideas within a number of theories related to geometry: valued fields, in three extended collaborations with Haskell and Macpherson, Kazhdan and Loeser; difference equations, in many papers with Zoé Chatzidakis, as well as one showing that the Frobenius automorphism of arithmetic geometry holds a critical place in the wide theory; definable measures in NIP theories, with Peterzil and Pillay, and later in general. Each of these turned out to have meaningful applications within the field under study. A very long range project with Itay Ben Yaacov attempts to incorporate global aspects of geometry.

In 2016 we moved to Oxford. I often teach Maths and Philosophy students, closing a circle with my first year of university. Recently, I have again been working on questions of fundamental model theory, rather than a specific theory, but they too have applications to approximate subgroups and approximate lattices.

Organization

Preparatory Committee (Until July 2003)

Front row, from right to left

Professor Kwok-Pui Fung (Member)

Head, United College, The Chinese University of Hong Kong

The late Professor Ma Lin (Promoter) (1924–2017)

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 (Founder of The Shaw Prize) (1907–2014)

Professor Yue-Man Yeung (Chairman)

Director, Hong Kong Institute of Asia-Pacific Studies,

The Chinese University of Hong Kong

The late Mrs Mona Shaw (Member) (1934–2017)

Chairperson, The Shaw Prize Foundation

Back row, from right to left

Mr Raymond Wai-Man Chan (Member)

Director, Shaw Movie City Hong Kong Limited

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

Professor Kwok-Kan Tam (Member)

Department of English, Faculty of Arts, The Chinese University of Hong Kong

Professor Sunny Kai-Sun Kwong (Member)

Associate Professor, Department of Economics, Faculty of Social Sciences,

The Chinese University of Hong Kong

Mr Charles Cheuk-Kai Cheung

Mr Koon-Fai Chor (Secretary)



Remarks: Titles of Members were then as of July 2003.

The Shaw Prize 2004

From right to left

The late Sir Richard Doll (1912–2005)
Laureate in Life Science and Medicine

Professor James Peebles
Laureate in Astronomy

Professor Stanley Cohen
Laureate in Life Science and Medicine

The late Mr Run Run Shaw (1907–2014)
Founder of The Shaw Prize

Mr Chee-Hwa Tung
The then Chief Executive of HKSAR

Professor Herbert W Boyer
Laureate in Life Science and Medicine

Professor Yuet-Wai Kan
Laureate in Life Science and Medicine

The late Professor Shiing-Shen Chern (1911–2004)
Laureate in Mathematical Sciences



The Shaw Prize 2005

From right to left

Professor Michel Mayor
Laureate in Astronomy

Professor Geoffrey Marcy
Laureate in Astronomy

The late Mr Run Run Shaw (1907–2014)
Founder of The Shaw Prize

Mr Rafael Hui
The then Acting Chief Executive of HKSAR

The late Sir Michael Berridge (1938–2020)
Laureate in Life Science and Medicine

Professor Andrew Wiles
Laureate in Mathematical Sciences



The Shaw Prize 2006

From right to left

Professor Brian Schmidt
Laureate in Astronomy

Professor Adam Riess
Laureate in Astronomy

Professor Saul Perlmutter
Laureate in Astronomy

Mr Donald Tsang
The then Chief Executive of HKSAR

The late Mr Run Run Shaw (1907–2014)
Founder of The Shaw Prize

Professor Xiaodong Wang
Laureate in Life Science and Medicine

Professor David Mumford
Laureate in Mathematical Sciences

The late Professor Wentsun Wu (1919–2017)
Laureate in Mathematical Sciences



The Shaw Prize 2007

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

Mr Henry Tang
The then Acting Chief Executive of HKSAR

Professor Robert Langlands
Laureate in Mathematical Sciences

Professor Richard Taylor
Laureate in Mathematical Sciences



The Shaw Prize 2008

From right to left

Professor Reinhard Genzel
Laureate in Astronomy

Sir Ian Wilmut
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



The Shaw Prize 2009

From right to left

Professor Frank H Shu
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



The Shaw Prize 2010

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

The late Professor Jean Bourgain (1954–2018)
Laureate in Mathematical Sciences



The Shaw Prize 2011

From right to left

Dr Enrico Costa
Laureate in Astronomy

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



SHAW PRIZE

The Shaw Prize 2012

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



The Shaw Prize 2013

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 HK SAR

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



The Shaw Prize 2014

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



The Shaw Prize 2015

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



The Shaw Prize 2016

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



The Shaw Prize 2017

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



The Shaw Prize 2018

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



The Shaw Prize 2019

From right to left

Professor Edward C Stone
Laureate in Astronomy

Mrs Carrie Lam Cheng Yuet-ngor
The then Chief Executive of HK SAR

Professor Maria Jasin
Laureate in Life Science and Medicine

Dr Michel Talagrand
Laureate in Mathematical Sciences



The Shaw Prize 2020 (Virtual)

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



SHAW PRIZE

The Shaw Prize 2021 (Virtual)

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



The Shaw Prize Council

Founding Members

Mrs Mona Shaw

Professor Ma Lin

Professor Chen-Ning Yang

Founding Member



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.

Founding Member



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.

Founding Member



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)

Dr Wai-Man Chan, Raymond

Professor Wai-Yee Chan

Professor Pak-Chung Ching

Professor Reinhard Genzel

Professor Yuet-Wai Kan

Council Member (Chair)



**Professor
Kenneth Young**

*(also 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.

Council Member



Dr
Wai-Man Chan,
Raymond

Dr Raymond Chan joined the Shaw Group in January 1994 and in December 2017, assumed the role of Managing Director of the Shaw Group of Companies, totalling fifty-four and situated locally and overseas. He was at the same time appointed Chairman of the Shaw Foundation and the Shaw Prize Foundation. Since 2012, he has been a Member on the Board of Advisors of Sir Run Run Shaw Charitable Trust.

Born and educated in Hong Kong, he continued his studies 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 has received an Honorary Degree of Doctor of Laws from the University of Liverpool, UK, in 2022. He is also a registered architect under the Architect Registration Board in both UK and Hong Kong.

He is a Member of the Board of Trustees of Shaw College, The Chinese University of Hong Kong and an Honorary Trustee of Peking University and the Honorary Chairman of Board of Directors of Nanjing Medical University, People's Republic of China. Dr Chan is also a Director of the Council of the Hong Kong Laureate Forum. From 2003 to 2016 he served as a Member of the Governing Committee of Tseung Kwan O Hospital. 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.

Council Member



**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), Hong Kong. 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.

Council Member



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.

Council Member



**Professor
Reinhard Genzel**

*(also Chair of
the Board of Adjudicators)*

Professor Reinhard Genzel, born in 1952 in Germany, is the Director and Scientific Member 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 (1978–1980), an Associate Professor of Physics and Associate Research Astronomer at Space Sciences Laboratory (1981–1985) and a Full Professor of Physics at UC Berkeley (1985–1986).

Professor Genzel has received many awards, including Newton Lacy Pierce Prize (1986), Leibniz Prize (1990), Janssen Prize (2000), Balzan Prize (2003), Stern-Gerlach Medal (2003), Petrie Prize (2005), The Shaw Prize in Astronomy (2008), Jansky Prize (2010), Honorary Doctorate University of Leiden (2010), Karl Schwarzschild Medal (2011), Crafoord Prize in Astronomy (2012) and Tycho Brahe Prize (2012), Herschel Medal (2014), Great Cross of Merit (with Star) of Germany (2014), Honorary Doctorate (Dr.h.c.), Paris Observatory OPSPM (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.

He is a Member of the European Academy of Sciences, the German Academy of Natural Sciences Leopoldina, the Bavarian Academy of Sciences, the Pontifical Academy of Sciences and the Order Pour Le Merite for Science and Arts of the Republic of Germany. He is also a Foreign Member/Foreign Corresponding Member/Associate of the Academy of Sciences of France, the US National Academy of Sciences, the Royal Spanish Academy, and the Royal Society of London.

Council Member



**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 Cagliari, 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).

Board of Adjudicators

Chair

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*

Members

Professor Scott D Tremaine

Chair of the Selection Committee in Astronomy

Professor

University of Toronto

Canada

and

Institute for Advanced Study, Princeton

USA

Professor Bonnie L Bassler

Chair of the Selection Committee in Life Science and Medicine

HHMI Investigator and

Squibb Professor and Chair

Department of Molecular Biology

Princeton University

USA

Professor Hélène Esnault

Chair of the Selection Committee in Mathematical Sciences

Einstein Professor of Mathematics

Mathematisches Institut

Freie Universität Berlin

Germany

Members of Selection Committees

Astronomy

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 Luis C Ho

*Director, Kavli Institute for Astronomy and Astrophysics and
University Chair Professor, Peking University, PRC*

Professor Elaine M Sadler

*Professor of Astrophysics, School of Physics,
The University of Sydney, Australia*

Life Science and Medicine

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 Marc Tessier-Lavigne

President and Bing Presidential Professor, Stanford University, USA

Professor Xiaodong Wang

*Director and Investigator, National Institute of Biological Sciences,
Beijing, PRC*

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

Professor Luigi Ambrosio

Full Professor, Scuola Normale Superiore, Pisa, Italy

Professor Gerd Faltings

*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 Karen K Uhlenbeck

*Professor Emerita, Department of Mathematics,
College of Natural Sciences, The University of Texas at Austin, USA*

Selection Committee Member



**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 Founder and the Head of the astrophysics group of Ecole Normale Supérieure de Lyon (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.

Selection Committee Member



**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, super-massive 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)

Selection Committee Member



**Professor
Luis C Ho**

Astronomy Committee

Professor Luis C Ho studied physics and astronomy as an undergraduate at Harvard University and obtained his PhD in Astronomy from the University of California, Berkeley. He was Staff Astronomer for 15 years at the Observatories of the Carnegie Institution for Science, before moving to China to serve as the Director of the Kavli Institute for Astronomy and Astrophysics and University Chair Professor at Peking University. He serves on numerous national and international advisory committees, and has been actively involved in helping to develop astronomy throughout China and East Asia, including the planning of current and future large telescopes and instruments.

Professor Ho's research uses a range of observational techniques to investigate the physics of active galaxies, massive black holes, black hole-galaxy coevolution, galaxy structure, extragalactic star formation, and the interstellar medium.

Selection Committee Member



**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 All-sky 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 2018 to 2022.

Selection Committee Member



**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).

Selection Committee Member



**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.

Selection Committee Member



**Professor
Marc Tessier-Lavigne**

*Life Science and
Medicine Committee*

Professor Marc Tessier-Lavigne became Stanford University's 11th president in 2016, where he is also the Bing Presidential Professor. 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-Lavigne 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)

Selection Committee Member



**Professor
Xiaodong Wang**

*Life Science and
Medicine Committee*

Professor Xiaodong Wang was born in Wuhan, China in 1963. He received his BS in Biology from Beijing Normal University in July, 1984 and his PhD in Biochemistry from the University of Texas Southwestern Medical Center in May, 1991.

Professor Wang has served as the Director and Investigator of the National Institute of Biological Sciences, Beijing, since 2010. Previously, he was a Howard Hughes Medical Institute Investigator from 1997 to 2010 and held the position of the George L MacGregor Distinguished Chair Professor in Biomedical Sciences at the University of Texas Southwestern Medical Center in Dallas, Texas from 2001 to 2010. He has been a Member of the US National Academy of Sciences since 2004 and a Foreign Associate of the Chinese Academy of Sciences since 2013.

Selection Committee Member



**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.

Selection Committee Member



**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.

Selection Committee Member



**Professor
Luigi Ambrosio**

*Mathematical Sciences
Committee*

Professor Luigi Ambrosio is presently Full Professor and Director of the Scuola Normale Superiore in Pisa, Italy. Born in 1963, he studied at the Scuola Normale and at the University of Pisa under the direction of Ennio De Giorgi. His research interests moved gradually from Calculus of Variations and Geometric Measure Theory, with basic contributions to the theory of BV functions and the theory of currents, to Optimal Transport and Probability. He is the author of more than 200 papers, many text and research books and the scientific advisor of many brilliant mathematicians worldwide. He has been sectional speaker at the ICM in Beijing and, more recently, plenary speaker at the ICM in Rio de Janeiro. He is currently Member of the Executive Committee of the IMU.

Selection Committee Member



**Professor
Gerd Faltings**

*Mathematical Sciences
Committee*

Professor Gerd Faltings is Director and Scientific Member at the Max Planck Institute for Mathematics in Bonn, Germany since 1994. 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.

Selection Committee Member



**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).

Selection Committee Member



**Professor
Karen K Uhlenbeck**

*Mathematical Sciences
Committee*

Professor Karen K Uhlenbeck received her BS in Mathematics from the University of Michigan in 1964, and her PhD from Brandeis University in 1968 under the direction of R S Palais. She held post doctoral and faculty positions at MIT, the University of California, Berkeley, the University of Illinois in both Champaign-Urbana and in Chicago and the University of Chicago. Most of her career from 1987–2014 was spent at the University of Texas at Austin. After her retirement, she moved to the Institute for Advanced Study in Princeton, and now holds a position as Distinguished Visiting Professor. Uhlenbeck's mathematical work is in geometric analysis. Throughout her career she has been involved in many programmes which encourage women in mathematics. Her awards include a Sloan Fellowship, a MacArthur Fellowship, membership in the US National Academy of Sciences, the National Medal of Science and honorary degrees from seven colleges and universities. In 2019, she was awarded the Abel Prize in Mathematics.

(Photo credit: Andrea Kane/Institute for Advanced Study, Princeton, NJ USA)

Presenter



**Mr
Leon Ko**

Theatre and Film Composer

Mr Leon Ko received a Richard Rodgers Development Award in the US for his musical “Heading East”. His musical “Takeaway” in 2011 was the first major British Chinese musical to premiere in London. In Hong Kong, he has won nine awards for his stage musicals such as “The Passage Beyond” and “Sing Out”. His movie works include “Perhaps Love” (Golden Horse Award and Hong Kong Film Award), “The Last Tycoon” (Best Original Film Song), “That Demon Within”, “Insanity” and “Monster Hunt”. Mr Ko was the musical director of Jacky Cheung’s 2004 world tour of “Snow, Wolf, Lake”. Recent works include the musical “The Impossible Trial” and “The Amazing Filmphony”, a concert of his film music with Hong Kong Sinfonietta; “The Originals”, a concert celebrating 50 years of Hong Kong original musicals which he curated. Besides music, Mr Ko launched “Time In A Bottle”, the first-ever perfume bottle exhibition in Hong Kong in 2010, showcasing the artistry of vintage bottles in the context of theatre.

Special Acknowledgement

CODESIGN^{LTD}



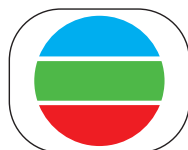
SHAW AUDITORIUM
逸夫演藝中心



SHAW
STUDIOS
邵氏影城



靈活聯繫



TVB

SUNCOLOR
PRINTING CO., LTD.



For more information,
please visit our official website
www.shawprize.org

The Shaw Prize Secretariat



Harkima Shiu
Administration Advisor



Jeannie Lee
Senior Administration Manager



Peggy Ng
Operations Manager



Tonya Tai
Communications
& Public Relations Manager



Judy Wong
Digital Marketing
& System Manager



Jenny Lam
Administration Officer

Level 5, Shaw House,
Shaw Studios, 201 Wan Po Road,
Tseung Kwan O, N. T., Hong Kong

Tel: (852) 2994 4888

Fax: (852) 2994 4881

Email: info@shawprize.org

