The Shaw Prize

The Shaw Prize is an international award to honour individuals 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 work was 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

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 modest influence, by establishing 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.

Messsage from the Chief Executive

I am pleased to congratulate this year's Shaw Laureates, whose innovative achievements advance global society and enhance quality of life. In doing so, they reflect the very goals of The Shaw Prize.

Among this year's six winners, three share the Shaw Prize in Astronomy, two were jointly awarded the Shaw Prize in Life Science and Medicine and one received the Shaw Prize in Mathematical Sciences.

The Hong Kong Government shares The Shaw Prize's commitment to science, mathematics and medical research. Indeed, we are putting renewed emphasis on the teaching of STEM subjects — science, technology, engineering and mathematics — in the Hong Kong educational system. As my 2016 Policy Address emphasised, we believe that innovation and technology can help boost economic growth while enhancing our lives.

The Shaw Prize both rewards and encourages research excellence, while inspiring tomorrow's scientists, mathematicians and medical specialists – in Hong Kong and all over the world.

The Honourable C Y Leung

I thank the Shaw Prize Foundation for its global vision. And I applaud the 2016 Shaw Laureates for their dedication and their research excellence. Their achievements are, in the end, ours.

C Y Leung
Chief Executive
Hong Kong Special Administrative Region

Message from Chairman of the Board of Adjudicators

The Shaw Prize was established by the late Mr Run Run Shaw in 2002 to honour international scientists in the fields of Astronomy, Life Science and Medicine, and Mathematical Sciences. Since the first prizes were awarded in 2004, many Shaw Prize Laureates have gone on to gain recognition by other prestigious awards including the Nobel Prize. We have great pleasure in presenting to the Chief Executive and honoured guests the 2016 Laureates.

In Astronomy, the detection of gravitational waves is considered the greatest discovery in decades and has required the effort of over a thousand people. As LIGO founders, the initial contributions of Ronald W P Drever, Kip S Thorne and Rainer Weiss are credited to the project's success.

In Life Science and Medicine, Adrian P Bird demonstrated how chemical modifications of the DNA and the proteins that bind to them control gene functions. Huda Y Zoghbi showed that gene mutations in these proteins lead to the Rett Syndrome and other neurologic disorders.

Mathematical Sciences 2016 is awarded to Nigel J Hitchin for his far-reaching contributions to geometry, representation theory and theoretical physics which have made a wide impact on the field.

We are indebted to the committees for selecting these laureates who will no doubt enhance the stature of The Shaw Prize.

Yuet-Wai Kan
Chairmen, Board of Adjudicators
Shaw Prize 2016

The Shaw Prize Medal

The front of the medal displays a portrait of 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, the relevant year and the name of the prizewinner. A seal of imprint of the Chinese phrase "制天命而用之" (quoted from Xun Zi – a thinker in the warring states period of Chinese history in 313 – 238 BCE) meaning "Grasp the law of nature and make use of it" appears in the upper right corner.

AGENDA

Arrival of Officiating Guest and Laureates

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Welcome Speech by Professor Yuet-Wai Kan

Member of the Council

Chairman of the Board of Adjudicators, The Shaw Prize

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Speech by Professor Peter Goldreich

Member of the Board of Adjudicators

Chairman of the Selection Committee for the Prize in Astronomy

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Speech by Professor Randy W Schekman

Member of the Board of Adjudicators

Chairman of the Selection Committee for

the Prize in Life Science and Medicine

****

Speech by Professor John W Morgan

Member of the Selection Committee for

the Prize in Mathematical Sciences

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Award Presentation

Grand Hall

Hong Kong Convention and Exhibition Centre

27 September 2016

AWARD PRESENTATION

(Category listed in alphabetical order)

Astronomy

Professor Ronald W P Drever

and

Professor Kip S Thorne

and

Professor Rainer Weiss

Life Science and Medicine

Professor Adrian P Bird

and

Professor Huda Y Zoghbi

Mathematical Sciences

Professor Nigel J Hitchin

Professor Peter Goldreich

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

Professor Peter Goldreich is the Lee A DuBridge Professor of Astrophysics & Planetary Physics Emeritus at the California Institute of Technology in Pasadena, California.

He received a PhD from Cornell University in 1963. After spending one year as a postdoc at Cambridge University and two as an Assistant Professor at the University of California, Los Angeles, he joined the Caltech faculty as an Associate Professor in 1966. He was promoted to Full Professor in 1969 and remained at Caltech until he retired in 2002. Subsequently, he was appointed Professor in the School of Natural Sciences at the Institute for Advanced Study in Princeton from which he retired in 2009. Professor Goldreich is a Member of the US National Academy of Sciences and a Foreign Member of the Royal Society of London. His awards include the Henry Norris Russell Lectureship of the American Astronomical Society, the US National Medal of Science, the Gold Medal of the Royal Astronomical Society, the Grande Medaille of the French Academy of Sciences, and the Shaw Prize. Professor Goldreich's research involves the application of physics to the understanding of natural phenomena, in particular those revealed by astronomical observations.

The Prize in Astronomy 2016

Ronald W P Drever

and

Kip S Thorne

and

Rainer Weiss

**for conceiving and designing the
Laser Interferometer Gravitational-
Wave Observatory (LIGO),
whose recent direct detection of
gravitational waves opens a new window in astronomy,
with the first remarkable discovery being
the merger of a pair of stellar mass black holes.**

An Essay on the Prize in Astronomy 2016

Ronald Drever, Kip Thorne and Rainer Weiss are the primary figures responsible for the conception and design of the Laser Interferometer Gravitational-Wave Observatory (LIGO). LIGO's recent direct detection of gravitational waves represents the first probe of physics in the limit of strong gravity, where massive objects moving at velocities close to that of light drive nonlinear waves in spacetime.

LIGO's discovery ranks among the most significant ever made in astronomy, and its importance can be viewed from a number of distinct perspectives. Most simply, LIGO has provided a third strand to the means by which we can observe the universe, in addition to electromagnetic radiation or energetic particles. LIGO has thus established an entirely new branch of astronomy, allowing us to study phenomena where signals from existing astronomical messengers are entirely lacking. The impact of this new tool seems likely to be as revolutionary as, for example, the opening up of radio astronomy and the subsequent discovery of pulsars and quasars.

The direct observation of gravitational radiation validates a basic prediction of general relativity, showing such fundamental expectations based on causality to be correct. However, LIGO's results go much beyond the weak spacetime fluctuations already inferred from the orbital decay of pulsars in binary systems. By probing the region of strong and time-dependent gravitational fields from which the waves originate, they reveal remarkable properties of black holes.

Black holes have been a feature of astronomical discussion at least since the detection of quasars in the 1960s, but almost all arguments for their existence were indirect. In X-ray binaries, or in the centres of galaxies, we see objects that are too compact and too massive to correspond to any alternative astronomical structure that can exist according to standard relativistic gravity. But a different theory of gravity might change this conclusion, for example by raising the maximum mass of a neutron star, so the existence of black holes could not be demonstrated without probing directly the characteristic features of general relativity, such as the event horizon. Even to demonstrate that a horizon existed would have been a huge step forward (towards which projects such as the Event Horizon Telescope have been dedicated). But LIGO has achieved this and much more: probing not only the structure of spacetime in strong gravity, but also how such a structure evolves dynamically. The results are as expected for the merger of a pair of black holes, even to the fine details of the ringdown oscillations of the horizon as the resultant single black hole settles to its final state, exactly as computed both analytically and numerically. All this pushes the validation of relativistic gravity into a completely new regime.

Perhaps the most impressive feature of LIGO's achievement is that it required the focused efforts of many scientists over more than four decades. But along the way, progress always hewed closely to the vision presented in the proposal that the LIGO team submitted to the US NSF in 1989. Such a triumph of team science is perhaps only matched by the 2012 detection of the Higgs boson at CERN.

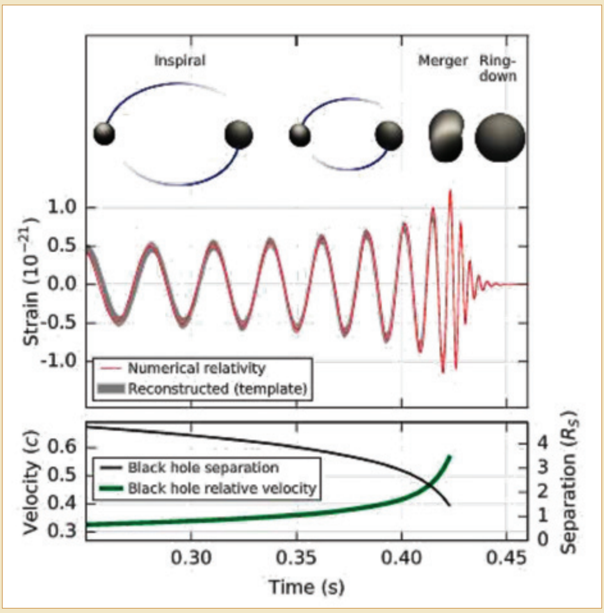

Fig 1: Estimated gravitational-wave strain amplitude from GW150914. Inset images show numerical relativity models of the black hole horizons as the holes coalesce. Bottom panel plots black hole separation in units of Schwarzschild radii ($R_S = 2GM/c^2$) and effective relative velocity divided by the speed of light, v/c, with f the gravitational wave frequency, and M the total mass. From PRL (2016).

Ronald W P Drever
Laureate in Astronomy

Ronald William Prest Drever, was born at home in Bishopton, just outside Glasgow, Scotland, in October 1931. The eldest son of a local doctor, Ronald and his family lived in a house that was also a busy village surgery.

Ronald was always an experimenter. In childhood, he occupied himself with inventing. He was most content while being creative: studying, winding wire, designing and making gadgets and countless electric motors. He gathered surplus war radios and cathode ray tubes along with other bits and pieces of "useful" electronic kit. Nothing was ever thrown away. He was fascinated by interactions between mirrors and light. He once made a rudimentary television in his Physics class at Glasgow Academy, which he replicated with a 4-inch salvaged cathode ray tube at home; enabling the family to watch the Queen's Coronation in 1953.

Ronald went on to embrace the University of Glasgow where he obtained his BSc(Hons), followed by gaining his PhD in 1958. During this time, he struck upon using the magnetic field of the earth to pick up nuclear magnetic resonance. Using basic apparatus yet with accurate measurement, the Hughes–Drever experiment was conducted in the family garden in Bishopton, away from urban interference. This unconventional approach drew attention from Harvard University which subsequently offered him a fellowship in researching the stabilisation of laser light. This was later described in the Pound–Drever–Hall technique, which has multiple applications today. Around the same time, he was also a consultant and visiting scientist at the Atomic Energy Research Establishment, Harwell, England.

Ronald always believed that gravitational waves existed and were detectable. On his return to Glasgow this was becoming a hot research topic. His experimental and inventive nature led him to construct models and prototypes from scrap, famously using the rubber matting from his laboratory floor. By 1978, Ronald had designed his own interferometer and wanted to build it on a shoestring. When the University of Glasgow cancelled plans for a new synchrotron, he procured the space and built an interferometer more than double the size of anything that had been seen before. However, this interferometer was still too small to conduct his experiment fully. Meanwhile, Kip Thorne had plans for a larger scale research project which needed Ronald's talents and enticed him on board.

In 1979, Ronald became a full Professor of the University of Glasgow and in the same year, Caltech hired him as part of an experimental gravitational wave group. His time was divided between laboratories in California and Glasgow. His expertise was in turning concepts into physical form. He would prefer drawing diagrams or making prototypes to convey his ideas over writing conventional documentation. The long distance travels between California and Glasgow provided him time to fill notebooks with sketches of instruments he wanted to develop.

After living on two continents for nearly five years, Caltech demanded Ronald's full commitment and this created a dilemma for him. He had to choose between Glasgow and California. During his time at Caltech, the prototyping of long arm interferometers had shown that size was fundamental. Despite deep connections and loyalty to Glasgow, he decided to say farewell to his home town, Glasgow, for California.

In 1984, Caltech and MIT signed an agreement for joint design and construction of LIGO with Ronald appointed as one of the co-leaders along with Kip Thorne and Rai Weiss. Ronald was often seen as a challenging person to work with. His life's sole focus was his work and he expected others to share his fervour. He never married but despite his hectic work schedule, he kept daily contact with his brother in Scotland. On retirement, Ronald became an Emeritus Professor and gave worldwide lectures on the subject of gravity.

Ronald's contribution has been recognized by numerous institutions. He was Vice President of the Royal Astronomical Society. He was also elected as a Fellow of the Royal Society of Edinburgh and a Fellow of the American Academy of Arts and Sciences. In addition, he is a Fellow of the American Physical Society, which gave him the Einstein Prize, jointly with Rai Weiss in 2007.

In 2009, Ronald was diagnosed with dementia. With encouragement and assistance he returned to Scotland soon after the death of his brother's wife, and moved in with his brother for a short while. After several years in sheltered housing in Edinburgh, he moved into residential care as his health deteriorated. His brother continues to visit him regularly.

Ronald's spirits have been buoyed by news of the discoveries of his life's work. He watched the announcement of 18th February and showed delight in the appearance of his fellow collaborators. He remains a cheerful character who enjoys the company of others. It's wonderful that he has witnessed the detection of gravity waves in his lifetime allowing others to build on his vision.

Information provided by the family of Professor Ronald W P Drever

Kip S. Thorne
Laureate in Astronomy

I was born on June 1, 1940 in Logan, Utah, USA, and grew up there. It was a small, green valley in the Rocky Mountains with deep snow in winter. I wanted to become a snow plough driver, because that seemed the most wonderful and powerful job in the world. But when I was eight my mother took me to a lecture about the solar system and I fell in love with astronomy. Then at age thirteen, I discovered the book "*One Two Three … Infinity*" by the physicist George Gamow, and reading it, I fell in love with theoretical physics and cosmology. So here I am, today, sixty-three years later: a theoretical physicist who loves astronomy and cosmology.

I have three sisters and a brother, and we are close friends. We connect by email or telephone or Skype several times a week. All of our ancestors, on all genealogical lines joined the Mormon church and moved to Utah before the completion of the railroad in 1869: on foot, by horse or by wagon. However, shortly before her death, our mother urged us all to leave the Mormon church because of its discrimination against women, and we all left, breaking our ties to our ancestral past.

Our mother, Alison Thorne, was a community activist who tried to make life better for migrant farm workers, poor children, and women in a male-dominated Mormon community. When she passed away, there was a giant headline in the local newspaper: *Old Radical Dies!* Our father, Wynne Thorne, a soil chemist, brought science to the agricultural community he had been reared in — and later in life, he brought science to farmers in Iraq, Iran, Libya, Pakistan, India and Russia.

I have married twice: Linda Thorne (for 15 years), the mother of my two children Kares and Bret; and more recently Carolee Winstein (for 34 years). Linda, Carolee, our children and I are all close friends. Linda is a plant physiologist and artist; Carolee is a biokinesiologist (she designs and directs clinical trials of techniques to help stroke victims recover their control of physical motions). Kares was an actress for a few years and now writes computer software for a large cosmetic company. Bret is an architect and contractor, and his daughter (my granddaughter) Larisa is beginning her third year as a PhD student in physics at Carnegie Melon University.

I studied physics at the California Institute of Technology (Caltech) from 1958–62 and at Princeton University from 1962–66. At Princeton, Professor John Wheeler inspired me and guided me in research about black holes and neutron stars, and Professor Joseph Weber (a visitor from Maryland) inspired me about gravitational waves and experiments to search for them. So, naturally, in 1968, when I returned to Caltech as a professor, I built a small research group (about six PhD students and three postdoctoral students), focused on theoretical research about black holes, neutron stars, and gravitational waves.

In 1972, together with my students and colleagues, I began to develop a vision for the science that could be done with gravitational wave detectors: the sources of waves that might be observed, and the information that might be extracted from the waves. That same year, Rainer (Rai) Weiss at MIT wrote one of the most remarkable scientific papers I have ever read: a detailed analysis of the *laser interferometer gravitational wave detector* that he had invented — an analysis, in which he identified all the major forms of noise that such an *interferometer* would encounter, he explained how these noises could be controlled, and he estimated the resulting sensitivity that could be achieved. I was unaware of this paper until a year later, and in my ignorance I was so skeptical of Rai's interferometer idea that I described it as "of little experimental interest" in the textbook *Gravitation* that I co-authored with John Wheeler and Charles Misner. How foolish I was! I have spent most of the rest of my professional life helping Rai, Ronald (Ron) Drever, and our colleagues perfect these interferometers (our *LIGO Project*), and with the interferometers, discover gravitational waves — the work for which we are being awarded the Shaw Prize.

Our discovery is the work of a thousand scientists and engineers in many nations around the world, and the real credit for the discovery belongs to them, to our whole team! I am proud to have co-founded our LIGO Project (with Rai and with Ron), and am lucky but uncomfortable to have become an icon for our Project and my thousand collaborators.

In the early 2000s, I withdrew from detailed participation in LIGO so as to create (with Saul Teukolsky of Cornell University), the *SXS Project* to simulate gravitational wave sources on computers. The SXS simulations were crucial for extracting the information carried by the gravitational waves that LIGO has discovered.

Since 2009 I have turned much of my effort to a very different direction: collaborations with artists, musicians and film makers — collaborations aimed at inspiring people, young and old, about science. Christopher Nolan's movie *Interstellar* was one fruit of these collaborations.

These artistic collaborations are, in some deep sense, my primary hobbies. My wife and I also enjoy travel and scuba diving. We used to ski and skateboard, but our intense professional lives (and our aging bones) have gotten in the way of that in recent years, so our principal exercise now is just working out at a gym twice a week — and wild dancing at clubs.

Rainer Weiss
Laureate in Astronomy

I was born in Berlin, Germany on September 29, 1932. My father was a neurologist who had rebelled against his family of well-off intellectual German jews with connections to the Rathenau family. He had become an idealistic communist. My mother was a Protestant who had rebelled against her family by becoming an actress. In 1932 the family emigrated to Prague, Czechoslovakia to escape the Nazis. In 1937 my sister Sybille was born. In September of 1938, after Chamberlain effectively gave Czechoslovakia to Hitler, we emigrated to the United States with the help of the Stix family of St Louis, arriving in New York in January 1939.

I received a scholarship to the Columbia Grammar and Preparatory School in New York graduating in 1950. After the end of WW II, with the ready availability of surplus electronics components I began to construct and service radios, ultimately designing, constructing and selling hi-fidelity music systems to people interested in classical music.

I started at MIT in Electrical Engineering then switched to physics. After a life-changing love affair which started me on learning the piano, I lost the girl and flunked out of MIT in 1953. I became an electronics technician in Professor Jerrold Zacharias's Atomic and Molecular beam laboratory which had developed the first practical atomic clock based on the hyperfine structure of Cesium. I worked with Zacharias to develop a new clock based on an atomic fountain with the intent of significantly greater precision to enable a terrestrial test of the Einstein Red Shift. The new clock didn't work but the idea of measuring the red shift got me into experimental gravitation and relativity. In 1957 I married Rebecca Young, a plant physiologist who later became a children's librarian.

In 1962, with our new daughter Sarah, we moved to Princeton for me to be a Post-Doctoral scientist with Robert Dicke who was bringing research in gravitation and General Relativity back from mathematics into physics. I learned critical experimental techniques from him: the idea of using feedback in mechanical experiments to damp and linearize, and the technique of modulating the effect to be measured to eliminate 1/f noise. The experiment I did was to search for scalar gravitational waves with a gravimeter to detect excitation of the monopole vibrational mode of the Earth at a 20.4 minute period.

In 1964 I returned to MIT on the Physics faculty and started a new group dedicated to Cosmology and Gravitation, working initially on the absolute frequency stabilization of lasers and a laser interferometer experiment to establish a limit on a tired photon hypothesis for the cosmological red shift. The interferometer operated at the quantum limit.

In 1967 I was asked to teach a General Relativity course. Not being very knowledgeable on the subject, I was at best one day ahead of the students; when we came to gravitational waves, I did not understand the interaction between the Weber bar and gravitational waves. I presented an alternate gedanken experiment: timing light between two free masses each carrying a clock travelling on adjacent geodesics. The gravitational waves change the travel time of light between the masses. My son Benjamin was born during this course. It was also the time when we began to study the spectrum and spatial isotropy of the cosmic background radiation from balloon platforms which ultimately led to COBE.

In 1972 I went back to the gedanken experiment to see if it could be converted into a real experiment. By using optical interferometry with powerful lasers between free masses, and with some tricks such as km scale multipass arms and modulation techniques on the light, it seemed possible to achieve astrophysically interesting sensitivity. I wrote a report on the idea and began to build a prototype system at MIT. Groups that had been working on Weber type detectors in Germany and Scotland began working on interferometric detectors as well.

In 1975 I was asked to chair a committee to determine the role of the space programme in cosmology and gravitation. Kip Thorne gave testimony to the committee. While together we discussed his interest in starting a new experimental group to complement the outstanding theoretical group he had started at Caltech. One of the areas we discussed was the detection of gravitational waves by interferometric techniques. After further consultation, he invited Drever from Scotland to start such a group. It was during this time that Kip and I began to think of collaboration between Caltech and MIT groups.

From 1980 through 1983 the MIT group, with help from Stan Whitcomb of Caltech, did a study with industry to establish the feasibility of constructing a long baseline interferometric gravitational wave detector system. The conclusion was that the technology was available to make a detector system that could reach interesting sensitivities. Caltech and MIT groups presented the results to an NSF committee which considered LIGO a risky but possibly high payoff project appropriate for a national programme. Even so, the NSF had difficulty getting approval to begin LIGO. In 1986 a special committee composed of scientists not directly involved with the programme made a positive recommendation to go forward. The committee also urged a single director to run the project. Rochus Vogt became the first Director and in 1994 Barry Barish, the second Director, successfully made the transition from a tabletop research programme to LIGO as big science.

My children also made significant transitions. Sarah became an ethnomusicologist and is now faculty at Yale-National University of Singapore while Benjamin became an art historian and is now Head of the Collection at the Fine Arts Museum in Boston. Sister Sybille had started as an actress and has become a successful playwright. Sam, the one grandchild, has an interest in physics.

Professor Randy W Schekman

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

Professor Randy W Schekman is a Professor in the Department of Molecular and Cell Biology, University of California, Berkeley, and an Investigator of the Howard Hughes Medical Institute. When he joined the faculty at Berkeley, he developed a genetic and biochemical approach to the study of eukaryotic membrane traffic, which reveals how proteins enter and move between membrane-bound compartments of cells.

Among the honours he has earned are the Gairdner International Award, the Albert Lasker Award in Basic Medical Research in 2002, and the Nobel Prize in Physiology or Medicine in 2013 — which he shared with James Rothman of Yale University and Thomas Südhof of Stanford University — for their discoveries of the mechanism regulating vesicle traffic, a major cellular transport system. In 2011, he was appointed Editor-in-Chief of the open access journal, "eLife", sponsored by the HHMI, The Wellcome Trust/UK and the Max Planck Society.

The Prize in Life Science and Medicine 2016

Adrian P Bird

and

Huda Y Zoghbi

for their discovery of the genes and the encoded proteins that recognize one chemical modification of the DNA of chromosomes that influences gene control as the basis of the developmental disorder Rett syndrome.

An Essay on the Prize in
Life Science and Medicine 2016

The expression of genes is titrated precisely to achieve the proper balance of functions in all human tissues, including the brain. Ratcheting expression up or down is orchestrated by proteins that bind to DNA, leading to suppression or activation of gene function, but it also depends on signals left on chromosomes, including chemical modifications of the DNA itself. Adrian Bird devised a method for mapping one such chemical mark along chromosomes, namely the presence of a methyl group on the cytosine residue in DNA. This revealed a pattern of methylated and non-methylated sites that helps demarcate genes that can be switched on from those that are to remain silent. One way that this works emerged from his discovery in the 1990s of five different proteins that depend on methylation for their binding to DNA and can silence genes. One member of the protein family, MeCP2, recruits a large complex of enzymes that chemically alter chromosome marks by removing an acetyl chemical tag from a major structural component of the chromosome known as histones. The inter-connection of these two chemical features — the presence of methylcytosine in chromosomal DNA and the loss of acetyl groups on histones — establishes "epigenetic" marking of chromosomal regions causing gene activity to be turned down.

The basic molecular mechanisms uncovered by Bird's research acquired new significance through completely independent work on a seemingly unrelated biological problem. Huda Zoghbi, a pediatric neurologist studying genetic disorders associated with developmental delay and intellectual disability, made an unexpected connection between one of Bird's methyl-cytosine-binding proteins, MeCP2, and a challenging neurological disorder called Rett syndrome.

Rett syndrome was first described by Andreas Rett in 1966 as a distinct but oddly variable neurobehavioral condition in females. The disease affects approximately 1 in 10,000 girls who show normal development for 6 to 18 months, but as the disease takes hold, they become withdrawn, regress in their mental development, exhibit compulsive behavior such as incessant hand-wringing, and eventually lose all purposeful use of the hands. What made Rett difficult to understand was that it was usually sporadic, appearing out of the blue in an otherwise healthy family. But because Rett is mainly seen in females, and only very rarely in families where there had been early loss of male children, Zoghbi suspected it to be caused by an X-linked mutation that is lethal in males. In 1999, after 15 years of scrutinizing the genome, Zoghbi and colleagues discovered that mutations in *MECP2* are the primary cause of Rett syndrome. Her discovery allowed a confusing set of symptoms to be turned into a straightforward diagnostic genetic test. Mutations in *MECP2* are now known to cause a variety of neuropsychiatric features ranging from autism to juvenile-onset schizophrenia.

The Zoghbi and Bird groups independently produced different genetic mouse models of Rett syndrome that reproduced the major symptoms of the disease. In dramatic contrast to the irreversible damage associated with many neurologic disorders, however, Bird's group demonstrated that the animal model of Rett Syndrome could be restored to normal by reintroducing a functional copy of MeCP2 in adult animals, even though they were already symptomatic. His group also found that the MeCP2 protein is quite abundant in nerve cells, approaching the level of the major chromosome-binding histones; a change in MeCP2 function is thus likely to have a profound affect on chromosome structure in the brain. Zoghbi's group showed that MeCP2 is critical for the normal function of many different types of neurons and that the brain is sensitive to relatively modest increases or decreases in the levels of MeCP2. In fact, doubling MeCP2 levels causes a progressive neurological syndrome in mice that is every bit as severe as Rett syndrome. These observations led to identifying *MECP2* as the culprit in children with large duplications spanning the gene in Xq28. *MECP2* Duplication Syndrome, which primarily affects male children, is now known to account for about 1% of cases of intellectual disabilities and autism. The Zoghbi lab was able to reverse this disorder in adult duplication syndrome mice by using antisense oligonucleotides (ASOs) to normalize MeCP2 levels.

These discoveries showed the profound importance of epigenetics to neurobiology and now suggest a path to treatment of certain neurologic disorders using the emerging technology of gene editing and ASOs. These highly complementary studies show, once again, the power of basic science to uncover the fundamental basis of human development and disease.

Adrian P Bird

Laureate in Life Science and Medicine

I was born in Wolverhampton in the West Midlands of England in 1947. My father was a journalist and my mother trained in architectural drawing, but stayed at home to look after her three children. None of my extended family was academically inclined, though my grandfather (who regrettably I never met) was an engineer, inventor and eccentric. As a child quite a lot of my free time was spent bird-watching, fishing and keeping pets (tortoises, rabbits, mice, a dog and various found animals). The other major occupation was sport — particularly cricket and field hockey.

These distractions continued into secondary education at a small country grammar (i.e. state funded) school. Academic work, by contrast, was less addictive and my attentiveness and performance fluctuated. Art was an exception as I developed an interest in drawing, which paid off as I later illustrated a series of children's books by my father — about a talking Irish dog. Of the other school subjects on offer, biology and chemistry stood out as they related to my extra-curricular interests. For example, I obtained chemicals to use at home and recall that the effect of sodium hydroxide on a wooden table-top impressed both me and my parents.

School biology lessons never really caught my imagination, but I happened to see on television a series of lectures in which Maynard–Smith, Korner, Perutz and Crick talked about their work. This would have been around 1962 when the Nobel Prizes for the structures of DNA and globin were awarded. DNA in particular fascinated me and, as it was not yet on any school curriculum, I wanted to find out more. The way forward was obviously to study biochemistry at university, and I was accepted at the brand new School of Biological Sciences at Sussex University. Fortunately John Maynard–Smith was dean and Asher Korner ran the biochemistry course. This was more like it.

During a genetics course I learned that Max Birnstiel in Edinburgh had purified the DNA encoding a single gene and I decided to apply there for a PhD. At the time it was not known whether all cells of the body had the same genome. I studied a dramatic case where gene copies are hugely amplified in a single cell type — the frog egg. As it turned out this is a rare exception rather than the rule, as the vast majority of cells retain the entire unaltered genome, regardless of whether they are blood cells, liver cells, neurons etc. I moved to Joe Gall's laboratory at Yale as a postdoctoral researcher and continued working on gene amplification. Here I encountered a very distinct and stimulating research style, based on genuine curiosity, clear thinking and simplicity of expression, which I have tried to emulate since. From there to Zurich, Switzerland where, fuelled by discussions with Hamilton Smith, discoverer of type 2 restriction enzymes, and Ed Southern, inventor of the eponymous blot technique, I realised that restriction enzymes could be used to map methylated sites in the genome. This triggered my laboratory's later involvement in the discovery of CpG islands. In DNA methylation I had found an unstudied aspect of DNA that I could really get my teeth into.

After moving to Edinburgh University for my first proper job, I became interested in how the DNA methylation signal is read. My group found proteins that bound to DNA only when it was methylated and implicated them as mediators of the repressive effect on transcription. One of these proteins was MeCP2 and we were busily learning more about it when a "bolt from the blue" changed our research agenda. Huda Zoghbi's laboratory identified that mutations of the *MECP2* gene were the elusive genetic cause of Rett syndrome. This severe disorder was named after Andreas Rett — a Vienna-based paediatrician and, coincidentally, my laboratory was in Vienna when we first isolated the MeCP2 protein. Andreas Rett was still working in that city, but we never met, as Huda's crucial link between our work and his took place after Dr Rett had passed away.

Despite moving from place to place somewhat during my career, Edinburgh has been a recurrent theme. My four children were born there and my wife is a geneticist at the university. Since the Scottish Enlightenment of David Hume and Adam Smith, Edinburgh has been a refreshingly non-conformist part of the United Kingdom, where questioning orthodoxy has often led to discovery. I try to be part of that tradition. Our finding that Rett syndrome in mice can be reversed by putting back the missing *MECP2* gene overturned the prevailing view that this was a condition rooted in irrevocable developmental defects. In fact there is a real prospect that one day this distressing disorder will be treatable. The goal of our field now is to make that prospect a reality.

Huda Y Zoghbi
Laureate in Life Science and Medicine

I was born and brought up in Beirut, Lebanon. My father owned a business making olive oil and olive oil soap, and my mother was a housewife. My parents loved learning and I grew up in a house that had an enormous library stocked floor to ceiling with books.

For college, I attended the American University of Beirut (AUB). After a brief but intense flirtation with literature, I decided to major in biology at my mother's insistence and continued on to medical school at AUB. Medical school changed the course of my life. I met the love of my life, William Zoghbi, who has been my greatest joy for the past 40 years and father to our two precious children, Roula and Anthony. It also brought me to the United States. In 1975, half way through my first year, civil war broke out, forcing those of us determined to continue our studies to sleep in double-walled rooms and basements on campus. That summer, my parents sent my brothers and me away with the full expectation that the war would end quickly and I'd return to Beirut for the next term.

However, the war worsened, leaving no way to come home safely. I applied to transfer to an American medical school, and was fortunate that Meharry Medical College agreed to take me even though school had already been in session for two months. I was terribly homesick and coped by studying constantly and dreaming of returning to Lebanon. But the war continued. Fortunately, William transferred to Meharry the next year, easing my loneliness.

We completed fourth year rotations at Stanford, Emory, and Baylor College of Medicine (BCM). I fell in love with BCM because of the nurturing collegial environment and Ralph Feigin, chair of the pediatrics department, who took me under his wing. When William and I graduated, we both matched at Baylor for residency. During that time, Ralph taught me clinical scholarship and became like a second father to me. I initially had my heart set on pursuing pediatric cardiology. However, on my pediatric neurology rotation, I met Marv Fishman, a fantastic clinician and teacher who helped me appreciate the beauty of taking a history and solving the puzzle of the patient through logic and physical exam. By the end of this rotation, Marv had inspired me to become a child neurologist.

In 1983, the course of my life changed again. At Texas Children's Hospital, I met a five-year-old girl with Rett syndrome — a new clinical entity that I had just learned about from a paper by Hagberg and colleagues. A week later, I encountered a second girl with Rett. The girls are born apparently healthy, but around 12 to 18 months they begin wringing their hands continuously and lose their acquired motor and language skills. The Rett presentation was so unusual and consistent that I thought it had to be genetic. I began searching for similar cases and within days I identified six more girls with Rett syndrome. Not only was this a puzzling constellation of symptoms, but the mechanism of disease was enigmatic, too: there was no apparent defect at birth, nor was there degeneration of the brain. I felt compelled to pursue research to understand the cause and be able to offer parents some kind of hope for treatment.

I was fortunate to join, as a post-doctoral fellow, the lab of Art Beaudet, who mentored me in molecular genetics despite my lack of experience. He steered me towards a project involving an adult ataxia syndrome that promised to be more tractable to genetic methods than a sporadic disorder like Rett. I started my own lab studying spinocerebellar ataxia type 1 in 1988, and in 1993, Harry Orr and I discovered that CAG repeat expansions were the culprit. Our continued collaboration has been one of the longest-running and most joyful of my career.

I had not forgotten Rett, though. I had been collecting data and had samples from over 200 families. Many scientists doubted a sporadic disease could be genetic and funding dried up. Thankfully, in 1996, I became a Howard Hughes Medical Institute investigator and the Rett families agreed to support a postdoc in my lab — two critical events that provided the funding that helped us to finally find, in 1999, that mutations in *MECP2* cause Rett. Many ask what kept me going all those years. The answer is the girls and a strong intuition that their symptoms had to be caused by a specific molecular defect.

The discovery of the Rett syndrome gene remains the most hard-won and personally important to me. I am forever grateful to the Rett families who trusted in me and for the tireless trainees who took a huge risk working on this project, especially Ruthie Amir, who persevered to discover the mutations despite three years of negative data. I am thankful that my clinical experiences guided me to the lab where I discovered how much I enjoy research and solving biological puzzles, how important basic science is to advance medicine, and the joy of mentoring students and fellows. I am deeply honoured to share the Shaw Prize with Adrian Bird, who has done so much to reveal the workings of MeCP2.

Professor Peter C Sarnak

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

Professor Peter C Sarnak is currently the Eugene Higgins Professor of Mathematics at Princeton University and Professor of the Institute for Advanced Study.

He has made major contributions to number theory, and to questions in analysis motivated by number theory. His interest in mathematics is wide-ranging, and his research focuses on the theory of zeta functions and automorphic forms with applications to number theory, combinatorics, and mathematical physics.

Professor Sarnak received his PhD from Stanford University in 1980. In the same year, he became Assistant Professor of Courant Institute of Mathematical Sciences of New York University and an Associate Professor in 1983. In 1987 he moved to Stanford University. He joined Princeton University as Professor in 1991, became the Henry Burchard Fine Professor of Mathematics in 1995 and the Chair of the Department of Mathematics from 1996 to 1999. From 2001 to 2005, he was Professor of Courant Institute of Mathematical Sciences of New York University.

He has received many awards, including the Frank Nelson Cole Prize, American Mathematical Society (2005) and Levi L Conant Prize, AMS (2003). He was elected as a Member of the US National Academy of Sciences and Fellow of the Royal Society of London in 2002.

The Prize in Mathematical Sciences 2016

Nigel J Hitchin

for his far-reaching contributions to geometry, representation theory and theoretical physics. The fundamental and elegant concepts and techniques that he has introduced have had wide impact and are of lasting importance.

An Essay on the Prize in Mathematical Sciences 2016

From antiquity the subject of geometry has been at the centre of mathematics. The ancient Greeks were fascinated by the subject and studied it extensively, giving us Euclidean geometry. The modern view of geometry dates to the middle of the 19^{th} century, when Gauss introduced and developed the theory of curved surfaces. He was followed by Riemann who constructed the theory of higher-dimensional curved spaces, now called Riemannian geometry. Their work began a period of flowering of geometry, and our present-day understanding of the subject emanates directly from their work.

Nigel Hitchin is one of the most influential geometers of our time. The impact of his work on geometry and on many of the allied areas of mathematics and physics is deep and lasting. On numerous occasions, he has discovered elegant and natural facets of geometry that have proven to be of central importance. His ideas have turned out to be crucial in areas of mathematics and physics, far removed from the context in which he first developed them. By exploring ignored corners of geometry, Hitchin has repeatedly uncovered jewels, many more than described below, that have changed the course of developments in geometry and related areas, and changed the way mathematicians think about these subjects.

In the modern period geometry has flourished and expanded greatly. With the development of topology (which may be described as the study of shapes, allowing deformation but not tearing) as an independent discipline in mathematics around 1900, the purview of geometry expanded to include auxiliary objects associated with spaces. A prime example is gauge theory, which is the study of the geometry of certain curved structures over spaces known as fiber bundles.

Geometry has close connections to other parts of mathematics such as representation theory, which is related to the study of symmetry, differential equations and dynamics, and number theory. It has had a profound impact on topology. Its connections to physics are long-standing as well: Einstein formulated general relativity in terms of the geometry of curved four-dimensional spacetime, essentially in the form that Riemann had introduced. More recently, the standard model of particle physics is formulated using the geometry of gauge theories, and much of theoretical high-energy physics beyond the standard model is formulated geometrically.

While Hitchin has introduced many important concepts and techniques in geometry, one of his most influential works is his study of Higgs bundles over a Riemann surface. The parameter space of all Higgs bundles over a fixed surface is itself a fiber bundle over that surface. On these fiber bundles Hitchin defined a natural function that produces an algebraically completely integrable Hamiltonian system on the space. The result is what is now called the Hitchin fibration of the space of Higgs bundles. One aspect of these spaces is that they give fundamental examples of important objects known as hyperkahler manifolds. But the impact of Hitchin fibrations is not limited to Higgs bundles and hyperkahler manifolds. Hitchin fibrations and his quantization of them are cornerstones of the construction of a modern branch of representation theory called "the geometric Langlands program". In addition, they are a foundational ingredient in Ngo's recent Fields-Medal-winning work in the theory of automorphic forms and number theory. In a related work, Hitchin used this theory to construct projectively flat connections over the moduli spaces of Riemann surfaces, which had been predicted by Witten's analysis of Chern–Simons theory, a three-dimensional topological quantum field theory. Hitchin fibrations have also served as a point of departure for physicists in their studies of certain four- and six-dimensional quantum field theories. The story of Hitchin fibrations is a perfect example of Hitchin's ability to find appealing and natural questions that had been previously overlooked but whose answers are of fundamental importance across a wide spectrum of mathematics and physics.

Hitchin's work with Atiyah, Drinfeld and Manin brought mathematics to bear on a question of fundamental importance in physics, namely the description of the moduli space of instantons on four-dimensional Euclidean space. Their approach using linear algebra, even now, thirty years later, forms a basis for much work on the study of instantons in both mathematics and theoretical physics, and serves as an important bridge between mathematics and physics.

The Kobayashi–Hitchin conjecture relating algebro-geometric stability and solutions to the partial differential equations describing instantons on complex algebraic surfaces was one of the first examples of a close relationship between the notion of stability in algebraic geometry and solutions of non-linear partial differential equations. This fundamental principle has reoccurred in various forms in many areas of mathematics.

The influence of Hitchin's work across the wide sweep of geometry and its applications to allied fields will be felt far into the future. His many achievements richly merit the award of the Shaw Prize in Mathematical Sciences.

Nigel J Hitchin
Laureate in Mathematical Sciences

I grew up in Duffield near Derby, in the midlands of England. In 1957 a new secondary school opened there and I, with 73 other 11-year olds, was one of the first pupils. With that small number, each teacher had to cover several areas and for a couple of years Mathematics was taught by the French master. Eventually, as the school grew, they employed a dedicated mathematician and I began to be attracted to the subject.

I was accepted in 1964 to study Mathematics at Jesus College in Oxford but, as was common then, I left school after the Entrance Examination and in my case got a temporary job in the Engineering Computing Department of Rolls-Royce in Derby. There I was surrounded by mathematics graduates and I absorbed several notions which were absent from my school curriculum. I was also given some interesting problems which required lateral thinking.

As an undergraduate in Oxford my mathematical interests were more on the pure side and in 1968 I became a graduate student with the topologist Brian Steer as supervisor. Michael Atiyah at that time had moved from Oxford to be a permanent member at the Institute for Advanced Study in Princeton but he returned each summer term, and one year while my supervisor was on sabbatical I had the benefit of being supervised by him. This extended my horizons enormously and broadened my interests by looking at questions which involved algebraic geometry and topology as well as differential geometry. This mixture of topics was formative for my future work.

In 1971 I moved to Princeton as Atiyah's assistant. This was an eye-opening experience for me, exchanging ideas with young postdocs, learning from senior visitors and being invited to give talks at various US universities. It was there that I met my wife Nedda, who was visiting her cousin, one of the other mathematical members. We married in 1973 and then spent a year in New York. At New York University I began reading the papers of Roger Penrose on zero rest-mass field equations in relativity.

When I returned to Oxford as a postdoc the following year Penrose had recently been appointed to a Chair and I began to learn that, through his newly-developed twistor theory, the Riemannian geometry I was interested in and the geometry of relativity were both put on the same footing. It meant that questions about Einstein's equations which were occupying me at the time made sense in this new setting. This was perhaps the first occasion I realized that there was an interface between my own interests and physics which I could exploit.

We had many senior visitors in Oxford then, and in 1977 Isadore Singer came with some new ideas from his physics colleagues at MIT. These were called instantons — Euclidean versions of the Yang–Mills equations of particle physics. The formalism however fitted perfectly with my earlier studies. Moreover Richard Ward, a student of Penrose, had just shown how twistor methods could be applied to these equations. Week by week we introduced new results in a seminar devoted to this subject and finally, combining recent work in differential geometry and algebraic geometry, Atiyah and I (and independently Drinfeld and Manin in Moscow who had also been following this development) gave a complete solution to the problem. As a consequence I travelled a great deal at this time giving talks (unfortunately for my wife around the time of the birth of our first child) and in 1979 I was eventually given a permanent Lectureship in Oxford, with a Fellowship at St Catherine's College.

I followed up the instanton work by attacking a related concept, magnetic monopoles. Then in 1983–84 I spent a sabbatical at Stony Brook — I had been approached to join their strong group in differential geometry. Instead I found myself discussing an idea of Martin Rocek in the Theoretical Physics group. This resulted in a framework within hyperkähler geometry which explained a number of previous facts and pointed to many more. Although we each described this in a different language it was clear that we were doing the same thing. In the end, however, despite an appeal from C N Yang, I returned to Oxford.

It was soon afterwards that the setting this work provided suggested a new gauge-theoretic concept which could naturally be applied to the classical area of Riemann surfaces. It yielded an entry point into a whole range of geometrical problems, providing a link between algebraic geometry and the representation theory of surface groups. Almost incidentally, the algebraic geometry also gave a vast generalization of integrable systems that had been studied piecemeal for decades. The consequences of this work were gradually elucidated by myself and various graduate students and ultimately came to the attention of string theorists who demonstrated a link with the geometric Langlands programme.

In the meantime I had left Oxford to become a Professor at the University of Warwick. Then in 1994 I was appointed to the Rouse Ball Chair in Cambridge (which brought me into closer contact with theoretical physicists) but three years later I accepted the Savilian Professorship of Geometry back in Oxford.

Subsequent work, as then, was often guided by the intuition of physicists, which differs from that of most mathematicians. I have found repeatedly that when the two worlds interact, fertile mathematical ideas emerge.

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Professor Lin Ma

Professor Lin Ma is Senior Advisor of the Board of Trustees of Shaw College and was Professor of Biochemistry (1972–1978) and Vice-Chancellor (1978–1987) of The Chinese University of Hong Kong; he is Emeritus Professor of Biochemistry and has published largely on protein chemistry. Professor Ma also served as Chairman of the Board of Trustees of Shaw College, The Chinese University of Hong Kong (1987–2011) since its inauguration. He has received honours from Great Britain, Japan and Germany, and honorary degrees from several international universities as well as from universities in Hong Kong, Macau and China.

Professor Ma was the Convenor of two sub-groups of the Hong Kong Basic Law Drafting Committee: (1) Education, Science and Arts, and (2) Hong Kong Flag and Emblem.

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.

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Mrs Mona Shaw, wife of the founder, the late Sir Run Run Shaw, is Chairperson of The Sir Run Run Shaw Charitable Trust, The Shaw Foundation Hong Kong Limited and The Shaw Prize Foundation. A native of Shanghai, China, she is an established figure in the Hong Kong media and entertainment industry and Chairperson of the Shaw Group of Companies.

Council Member

Professor Yuet-Wai Kan

Professor Yuet-Wai Kan is currently the Louis K Diamond Professor of Hematology at the University of California, San Francisco and he focuses his research 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 led to the innovation of DNA diagnosis and the discovery of human DNA polymorphism that have found wide application in genetics and human diseases. For his work, he has received many national and international awards including the Albert Lasker Clinical Medical Research Award, the Gairdner Foundation International Award and the Shaw Prize. He is the first Chinese elected to the Royal Society, London, and is a Member of the US National Academy of Sciences, Academia Sinica, the Third World Academy of Sciences and the Chinese Academy of Sciences. He has received honorary degrees from The University of Caglieri, Italy, The Chinese University of Hong Kong, The University of Hong Kong and The Open University of Hong Kong.

Council Member

Professor Kenneth Young

Professor Kenneth Young is a theoretical physicist, and is Master of CW Chu College and 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. 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.

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Professor Pak-Chung Ching

Professor Pak-Chung Ching is Director of Shun Hing Institute of Advanced Engineering and Choh-Ming Li Professor of Electronic Engineering of The Chinese University of Hong Kong. He received his Bachelor in Engineering (First Class Honours) and PhD degrees from the University of Liverpool, UK, in 1977 and 1981 respectively. Professor Ching is a Fellow of IEEE, IEE, HKIE and HKAES. He was Chairman of the Hong Kong Council for Testing and Certification between 2009 and 2015. He is presently Chairman of the Veterinary Board of Hong Kong and Member of the Advisory Committee on Innovation and Technology. He also sits on the boards of a number of research and development organizations in Hong Kong. Professor Ching was awarded the IEEE Third Millennium Award in 2000, and the HKIE Hall of Fame and the Bronze Bauhinia Star by the Government of HKSAR in 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 Wai-Yee Chan

Professor Wai-Yee Chan is Professor of Biomedical Sciences and Director of School of Biomedical Sciences, The Chinese University of Hong Kong (CUHK), Hong Kong. Professor Chan obtained his BSc (First Class Honours) from CUHK in 1974 and PhD from the University of Florida, Gainesville, Florida, USA in 1977. Prior to assuming his current position in June of 2009, he was Professor of Pediatrics, Georgetown University, Washington, DC, and Head and Principal Investigator, Section on Developmental Genomics, National Institute of Child Health and Human Development, National Institutes of Health, Bethesda, MD, 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 board of a number of international scientific journals and on review panels of regional and international research funding agencies.

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Sedleian Professor of Natural Philosophy and Fellow of the Queen's College, University of Oxford, UK

Professor David Eisenbud
Professor of Mathematics, University of California, Berkeley, USA

Professor W Timothy Gowers
Royal Society Research Professor and Rouse Ball Chair in Mathematics, Department of Pure Mathematics and Mathematical Statistics, University of Cambridge, UK

Professor John W Morgan
Director, Simons Center for Geometry and Physics, Stony Brook University, USA

Selection Committee Member

Professor Reinhard Genzel

Astronomy Committee

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 Full Professor of Physics, UC Berkeley since 1999.

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 received many awards, including Newton Lacy Pierce Prize, Leibniz Prize, Janssen Prize, Balzan Prize, Petrie Prize, the Shaw Prize in Astronomy, Jansky Prize, Karl Schwarzschild Medal, Crafoord Prize in Astronomy and Tycho Brahe Prize, Herschel Medal of RAS, Great Cross of Merit of Germany, Honorary Doctorate of Paris Observatory OPSPM, Harvey Prize in Science and Technology.

He is a Member of the European Academy of Sciences, the German Academy of Natural Sciences Leopoldina, the Bavarian Academy of Sciences. 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.

Selection Committee Member

Professor Victoria Kaspi

Astronomy Committee

Professor Victoria Kaspi is a Professor of Physics at McGill University, where she holds the Lorne Trottier Chair in Astrophysics and Cosmology, and a Canada Research Chair in Observational Astrophysics. She is also Director of McGill Space Institute. She received a BSc (Honours) in Physics from McGill University in 1989, and an MA and PhD in Physics from Princeton University in 1991 and 1993 respectively.

Professor Kaspi uses techniques of radio and X-ray astronomy to study rapidly rotating, highly magnetized neutron stars. She has done significant work involving radio pulsars and magnetars. More specifically, she has contributed among other things to the study of binary pulsar dynamics, the neutron star population, as well as the study of magnetars, the most highly magnetized objects known in the Universe.

Professor Kaspi has received numerous awards and honours, including the Killam Prize in 2015, NSERC's John C Polanyi Award in 2011, the Prix du Quebec in 2009 and the Harvard University Sackler Lectureship in 2009. She is a Fellow of the Royal Society of Canada and the Royal Society of London, and elected to the US National Academy of Sciences and the American Academy of Arts and Sciences.

Selection Committee Member

Professor John A Peacock

Astronomy Committee

Professor John A Peacock studied Natural Sciences as an undergraduate at Jesus College, Cambridge, where he also completed a PhD in Radio Astronomy in 1981. He then moved to Edinburgh, initially working as a Research Astronomer at the Royal Observatory Edinburgh, before joining the University of Edinburgh as Professor of Cosmology in 1998. He was Head of Astronomy there between 2007 and 2013. Between 2015 and 2020, he will hold an Advanced Grant from the European Research Council.

His research interests lie at the interface of observational and theoretical cosmology: the evolution of active galaxies; gravitational lensing; galaxy formation and evolution; large-scale clustering. He was UK Chairman of the 2dF Galaxy Redshift Survey (1999–2005). He is the author of "Cosmological Physics", a highly successful postgraduate textbook.

Professor Peacock has received many significant awards for his work: most notably election as a Fellow of the Royal Society (2007) and the Shaw Prize in Astronomy (2014).

Selection Committee Member

Professor
Ewine van Dishoeck

Astronomy Committee

Professor Ewine F van Dishoeck is a Professor of Molecular Astrophysics at Leiden University, the Netherlands, and External Scientific Member of the Max Planck Institute for Extraterrestrial Physics in Garching.

She graduated at Leiden University, and held positions at Harvard, Princeton and Caltech from 1984–1990. The research of her group is at the boundary of astronomy, laboratory astrophysics and chemistry and uses ground-based and space-based observatories. The current focus is on the physical and chemical evolution of material from interstellar clouds to planet-forming disks and the importance of molecules as diagnostics of the star-formation process.

Professor van Dishoeck holds many national and international science policy functions, including Scientific Director of the Netherlands Research School for Astronomy (NOVA), President-elect of the International Astronomical Union, former member of the ALMA Board and Co-PI of the JWST-MIRI instrument.

She has received the Dutch Spinoza Award, an ERC Advanced Grant, and the Dutch Academy Prize. She is a Member of the Dutch Royal Academy of Sciences and the Leopoldina German Academy of Sciences, Foreign Associate of the US National Academy of Sciences, and Foreign Member of the American Academy of Arts and Sciences.

Selection Committee Member

Professor
Bruce A Beutler

Life Science and Medicine Committee

Professor Bruce A Beutler is a Regental Professor and Director of the Center for the Genetics of Host Defense at UT Southwestern Medical Center in Dallas, Texas. He received his medical training at the University of Chicago, graduating in 1981. As a postdoctoral fellow at The Rockefeller University (1983–1986), he isolated mouse tumor necrosis factor (TNF) and discovered its importance as a mediator of inflammation. Subsequently, at UT Southwestern, he analyzed mammalian responses to bacterial lipopolysaccharide. This work culminated in the identification of Toll-like receptors as key sensors of the innate immune system, used to detect infection. In further studies, Professor Beutler employed a forward genetic strategy to elucidate many aspects of mammalian immunity.

He has received numerous awards for his work including the Balzan Prize (2007), the Albany Medical Center Prize (2009), the Shaw Prize (2011), and election to both the US National Academy of Sciences and the Institute of Medicine (2008). In 2011, he shared the Nobel Prize in Physiology or Medicine for "discoveries concerning the activation of innate immunity".

Selection Committee Member

Professor
Carol Greider

Life Science and Medicine Committee

Professor Carol Greider received a BA from UC Santa Barbara in 1983 and a PhD in 1987 from UC Berkeley. In 1984, together with Elizabeth Blackburn, she discovered telomerase, an enzyme that maintains chromosome ends. In 1988, Professor Greider was appointed as a Fellow at Cold Spring Harbor Laboratory, and in 1994 was promoted to Investigator. In 1997, Professor Greider moved to Johns Hopkins University School of Medicine. In 2004, she was appointed as the Daniel Nathans Professor and Director of the Department of Molecular Biology and Genetics at Johns Hopkins University.

Professor Greider's lab currently studies telomeres and telomerase in cancer and age-related degenerative disease. Professor Greider shared the Nobel Prize in Physiology or Medicine with Professors Elizabeth Blackburn and Jack Szostak in 2009.

Selection Committee Member

Professor Franz-Ulrich Hartl

Life Science and Medicine Committee

Professor Franz-Ulrich Hartl is a Director at the Max Planck Institute of Biochemistry in Martinsried, Germany. After completing his medical studies he earned a D med degree in Biochemistry from the University of Heidelberg and then worked as postdoctoral fellow and group leader at the University of Munich. From 1991 to 1997 he was a Professor at Memorial Sloan-Kettering Cancer Center in New York where he was appointed HHMI Investigator in 1994. Professor Hartl's laboratory has elucidated the role of molecular chaperones in protein folding and discovered that the chaperonins — a class of ATP-driven chaperones — function as nano-cages for single protein molecules to fold unimpaired by aggregation. His recent research has focused on understanding the mechanisms underlying the toxicity of protein misfolding in neurodegenerative disease.

Among Professor Hartl's honors are the Gairdner International Award, the Louisa Gross Horwitz Prize, The Rosenstiel Award, The Wiley Prize, the Albert Lasker Award for Basic Medical Research, the Heineken Prize and the Shaw Prize in Life Science and Medicine. He was elected as a Foreign Associate of the US National Academy of Sciences in 2011.

Selection Committee Member

Professor Robert J Lefkowitz

Life Science and Medicine Committee

Professor Robert J Lefkowitz, MD is James B Duke Professor of Medicine and Professor of Biochemistry at the Duke University Medical Center. He has been an Investigator of the Howard Hughes Medical Institute since 1976. He has received numerous awards and honours for his research, including the National Medal of Science, the Shaw Prize, the Albany Prize, and the 2012 Nobel Prize in Chemistry. He was elected to the US National Academy of Sciences in 1988, the American Academy of Arts and Sciences in 1988, and the Institute of Medicine in 1994.

He is best known for his studies of G protein coupled receptors, a field which he has pioneered for more than forty-five years.

Selection Committee Member

Professor
Eve E Marder

Life Science and Medicine Committee

Professor Eve E Marder received her PhD from UCSD in 1974 and did postdoctoral work at the Ecole Normale Superieure, Paris. She is the Beinfield Professor of Neuroscience at Brandeis University. In the year 2007–2008, she served as President of the Society for Neuroscience, USA.

Her honours include membership in the US National Academy of Sciences, the American Academy of Arts and Sciences, the Salpeter Award from WIN, the Gerard Prize from the SfN, the George A Miller Award from the Cognitive Neuroscience Society, the Karl Spenser Lashley Prize from the American Philosophical Society, an Honorary Doctorate from Bowdoin College, and the 2013 Gruber Prize in Neuroscience. She served on the NIH Director's BRAIN Working Group.

Professor Marder's studies in the dynamics of small neural circuits was instrumental in demonstrating that neuronal circuits are not "hard-wired" but can be reconfigured by neuromodulatory neurons and substances. Her lab pioneered studies of homeostatic regulation of intrinsic membrane properties, and stimulated work on the mechanisms by which brains remain stable while allowing for change during development and learning. Professor Marder now studies how similar network performance can arise from different sets of underlying network parameters, opening up rigorous studies of the variations in individual brains of normal healthy animals.

Selection Committee Member

Professor
Shinya Yamanaka

Life Science and
Medicine Committee

Professor Shinya Yamanaka is most recognized for his discovery of induced pluripotent stem (iPS) cells, which are differentiated cells that have been reprogrammed to the pluripotent state. He is Director of the Center for iPS Cell Research and Application (CiRA) at Kyoto University and Senior Investigator at the Gladstone Institutes in San Francisco.

Since his breakthrough finding, he has received many prestigious awards including the Shaw Prize, the Albert Lasker Basic Medical Research Award, the 100th Imperial Prize, Japan Academy Prize, and the Wolf Prize in Medicine. The significance of iPS cells was culminated with Professor Yamanaka being awarded the Nobel Prize in 2012. He serves as a Foreign Associate of the US National Academy of Sciences, the US National Academy of Medicine, Pontifical Academy of Sciences, French Academy of Sciences, and the Japan Academy. In 2014, he received an honorary degree from the University of Hong Kong, the Chinese University of Hong Kong and was named Dr Lui Che Woo Distinguished Professor by the Chinese University of Hong Kong.

Selection Committee Member

Professor
Sir John M Ball

Mathematical Sciences Committee

Professor Sir John M Ball is Sedleian Professor of Natural Philosophy and Fellow of the Queen's College at the University of Oxford, where he is Director of the Oxford Centre for Nonlinear Partial Differential Equations in the Mathematical Institute. He previously spent over 20 years in the Department of Mathematics at Heriot-Watt University, Edinburgh.

His main research interests are in applications of nonlinear analysis to mechanics, specifically problems of materials science and liquid crystals, together with related problems of the calculus of variations and infinite-dimensional dynamical systems.

He has received various awards, including the John von Neumann lecture of SIAM, the Sylvester Medal of the Royal Society, the Royal Medal of the Royal Society of Edinburgh and the David Crighton Medal of the London Mathematical Society and IMA. He is a Fellow of the Royal Societies of London and Edinburgh, and a Foreign Member of the French Academy of Sciences, the Norwegian Academy of Science and Letters, and the Istituto Lombardo. He was President of the International Mathematical Union from 2003–2006.

Selection Committee Member

Professor
David Eisenbud

Mathematical Sciences Committee

Professor David Eisenbud received his PhD in Mathematics in 1970 at the University of Chicago, and was on the faculty at Brandeis University before joining University of California, Berkeley, where he became Professor of Mathematics in 1997. He has served as Director of MSRI from 1997–2007 and from 2013 to the present. From 2009 to 2011 he was Director for Mathematics and the Physical Sciences at the Simons Foundation, and is currently on the Board of Directors of the Foundation. Professor Eisenbud's mathematical interests range over commutative and non-commutative algebra, algebraic geometry, topology, and computer methods.

Professor Eisenbud was President of the American Mathematical Society from 2003 to 2005. He is a Director of Math for America, a foundation devoted to improving mathematics teaching. He has been a member of the Board of Mathematical Sciences and their Applications of the National Research Council, and of the US National Committee of the International Mathematical Union. In 2006, Eisenbud was elected a Fellow of the American Academy of Arts and Sciences.

Selection Committee Member

Professor
W Timothy Gowers

Mathematical Sciences Committee

Professor Timothy Gowers was born in Marlborough, England, in 1963. From 1973 to 1976 he was a chorister in the choir of King's College, Cambridge, after which he went as a scholar to Eton College. He studied mathematics at Trinity College, Cambridge, where he also did his PhD, under the supervision of Béla Bollobás. In 1989 he became a research fellow at Trinity, moving to University College London two years later as a lecturer. In 1995 he returned to Cambridge, and Trinity, where he was first a Lecturer and then a Professor. He is currently a Royal Society Research Professor and also holder of the Rouse Ball Chair in Mathematics. In the early part of his career he solved some old problems in Banach space theory, including two of Banach himself. He then discovered the first quantitative proof of Szemerédi's theorem and has subsequently worked in additive combinatorics. For this work he was awarded a Fields Medal in 1998.

Selection Committee Member

Professor John W Morgan

Mathematical Sciences Committee

Professor John W Morgan is a Professor of Mathematics and Director of the Simons Center for Geometry and Physics at Stony Brook University. His work is in the areas of geometry and topology. He has concentrated study of manifolds and smooth algebraic varieties. His most recent work includes a book, joint with Gang Tian, explaining in detail the proof of the Poincaŕe Conjecture.

Professor Morgan received his PhD from Rice University in 1969. He was an instructor at Princeton from 1969 to 1972, an Assistant Professor at MIT from 1972 to 1974, and was Associate Professor and then Professor at Columbia University from 1974 to 2009. In 2009, he joined Stony Brook University.

His awards include the Levi L Conant Prize of the AMS (2009). He is a Member of the AMS, a Fellow of the AMS (2013), and a Member of the US National Academy of Sciences.

Presenter

Ms
Do Do Cheng

Award-winning Actress
Versatile TV Performer
Programme Host

Award-winning actress, versatile TV performer and programme host Ms Do Do Cheng has starred in many TVB classic dramas and won film awards, local and international. Her hosting of the Hong Kong version of "The Weakest Link" and starring in Television Broadcasts Limited's (TVB) sit-com "War of the Genders" became talk-of-the-town. Ms Cheng's success in hosting the TVB game show on legal knowledge "Justice for All" brought her career to a new height. In addition to the 2008 Beijing Olympics for TVB, she has also been hosting many yearly events of the Company namely TVB Anniversary Gala, TV Award Presentation and Miss Hong Kong Pageant. She has also been a popular talk show host at Hong Kong Commercial Broadcasting Corporation Ltd since September 2011. From its inception in 2004, Ms Cheng has been one of the presenters for the Shaw Prize Award Presentation Ceremony.

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 2011was the first major British Chinese musical to premiere in London. His music for the movie "Perhaps Love" won him a Golden Horse Award and a Hong Kong Film Award. He won Best Original Film Song for the movie "The Last Tycoon" at the 32nd Hong Kong Film Awards, and received another Best Song nomination for the movie "Insanity" at last year's Hong Kong Film Awards. For the stage, he won five Best Score awards for his musicals in Hong Kong. Mr Ko was the musical director of Jacky Cheung's 2004 world tour of "Snow, Wolf, Lake". Recent works include music for the play "Tonnochy" and the Cantonese opera "Reincarnation of the Red Plum Blossoms" in Hong Kong, as well as the score for the movie "Monster Hunt", currently the second highest grossing film ever in China. 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. Mr Ko is currently a council member of the Hong Kong Arts Development Council and the Hong Kong Academy for Performing Arts.

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