



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's Biographical Note

The Shaw Prize was established under the auspices of Mr Run Run Shaw. Mr Shaw, born in China in 1907, is 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 launched in Hong Kong in 1967. Mr Shaw has also founded two charities, The Sir Run Run Shaw Charitable Trust and The Shaw Foundation Hong Kong, both dedicated to the promotion of education, scientific and technological research, medical and welfare services, and culture and the arts.

Message from the Chief Executive

Now in its 10th year, the Shaw Prize has become one of the world's most illustrious awards for scientific achievements that have greatly benefitted humankind.

Six eminent scientists, whose work has brought us towards new frontiers of knowledge and made a profound and lasting impact on humanity, will receive the Shaw Prize this year. I sincerely congratulate all of them on their accomplishments. By grasping the laws of nature, their work has helped us to better understand our universe, the complexity of the biological clock and how to unlock the potential of big data analysis.



On this auspicious occasion, I also pay tribute to Sir Run Run Shaw, who has shown great vision through his far-sighted efforts to stimulate education, science and research, and countless other philanthropic contributions which have made our world a better place.

No doubt the Shaw Prize will continue to live up to its mission of furthering societal progress, enhancing quality of life, and enriching humanity's spiritual civilisation.

A handwritten signature in black ink, appearing to read 'C Y Leung'. The signature is fluid and cursive, written on a white background.

C Y Leung
Chief Executive
Hong Kong Special Administrative Region

Message from the Founder

The gift of imagination empowers us to change the environment and, coupled with the gift of education, allows us to build on past discoveries and progress cultural evolution. Scientific achievements



have advanced all aspects of daily life and strengthened our belief in our ability to control our destiny. Future progress will be determined by those rare individuals endowed with the ability, belief and patience to confront and conquer the unknown, and through their achievements our lives and the environment will continue to be transformed. The Shaw Prize recognizes their achievements and signals the younger generation to share their ideas and experiences to hasten discovery and facilitate change.

A handwritten signature in black ink that reads "Run Run Shaw". The signature is fluid and cursive, with a long horizontal stroke at the end.

Run Run Shaw

Message from Chairman of the Board of Adjudicators

It was in this Hall in September 2004 that the first Shaw Prize Ceremony took place. Tonight at this tenth Shaw Prize Ceremony, it is perhaps not inappropriate to remind ourselves of the reasons why the Shaw Prize was established at the beginning of the 21st century.



A century ago, in 1901, the Nobel Prize was launched in Stockholm with Roentgen as the first physics Nobel Prize Laureate. Roentgen's discovery of x-rays was, as we all know, very, very important for mankind. But in retrospect its importance was dwarfed by other later discoveries that have saved even more human lives: In 1923 there was the discovery of insulin as the cure for diabetes, the disease more feared at that time than cancer is today. In 1945 there was the discovery of penicillin, the miracle drug, which together with its derivatives has saved more human lives than any other medicine known to mankind.

Indeed discoveries in physical and biological sciences in the 20th century have brought about unprecedented advances in human productivity, health and welfare, as well as its intellectual horizon, thereby fundamentally changing the fate of mankind on earth.

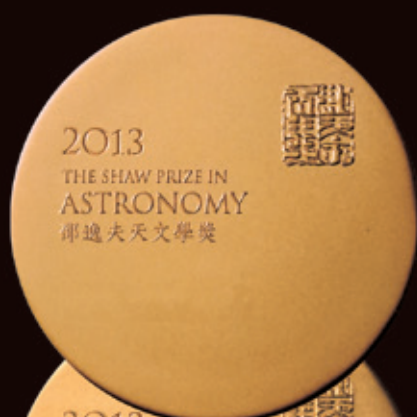
But such advances unfortunately also brought about unprecedented new problems for the 21st century, which include: explosive growth of population, shortage of resources, worsening environmental problems, the threat of epidemics and of nuclear war, etc. And it is obvious that these difficult problems can only be solved by new advances in scientific research.

It was to promote and foster such advances in scientific research that Sir Run Run decided to establish the Shaw Prizes at the turn of the century.

Chen Ning Yang

Chen-Ning Yang

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 B.C.) meaning "Grasp the law of nature and make use of it" appears in the upper right corner.

AGENDA

Arrival of Officiating Guest and Laureates

Welcome Speech by **Professor Chen-Ning Yang**

Member of the Council

Chairman of the Board of Adjudicators, The Shaw Prize

Speech by **Professor Peter Goldreich**

Member of the Board of Adjudicators

Chairman of the Selection Committee for the Prize in Astronomy

Speech by **Professor Yuet-Wai Kan**

Member of the Board of Adjudicators

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

Speech by **Professor Peter C Sarnak**

Member of the Board of Adjudicators

Chairman of the Selection Committee for
the Prize in Mathematical Sciences

Award Presentation

Grand Hall

Hong Kong Convention and Exhibition Centre

23 September 2013

AWARD PRESENTATION

(Category listed in alphabetical order)

Astronomy

Professor Steven A Balbus

and

Professor John F Hawley

Life Science and Medicine

Professor Jeffrey C Hall,

Professor Michael Rosbash

and

Professor Michael W Young

Mathematical Sciences

Professor David L Donoho



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 2013

Steven A Balbus

and

John F Hawley

**for their discovery and study of the magnetorotational
instability, and for demonstrating that this instability
leads to turbulence and is a viable mechanism
for angular momentum transport in
astrophysical accretion disks**

An Essay on the Prize in Astronomy 2013

The attractive force of gravity is responsible for the formation of bound structures over a wide range of scales, from planets to clusters of galaxies. Unbalanced, gravity would cause matter to collapse into black holes. Fortunately, the concentration of mass by gravity is impeded, at least temporarily, by the requirement that the contracting material rid itself of excess energy and angular momentum. Bulk kinetic energy can be converted into heat and radiated away but angular momentum is less readily disposed of. Consequently, contracting material often assumes the form of a differentially rotating disk. Familiar examples include Saturn's rings and spiral galaxies. Nascent stars grow by accreting mass from disks that live several million years. The coplanar orbits of the solar system planets and multi-planet systems around other stars are vestiges of these disks.

More exotic accretion disks are found around compact objects such as white dwarfs, neutron stars and black holes. These systems shine by radiating gravitational potential energy released as mass spirals inward. For fluid to spiral in, its angular momentum must be transported out, but how this happens was for long a mystery. For decades, it was speculated that accretion disks were unstable and that the accretion torque arises from turbulent stresses. However, analytic analyses and numerical simulations consistently failed to identify any appropriate instability. In 1991 Balbus and Hawley announced an elegant solution to this longstanding problem. They demonstrated that even a weak seed magnetic field is sufficient to unleash a powerful instability, the magnetorotational instability (MRI), that both creates and sustains turbulence while also amplifying the magnetic field.

The beauty and simplicity of the MRI is neatly captured graphically. Data for the plots shown below (Fig. 1) were obtained by solving Newton's equations of motion for two identical particles revolving counterclockwise around a spherical central mass. In the upper sequence the particles move independently on circular coplanar orbits. As discovered by Kepler and later explained by Newton, the orbital period increases as radius raised to the $3/2$ power. This accounts for the growing lead in longitude of the inner (green) particle with respect to the outer (red) one. The separation of the particles increases by about a factor of five in a single orbital period. In the lower sequence, the particles are connected by an elastic tether whose tension increases in proportion to its length. Although the particles start out on circular orbits, deviations soon become apparent. By the end of the sequence both their separation and the tension in the tether have increased more

than tenfold. Comparison of the upper and lower sequences reveals a remarkable fact. Two particles separate more rapidly when gently pulled towards each other by the tether than they do when moving independently. This is a consequence of the seemingly obstinate behavior of an orbiting body. Gently pulled forward (backward), it moves onto an orbit of larger (smaller) radius where it orbits more slowly (rapidly).

The tether transfers angular momentum and energy from the inner to the outer particle. The total angular momentum carried by the two particles remains unchanged. However, their total energy decreases with the deficit stored as elastic energy in the tether. It is important that the behavior of the particles linked by the tether is an instability. The rate at which the inner particle spirals inward and the outer outward is proportional to the tether's tension. Moreover, the rate at which the tension increases depends upon the rate at which the particles separate. No matter how small the initial tension is set, both the separation of the particles and the magnitude of the tension grow exponentially.

How does this simple example relate to the MRI? Given sufficient electrical conductivity, magnetic field lines couple fluid elements they link and provide a tension which grows as they stretch. A key point is that the MRI amplifies weak magnetic fields. This is the crucial ingredient of a dynamo. A full treatment of the MRI requires large scale numerical simulations. In place of our simple two particle system, imagine many pairs of particles connected by tethers. As they move the tethers stretch, break and reconnect. Viewed this way, perhaps it is not surprising that a fluid undergoing the MRI exhibits a complicated flow called turbulence.

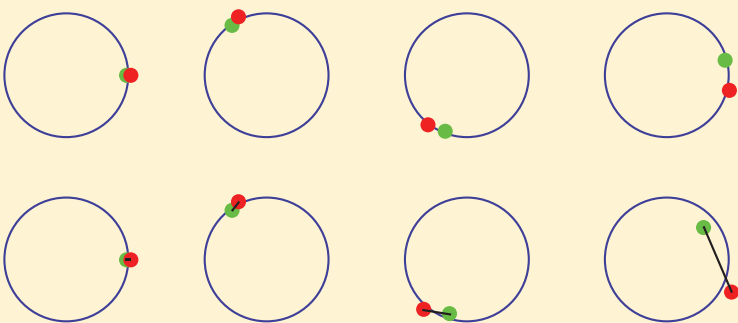


Fig. 1 - To be read from left to right and top to bottom.

Video link reference: <http://www.shawprize.org/essayinastronomy2013>

Steven A Balbus Laureate in Astronomy



I was born in Philadelphia in 1953 and attended the William Penn Charter School for my secondary education. I was particularly drawn to mathematics. In my last year in high school, I was excused from these classes. I also developed an interest in astronomy, then a sort of hobby.

In 1971, I entered the Massachusetts Institute of Technology. I thoroughly enjoyed my experience. I was much taken with my applied mathematics and physics courses, and elected to double major in these two subjects. I still followed astronomy at the *Scientific American* level, so at the conclusion of my undergraduate studies I decided to continue in theoretical astrophysics, a natural union of all my interests.

My PhD studies were undertaken at the University of California, Berkeley. The thesis work was guided by Christopher McKee, whom I held, and continue to hold, in the highest regard. The Astronomy Department in Campbell Hall hosted at that time a cadre of brilliant postdocs, many of whom would ultimately dominate their fields. For a graduate student, it was a daunting but exhilarating experience. I completed my thesis in 1981 on the fate of cool interstellar gas clouds embedded in a very hot ambient plasma. The thesis involved some knotty challenges that took a long time to understand, and impressed upon me the subtlety that often attends problems in astrophysical fluids.

After formative postdoctoral appointments at MIT and Princeton, in 1985 I accepted a faculty offer from the UVa. I became fascinated by the thermal stability behavior of X-ray emitting gas, then a University of Virginia specialty. In the course of my studies, I found that cooling in a *magnetized* gas was very different from an unmagnetized gas, even if the field is quite weak. This was surprising, and made a deep impression upon me.

John Hawley arrived at the UVa in 1987. We got on well from the start, and began collaborating. John had a definite idea about what constituted the best topic to be working on: accretion disks. I was no stranger to disk dynamics, having done calculations on gas in spiral galaxies during my postdoc. In 1990, John showed me a paper in which a wave propagating through a disk amplified a magnetic field. The wave itself, however, was not allowed to be altered by the field. Based on my thermal studies, I was unconvinced by this approach. So I worked the problem from scratch, including the magnetic field self-consistently, and after sorting out some conceptual puzzles, discovered something peculiar. An additional, highly unstable, mode appeared. Subsequent literature searching showed that others had started down this route, but in a very opaque manner. The significance had not been grasped at all. In 1990, the unstable mode had no name. It is now known as

the magnetorotational instability (MRI), and has become part of the astrophysical landscape.

Having played a key developmental role, John possessed one of the few magnetohydrodynamic codes in the world. He was able to verify the analysis and then led the way in showing that the outcome of the instability was turbulence. The origin of accretion disk turbulence had been a longstanding astrophysical puzzle, and we were both tremendously excited. We now understood the physics of why simple disk orbits broke down, and could both simulate and visualize the turbulence. Our combination of skills put us in a unique position to give substance to notions that previously had been speculation and phenomenology, laying the groundwork of a new field. Indeed, the MRI goes beyond accretion disks, it proved to be a whole new window on the dynamics of weakly magnetized astrophysical gases. I was thus able to spend several happy years working on progressively more ambitious studies of this type of problem with students and postdocs.

In 2004, I moved to the Ecole Normale Supérieure in Paris, France. It meant having to break a close working relationship with John, but personal events had intervened. Two years earlier I had married Caroline Terquem, a French astrophysicist. Now a position had come my way at the ENS, a renowned institution up the street from the Institut d'Astrophysique de Paris, where Caroline worked. Shortly after arrival, I was awarded a Chaire d'excellence by the French Ministry of Higher Education, which supported my work generously. I was able to purchase a cluster for large scale simulations and to hire several excellent postdocs. My work focused on the dynamics of protoplanetary disks, magnetic Prandtl number effects in turbulence, and pursuing thermal analogues of the MRI with heat playing the role of angular momentum. Later, I became something of a solar astronomer, developing with colleagues a novel approach to understanding important features of the Sun's internal rotation.

In the autumn of 2012, I moved to Oxford University to take up the post of Savilian Professor of Astronomy, succeeding Joe Silk in this ancient and venerable Chair. Caroline also secured an excellent position at Oxford. We were both delighted with this turn of events, together with the many opportunities it afforded.

It has been my good fortune to have worked with exceptional mentors, colleagues, postdocs, and students. They say that fortune favors the prepared mind, but I have little doubt that much of what I have been able to accomplish has been strongly influenced by interacting with these individuals. This occasion is just the moment to thank them from the bottom of my heart.

John F Hawley Laureate in Astronomy



I was born in Annapolis, Maryland in 1958. My family lived in Severna Park, Maryland until early 1965 when we moved to Salina, Kansas. Our family consisted of my parents, Bernard and Jeanne Hawley, my brothers Jim and Steve, my sister Diane, and assorted cats. My interest in astronomy was stoked by my fascination with the 1960s era space programme. Isaac Asimov's essays, especially those on cosmology, black holes and space, were also influential. My older brother Steve served as a role model. His abiding interest in astronomy led him eventually to a PhD in astronomy and a career as a space shuttle astronaut.

I graduated from Salina Central High School in 1976 and attended Haverford College in Pennsylvania where I majored in astronomy and physics. My senior thesis project was computational; I modelled the nuclear reactions of the helium-burning shell of a red giant star. Sometime in my senior year I attended a seminar on accretion disks, then a novel subject. I was struck by the comment that no one knew the nature or strength of the internal stress that drove accretion, but that ignorance could be reduced to a single parameter, "alpha." This was my introduction to the fundamental problem in accretion.

After graduation in 1980, I joined the graduate programme at the University of Illinois. My PhD adviser Larry Smarr, a pioneer in numerical relativity, inspired me to pursue the numerical simulation of gas dynamics around black holes as a thesis topic.

I completed my PhD in 1984 and went to the California Institute of Technology as a Bantrell Prize Fellow. Among other things, I studied a global disk instability discovered by John Papaloizou and James Pringle. I collaborated with members of the theoretical astrophysics group in a way that combined simulation and analysis. This synergy provided new insight into the fundamental nature of the instability, and found a previously unknown type of orbiting equilibrium. This set the pattern for future work.

During my postdoctoral years I attended a conference on general relativity where I met a graduate student named Katherine Holcomb, who was presenting work on general relativistic simulations of non-isotropic cosmologies. She was eventually to become my wife; conferences can inspire one in new and rewarding directions.

I joined the faculty at the University of Virginia in the fall of 1987. My experience at Caltech had impressed upon me the power of wedding numerical simulation with analysis. Steve Balbus, with his keen understanding of fluid dynamics and formidable mathematical skill, was the ideal collaborator. By 1990, Steve and I had started to consider the nature of waves in a magnetized disk. Steve's earlier experience with cooling flows of gas in galaxy clusters had impressed upon him that magnetic fields can change the linear properties of a gas in significant ways. As it turned out, this was especially true in a disk, where magnetic fields prove to be unstable to the magneto-rotational instability, or MRI. When Steve showed me his first results, my response was simple: "That's very important." I immediately ran a short simulation of vertical magnetic fields in a disk. A plot from that first simulation showed the development of kinks in the initially smooth field lines. Steve kept that plot on his office wall for many years.

A demonstration that the MRI led to turbulence and stress required three-dimensional simulations. Steve, Charles Gammie and I published the first turbulent "shearing box" simulations in 1995. The shearing box approximation has proven to be a valuable tool; it has since been used for a wide range of problems in a variety of astrophysical contexts.

In 2003 I returned to general relativistic simulations when my postdoc Jean-Pierre De Villiers and I developed a new GR-MHD code. Over the last decade I have collaborated with Julian Krolik (Johns Hopkins University) on global simulations of disks and jets. GR-MHD disk simulations are now widely used to investigate increasingly detailed issues of stress distribution, emission, and jet formation. The theory community seems to be moving rapidly toward fulfilling the dream of first-principle disk models.

In 2006 I was asked to be the Chair of the Department of Astronomy. In 2012 I was appointed the Associate Dean for the Sciences in the College of Arts and Sciences. While administration is not nearly as much fun as computational theoretical astrophysics, I have gained a considerably broader perspective into the academy and the wide range of scientific disciplines contained within.

Looking back at my education and career, one thing stands out: the interactions with insightful individuals who influenced my thinking along constructive new paths. I was fortunate to participate in the tremendous growth of computational astrophysics. I was even more fortunate to work with collaborators whose unique skills, knowledge and ability could complement my own so well.



Professor Yuet-Wai Kan

*Member of the Board of
Adjudicators*

*Chairman of the Selection
Committee for the Prize in
Life Science and Medicine*

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 Cagliari, Italy, The Chinese University of Hong Kong, The University of Hong Kong and The Open University of Hong Kong.



The Prize in Life Science and Medicine 2013

**Jeffrey C Hall,
Michael Rosbash
and
Michael W Young**

**for their discovery of molecular mechanisms
underlying circadian rhythms**

An Essay on the Prize in Life Science and Medicine 2013

Circadian rhythms of activity and physiology are evident across the animal kingdom as well as in plants and some bacteria. The scientific study of biological clocks goes back almost 300 years to a French astronomer called Jean-Jacques d'Ortous De Mairan, who discovered that the diurnal closing of *Mimosa* leaves persisted under conditions of constant darkness. Whether this was due to mysterious “magnetic rays”, or to the presence of an equally mysterious internal clock in the plant was controversial, but it later became clear that light-independent twenty-four hour clocks could also be found in animals. The mechanisms underlying such clocks were a long-standing puzzle until the Shaw Prize Laureates of 2013, Jeffrey C Hall, Michael Rosbash and Michael W Young discovered two key components of the endogenous clock mechanism of the fruit fly, *Drosophila melanogaster*. Over the course of the last twenty-five years, thanks to the work of these pioneers, details of the clock mechanism in animals have steadily emerged. It is a much more complicated molecular machine than any theorist had imagined.

The crucial first step for the molecular understanding of biological clocks came in 1971, when Ronald Konopka and Seymour Benzer identified three mutant strains of fruit flies that showed heritably altered circadian rhythms. Mapping the mutations revealed a single gene, *Period*, or *Per*, that could be mutated to give either shorter or longer cycles of activity, or no rhythmic activity cycles at all. Clearly, *Per* was intimately connected with the clock. But how the clock worked could only be a matter for speculation until the *Per* gene was cloned, a challenging feat that was achieved in 1984 by Michael Young at Rockefeller University and, independently, by a collaboration between Jeffrey Hall and Michael Rosbash at Brandeis University. But the deduced protein sequence of *Per* did not at first reveal its nature or function.

The truth began to dawn in 1988 and 1990, when the Hall and Rosbash labs measured *Per* protein and mRNA levels in the flies' heads during the day and night. High levels of *Per* were found at night, and low levels by day. Crucially, these circadian oscillations continued even when the animals were kept in constant darkness, suggesting that *Per* was truly a central component of the clock mechanism. The most revealing finding was that the level of *Per* messenger RNA was maintained at a constant high value in arrhythmic *Per* mutants, implying that *Per* shut off its own synthesis. This turned out to be quite right: *Per* is a transcriptional repressor.

The next clue came from Young's lab in 1994, where a fresh genetic screen for flies with abnormal circadian rhythms revealed a second key component of the clock, called Timeless, or *Tim*. Remarkably, their studies revealed that levels of *Tim* protein and mRNA oscillate in parallel with *Per*. Even more telling, in *Tim* mutant

flies with disrupted circadian rhythm, *Per* protein failed to enter the nucleus where it normally accumulates, indicating a critical interaction between *Tim* and *Per*.

Subsequent studies provided additional information on the core clock mechanism discovered by Hall, Rosbash, and Young. Further genetic screens by the two groups uncovered a number of proteins needed for proper functioning of the core mechanism, including Doubletime, a kinase discovered by Young's lab that regulates the half-life of the *Per* protein, Cryptochrome, a light sensor uncovered by the Hall and Rosbash labs that allows entrainment, or resetting, of the clock, and other proteins involved in the transcription of *Per* and *Tim* genes, or the stability or nuclear localization of *Per* and *Tim* proteins. Other groups also began to contribute to the growing understanding of the *Drosophila* clock and, beginning with the cloning of a mouse clock gene by Joseph Takahashi's group, information began to appear about a related clock mechanism in mammals.

With time, a detailed picture has emerged in which the protein products of the *Per* and *Tim* genes associate and are transported to the nucleus. There, the *Per-Tim* complex inhibits *Cycle* and *Clock*, two factors needed for *Per* and *Tim* gene transcription, resulting in a drop in the production of *Per* and *Tim* mRNAs and proteins. A further decline in nuclear *Per-Tim* complexes occurs owing to specific kinases and phosphatases that alter protein stability and/or transport to the nucleus. As a result, the repression of *Per* and *Tim* gene transcription is relieved, transcription restarts, and the whole process is then repeated. The correct twenty-four hour timing of the cycle is ensured by built-in delays between transcription and translation, as well as by the enzymes that regulate the stability of *Per-Tim* complexes and their nuclear transport.

The pioneering studies of Hall, Rosbash and Young on circadian rhythms constitute a major contribution to our understanding of a fundamental biological process. They discovered the core components and mechanisms of the *Drosophila* circadian clock and then went on to make numerous additional contributions to our present knowledge of how these mechanisms are regulated to ensure proper twenty-four hour cycles of physiology and behavior. We now know that many of the genes involved in the *Drosophila* circadian clock are present not only in insects, but also in mammals, where they appear to play similar roles. The human circadian clock is associated with sleep as well as other processes, including daily fluctuations in hormones and metabolism. Two human counterparts of the *Drosophila Period* gene have now been associated with hereditary syndromes that affect circadian patterns of sleep in humans, suggesting that these and other clock genes first discovered in fruit flies could ultimately shed light on mechanisms that control sleep as well as other important processes under circadian control in humans.

Jeffrey C Hall Laureate in Life Science and Medicine



Photo: © Brian Summers

I spent my formative years in the suburbs of Washington DC, USA. Subsequently, I was a student at Amherst College (Amherst, MA, USA), where I concentrated on studying biology. In conjunction with those activities, I performed some entry-level research under the tutelage of a professional biologist who, I later learned, was a *Drosophila* geneticist of high reputation — but even during my college stint as a low-level researcher, I had perceived my trainer to be a valuable mentor. This experience influenced me to enter graduate school at a place where I could further my genetic education and training, leading to my earning a PhD in Genetics from the University of Washington, Seattle, WA, USA in 1971. My thesis research mostly involved hard-core *Drosophila* genetics, augmented by my gaining some modest experience involving the organism's biology. In a sense, that component of my graduate-student experience served as a springboard for me to seek post-doctoral training in “bio-genetics”.

This next career stage transpired at the California Institute of Technology (Pasadena, CA, USA), where I investigated *Drosophila* neurobiology and behavior, taking a genetic approach. As of early 1974, I moved from my post-doc location to become a faculty member at Brandeis University (Waltham, MA, USA) and there I continued to investigate in the arena

of *Drosophila* behavior — and neuro-genetics. Initially, my laboratory at Brandeis concentrated on reproductive biology on the one hand, and neurochemical variants on the other. An element of the fruit-fly’s courtship behavior was revealed by our lab to include a rhythmic component. This discovery prompted me and colleagues to begin investigating genetic variants manifesting various kinds of biological-rhythm abnormalities.

As the 1980s (and subsequent) decades unfolded, this research homed-in upon daily (“circadian”) rhythms in *Drosophila* and principally involved the animal’s behavior (daily cycles of locomotion versus rest). The approach to studying such phenomena remained genetic, substantially enhanced by infusing the principles and practices of molecular genetics. The latter investigations were performed via a collaboration between the Hall lab and that of Michael Rosbash (also at Brandeis University). Accomplishments effected during the course of this collaborative research included molecular identification of a previously known “clock gene”, genetic and molecular identification of novel such factors, elucidation of ways that the products of such genes act and interact to comprise a “core” circadian-clock, and analysis of the neural substrates underlying rhythmic behaviour.

Michael Rosbash Laureate in Life Science and Medicine



I am always reluctant to write about my life. When necessary, I follow the advice of the Queen in *Alice in Wonderland*. When asked by Alice how to proceed on her journey, the Queen replied, “Start at the beginning, continue until you get to the end, then stop.” Although a length restriction makes this strategy challenging, I will try to follow this chronological advice with only a few exceptions. The first is that I won’t start quite at the beginning, which is not my early childhood or even my birth but the emigration of my parents from Nazi Germany and their new life in the USA. A one sentence summary of these events is that after some years of trouble and considerable hard work, my parents established a satisfactory if not comfortable life for themselves and their two children.

My father then died of a heart attack at forty-two years of age, when I was ten and my brother was six. This tragedy affected the emotional stability of my small nuclear family. A difficult home life continued until I left for college at the age of seventeen. In fact, I chose to go to Caltech not only because of its sterling reputation as a science educational institution but also because it was 3,000 miles from my home in Newton Massachusetts. I was a difficult kid and a somewhat indifferent student but realized somehow that a new start at a good place and far from home was important.

Nonetheless, Caltech did not smooth over all my personal rough edges. Remarkably, these idiosyncrasies did not destroy my professional progress — in school, at university and afterwards, which is a testament to the American system. Moreover, my nine years of post-secondary school education, the four at Caltech and the five more at MIT, were at particularly liberal institutions. In addition to the fact that it was the 60s, an especially permissive time, elite US institutions like Caltech and MIT are filled with weird characters. Importantly, many of my professors were also wildly enthusiastic about their jobs and research, which was infectious. My PhD adviser Sheldon Penman certainly deserved the adjective “weird,” but he was brilliant, fun and a great mentor. The 60s and 70s were also a time of dramatic expansion in universities and research. In short, I came of age in a golden era of meritocracy and optimism in scientific academia.

I arrived at Brandeis in the fall of 1974 after three wonderful post-doc years in Edinburgh, from the personal as well as the professional point of view. I loved the city as well as the UK, and my post-doc mentor John Bishop taught me a lot about nucleic acids and biology in general. Indeed, my entire eight years in research had been focused on gene expression, and I continued this kind of work when I first arrived at Brandeis. Although “gene expression” and “genetics” were almost indistinguishable from the perspective of neuroscience or physiology, the latter had its own culture – and practices. I myself only realized this after arriving at Brandeis in the fall of 1974.

This is in large part because my then pal and future *Drosophila* circadian rhythm collaborator Jeff Hall was the quintessential genetics devotee — and prophet. Jeff arrived at Brandeis six months before I did, and we became fast friends. We were both keen on sport, as participants as well as spectators, and we had similar political interests. However, it was not until 1982 that we began working together. This is because my biochemical expertise was irrelevant until recombinant DNA technology became a practical possibility in about 1980. It allowed a molecular attack on, and ultimately a demystification of circadian rhythms. This work was initiated by us at Brandeis and independently by Mike Young and colleagues at Rockefeller University. My contributions to this field continue to this day and mean of course the contributions of my lab. I owe an immeasurable debt of gratitude to the talented people who worked with me over these thirty years. Without their tireless efforts, none of this would have been possible. These people also made and continue to make the lab a fun place to work, and I consider many of them friends as well as colleagues.

1982 was also a watershed year from a personal point of view. I began a relationship with my graduate student Nadja Abovich, who became my wife. I have two wonderful daughters, Paula who is now thirty-eight and from my wife’s first marriage and Tanya who is twenty-seven. Sport remains a major interest in the family. More importantly, these three women have been an indispensable source of love and stability, which have complemented my professional life. I am so fortunate to have found joy at home as well as at work.

Michael W Young Laureate in Life Science and Medicine



My parents grew up in Knoxville Tennessee and drove to Miami Florida for their honeymoon in 1946. After a few days of warm weather in the middle of winter they decided to stay. My father managed aluminum ingot sales throughout the Southeastern United States for Olin Mathieson Chemical Corporation. My mother worked as a secretary at a law firm. I was born in 1949 and my sister, Denise, who now lives in Dallas Texas, was born in 1951.

Although there was no history of science or medicine to be found in either of my parents' families, and formal education for my parents ended with high school, they both encouraged my interest in science. They bought me the microscopes and telescopes I begged for and tolerated my destruction of a terra cotta floor with my chemistry set. I also had an interest in machinery and built a go-kart from a frame I found at a used bike store and a gasoline engine I unbolted from the family lawnmower. It was very crude — I ran a chain from a sprocket I put on the crankshaft directly to another on a rear half-axle. You pushed it to start it and then had to jump on and hit the gas to keep it from stalling. It would do about 30 mph and had poor brakes.

Our backyard was my jungle. There were private zoos in the area and animals were always escaping. I would find iguanas, parrots and toucans in our trees. There was also a strange plant with flowers that closed during the day and opened at night. When I was twelve or thirteen, my parents gave me a book on Darwin, evolution, and a range of biological mysteries. There was a description of biological clocks that control those flower movements and help birds and insects to navigate. The book made it clear that the location and composition of these clocks were completely unknown.

Our family moved to Dallas Texas when I was in high school. In 1971 I graduated from the University of Texas at Austin. I stayed on for graduate school after a fascinating summer of research with Burke Judd. Genetic studies suggested the *Drosophila* genome contained only 5,000 or 6,000 genes - no more than many bacteria. I wanted to know if genes with subtle roles in the life of the fly had been missed. I collected randomly induced chromosome rearrangements and then asked whether each break was lethal or viable. What was the proportion? I thought I could look for subtle

phenotypes in the non-lethal breaks after I had already collected them. When I was well into this project, Ron Konopka and Seymour Benzer reported their discovery of *Drosophila* circadian rhythm mutants at the period (*per*) locus. I realized one of my chromosome rearrangements broke the gene. That provided my doorway to cloning the gene a few years later.

I went to Dave Hogness' lab at Stanford in 1975 for postdoctoral work and to learn how to do molecular biology. Methods for producing "Recombinant DNA" had just been introduced and Dave was applying these to *Drosophila* chromosomes. Thanks to Burke Judd I did not leave Texas alone. A few years earlier Burke had introduced me to an undergraduate student, Laurel Eckhardt. By this time we were inseparable, so while I worked with Dave Hogness, Laurel worked on a PhD with Len Herzenberg just down the hall.

When I started my lab at The Rockefeller University in 1978 I began to think about *per* again — was it premature to try to use molecular biology to study behavior? In 1983, together with a postdoc in the lab, Ted Bargiello, now at Einstein College of Medicine, I used my old chromosome rearrangements from Texas to locate and map the gene in a prolonged chromosome walk. Ted constructed segments of recombinant DNA, amplified them in bacteria, and I injected the purified DNA into *per* mutant (arrhythmic) *Drosophila*. Ted and I camped in the lab night and day to watch the fly activity patterns that would tell us if we had the gene. In those days activity data were collected on chart paper. As a fly began to walk, a pen would start to leave jagged lines of red ink. It took about twenty feet of chart paper and three or four days and nights to convince us we had transferred a functional *per* gene and restored circadian behavioral rhythms to the mutant fly. This was of course only the beginning of studies that were to occupy my interests for the next thirty years.

Today Laurel and I work within a few blocks of each other. Laurel is a Professor of Biology at Hunter College and oversees the Biology PhD programme for all campuses composing the City University of New York. We have two daughters. Natalie is a PhD student at the University of Pennsylvania and Arissa is a medical student at Einstein College of Medicine.



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 2013

David L Donoho

**for his profound contributions to modern
mathematical statistics and in particular
the development of optimal algorithms for statistical
estimation in the presence of noise and of
efficient techniques for sparse representation
and recovery in large data-sets**



An Essay on the Prize in Mathematical Sciences 2013

For more than two decades David Donoho has been a leading figure in mathematical statistics. His introduction of novel mathematical tools and ideas has helped shape both the theoretical and applied sides of modern statistics. His work is characterized by the development of fast computational algorithms together with rigorous mathematical analysis for a wide range of statistical and engineering problems.

A central problem in statistics is to devise optimal and efficient methods for estimating (possibly non-smooth) functions based on observed data which has been polluted by (often unknown) noise. Optimality here means that, as the sample size increases, the error in the estimation should decrease as fast as that for an optimal interpolation of the underlying function. The widely used least square regression method is known to be non-optimal for many classes of functions and noise that are encountered in important applications, for example non-smooth functions and non-Gaussian noise. Together with Iain Johnstone, Donoho developed provably almost optimal (that is, up to a factor of a power of the logarithm of the sample size) algorithms for function estimation in wavelet bases. Their “soft thresholding” algorithm is now one of the most widely used algorithms in statistical applications.

A key theme in Donoho’s research is the recognition and exploitation of the fundamental role of sparsity in function estimation from high dimensional noisy data. Sparsity here refers to a special property of functions that can be represented by only a small number of appropriately chosen basis vectors. One way to characterize such sparsity is to minimize the L^0 -norm of the coefficients in such representations. Unfortunately, the L^0 -norm is not convex and is highly non-smooth, making it difficult to develop fast algorithms for its computation. In addition to pioneering the exploitation of sparsity, Donoho also introduced

the computational framework for using the L^1 -norm as a convexification of the L^0 -norm. This has led to an explosion of efficient computational algorithms realizing this sparsity framework which have been used effectively in a wide variety of applications, including image processing, medical imaging, data mining and data completion.

A recent and much celebrated development along this sparsity- L^1 theme is Compressed Sensing (a term coined by Donoho). Data compression is widely used nowadays — for example the JPEG standard for compressing image data. Typically, the data is gathered from sensors (for example a camera) and the data is then compressed (that is represented by a much smaller number of coefficients in an appropriate basis, while preserving as much accuracy as possible). Corresponding de-compression algorithms are then used to recover the original data. The revolutionary idea in Compressed Sensing is to shortcut this standard approach and to “compress while sensing”, that is to collect a small number of appropriately chosen samples of the data, from which the original data can be recovered (provably exactly under appropriate assumptions) through corresponding de-compression algorithms. The key ingredients are again sparsity (most typical in a wavelet basis), use of L^1 -norm for recovery, and the use of random averaging in sensing. Along with Emmanuel Candes and Terence Tao, Donoho is widely credited as one of the pioneers of this exploding area of research, having contributed fundamental ideas, theoretical frameworks, efficient computational algorithms and novel applications. This is still a thriving area of research with wide applications, but already many stunning results have been obtained (both theoretical and practical).

David L Donoho Laureate in Mathematical Sciences



My father Paul was a physics professor at Rice University. I remember the chalk dust, slate blackboards and marble hallways of his academic office, and the lasers and low-temperature gadgets in his laboratory. Paul took our family on sabbatical to Grenoble, France, where I attended 6th grade — a transforming educational experience.

For university, my mother Julia chose Princeton, a hotbed of bright and ambitious students (eg. Eric Lander!). My father's advice was 'learn computers'; so I developed data analysis software for the Statistics Department. John Tukey, inventor of the Fast Fourier Transform and the words 'bit' and 'software', was my undergraduate thesis adviser; Tukey advocated robust statistical methods, such as fitting equations by minimizing the ℓ_1 norm of residuals rather than the ℓ_2 norm. He criticized 'classical' mathematical statistics as searching for polished answers to yesterday's problems.

After college, I worked in oil exploration research for Western Geophysical, and witnessed the seismic signal processing revolution driven by digital measurement and exciting computer algorithms. Ongoing experiments in blind deblurring and signal recovery from highly incomplete measurements were phenomenally successful. Experimentally, minimizing the ℓ_1 norm of the reconstructed signal (rather than the ℓ_2 norm of the residual) was miraculously effective. The strange interactions of sparse signals, undersampled data, and ℓ_1 -norm minimization, inspired me (age 21!) to pursue 'non-classical' mathematics, to one day explain and use such phenomena.

At Berkeley during my postdoctoral and junior faculty years (1985–1990), I was in the Mecca of classical mathematical statistics, but I pursued my 'non-classical' interests. Iain Johnstone and I showed how to optimally 'denoise' sparse signals observed in noise, injecting 'sparsity' into top statistics journals. A sparse signal sticks up here and there above the noise, like daisies above weeds; our denoiser, based on ℓ_1 -minimization, chops away the weeds while leaving the daisies. Jeff Hoch and Alan Stern successfully applied such ideas in Magnetic Resonance spectroscopy.

To publish 'non-classical' work on undersampled measurements of sparse signals, I turned to applied mathematics journals. Philip Stark and I found that a highly sparse signal could be perfectly recovered from randomly chosen (slightly) incomplete Fourier measurements, by ℓ_1 -minimization on the recovered signal. Ben Logan and I extended Logan's PhD thesis, and work of Santosa and Symes, to show that sparse signals missing low frequency information could be perfectly recovered, again by ℓ_1 -minimization on the recovered signal. Finally, sparse signals missing high frequencies need really very few measurements, if the sparse signal is nonnegative.

'Wavelets' swept over applied mathematics in 1988-1992, led by Yves Meyer, Ingrid Daubechies and Stephane Mallat. The wavelet transform could sparsify

signals and images; I was inspired! Iain Johnstone, Dominique Picard, Gérard Kerkycharian and I used wavelets to optimally remove noise from certain kinds of signals and images. The wavelet transform turned noisy images into sparse signals embedded in noise, and we could rescue the daisies from among the weeds, using ℓ_1 -minimization.

Coifman and Meyer, and Mallat and Zhang, proposed in the early 1990's to represent signals by combining several transforms – controversial to most, because the equations would be underdetermined, but inspiring to me. Scott Chen, Michael Saunders and I showed that ℓ_1 minimization ('Basis Pursuit') could often successfully find sparse solutions to such systems.

By the late 1990's, I sought theory explaining such successes. Xiaoming Huo, Michael Elad and I gave 'incoherence' conditions on underdetermined systems guaranteeing that ℓ_1 minimization found sufficiently sparse solutions perfectly; soon, many others entered this area. In 2004, Emmanuel Candès and Terence Tao got dramatically stronger guarantees by interesting and deep mathematics, triggering a tidal wave of interest.

My 2004 paper 'Compressed Sensing' explained that, because the wavelet transform sparsifies images, images can be recovered from relatively few random measurements via ℓ_1 minimization. Michael Lustig's 2007 Stanford Thesis used compressed sensing in medical imaging MRI, and, with co-authors, pushed MRI to solve seemingly intractable problems, where ℓ_1 -minimization from undersampled measurements enables totally new application areas, like MRI movies of the beating heart, or MR spectroscopic imaging (revealing metabolism). In recent MRI conferences, compressed sensing became the most popular topic.

During 2004–2010, Jared Tanner and I discovered the precise tradeoff between sparsity and undersampling, showing when ℓ_1 -minimization can work successfully with random measurements. Our work developed the combinatorial geometry of sparse solutions to underdetermined systems, a beautiful subject involving random high-dimensional polytopes. What my whole life I thought of privately as 'non-classical' mathematics was absorbed into classical high-dimensional convex geometry.

Arian Maleki, Andrea Montanari and I discovered in 2009 a new approach to the sparsity/undersampling tradeoff. Solving random underdetermined systems by ℓ_1 -minimization was revealed as *identical to* denoising of sparse signals embedded in noise. Two separate threads of my research life became unified.

This brutally compressed account omits extensive work by many others, often more penetrating than my own, and much prehistory. I thank my mentors Peter Bickel, Raphy Coifman, Persi Diaconis, Brad Efron, Peter Huber, Lucien Le Cam and Yves Meyer, all my co-authors, students, and postdocs, and my wife Miki and son Daniel.

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Mr Run Run Shaw (Founder of The Shaw Prize)

* Professor Yue-Man Yeung (Chairman)

*Emeritus Professor of Geography and Resource Management
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* Mrs Mona Shaw (Member)

Chairperson, The Shaw Prize Foundation.

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Director, Shaw Movie City Hong Kong Limited;

* Professor Pak-Chung Ching (Member)

Pro-Vice-Chancellor, The Chinese University of Hong Kong;

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SHAW PRIZE

The Shaw Prize 2012

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Mrs
Mona Shaw

Mona Shaw, wife of 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. She was Deputy Chairperson and Managing Director of Television Broadcasts Limited until her resignation in March 2012, and is now a Non-Executive Director of the company.

Council 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 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, 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

Council Member



**Professor
Kenneth Young**

Professor Kenneth Young is a theoretical physicist, and is Master of C W 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 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.

Council Member



**Professor
Pak-Chung Ching**

Professor Pak-Chung Ching is Pro-Vice-Chancellor/ Vice-President, Director of CUHK Shenzhen Research Institute, Director of Shun Hing Institute of Advanced Engineering and Professor of Electronic Engineering of The Chinese University of Hong Kong. He received the Bachelor in Engineering (first class) 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 is Chairman of the Hong Kong Council for Testing and Certification and Member of the Steering Committee on Innovation and Technology. He also sits in 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 HKSAR Government 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 (Hon. 1st Class) 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 boards of a number of international scientific journals and on review panels of regional and international research funding agencies.

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**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 (1986), Leibniz Prize (1990), Janssen Prize (2000), Balzan Prize (2003), Petrie Prize (2005), the Shaw Prize in Astronomy (2008), Jansky Prize (2010), Karl Schwarzschild Medal (2011), Crafoord Prize in Astronomy (2012) and Tycho Brahe Prize (2012).

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
Douglas N C Lin**

Astronomy Committee

Professor Douglas Lin is the Founding Director of the Kavli Institute for Astronomy and Astrophysics at Peking University and Professor of Astronomy and Astrophysics at the University of California, Santa Cruz. He obtained his PhD at the Institute of Astronomy, Cambridge University. He held post-doctoral fellowships at Cambridge and Harvard University. He joined the faculty at the Department of Astronomy and Astrophysics, University of California, Santa Cruz in 1979, became a Full Professor in 1985, served as its Chair in 1998, and was elected as a Distinguished Faculty in 2009. For his research, he has won awards from the US, Germany, UK, and Russia. He was elected to the American Academy of Arts and Sciences in 2002 and an Honorary Fellow of the Royal Astronomical Society in 2010.

He is the author or co-author of over 200 research papers, mainly on astrophysics and planetary sciences and several science articles for the general public. He has frequent television and newspaper interviews and lectures widely, and has held visiting professorships at many universities around the world.

Selection Committee Member



**Professor
Ramesh Narayan**

Astronomy Committee

Professor Ramesh Narayan is the Thomas Dudley Cabot Professor of the Natural Sciences at Harvard University.

Professor Narayan received a BSc in Physics from Madras University (1971), and an MSc (1973) and a PhD (1979) from Bangalore University. After a few years as a Research Scientist at the Raman Research Institute, Bangalore, he went in 1983 to Caltech, where he was a Senior Research Fellow. He joined the faculty at the University of Arizona in 1985, and moved to Harvard University in 1991.

Professor Narayan has carried out research in a number of areas of theoretical astrophysics, including accretion disks, gravitational lensing, gamma-ray bursts, neutron stars and black holes.

Professor Narayan is a Fellow of the Royal Society (London), a Fellow of the American Association for the Advancement of Science, and a Member of the US National Academy of Sciences.

Selection Committee Member



**Professor
Adam G Riess**

Astronomy Committee

Professor Adam G Riess is a Professor of Physics and Astronomy at Johns Hopkins University and a Staff Astronomer at the Space Telescope Science Institute. He received his bachelor's degree from MIT in 1992 in Physics and his PhD from Harvard in 1996. He leads the Higher-Z SN Search program, which uses the Hubble Space Telescope to discover distant supernovae. In 1998, he led the study for the High-Z Supernova Search Team which first reported evidence that the Universe is accelerating. Science Magazine named this the 1998 "Breakthrough of the Year."

In 1999 Professor Riess received the Trumpler Award from the ASP, the Bok Prize from Harvard University in 2001, the Warner Prize from the AAS in 2003 and the Sackler Prize in 2004. In 2006, he shared the Shaw Prize in Astronomy with Professors Schmidt and Perlmutter and the 2007 Gruber Prize with members of the High-Z team and the Supernova Cosmology Project. Professor Riess won a MacArthur Fellowship in 2008, was elected to the US National Academy of Sciences in 2009 and received the Einstein Medal in 2011. Last but not least, he was awarded the Nobel Prize in Physics 2011 together with Professor Saul Perlmutter and Professor Brian Schmidt.

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
Günter Blobel**

*Life Science and
Medicine Committee*

Born in Germany, Professor Günter Blobel earned an MD degree from Tuebingen, Germany and a PhD degree in Oncology from Madison, Wisconsin. Following postdoctoral training, he became Full Professor of Cell Biology at Rockefeller University in New York in 1976. Since 1986 he is also Investigator of the Howard Hughes Medical Institute. He received numerous awards, among them the 1993 Lasker Award and the 1999 Nobel Prize in Medicine. He donated the entire proceeds of the Nobel Prize of one million USD to the reconstruction of the Frauenkirche and the Synagogue in Dresden, Germany. His research has focused on how proteins translocate across or integrate into membranes and on bidirectional traffic between the cytoplasm and the nucleus. A recent research objective is to piece together the atomic structure of the 100 MDalton nuclear pore complex by crystallographic and cryo electron microscopic analyses.

Selection Committee Member



**Professor
Linda B Buck**

*Life Science and
Medicine Committee*

Professor Linda B Buck is a Howard Hughes Medical Institute Investigator at Fred Hutchinson Cancer Research Center and Affiliate Professor of Physiology and Biophysics at the University of Washington. She received a BS from the University of Washington in 1975, a PhD from the University of Texas Southwestern Medical Center, Dallas in 1980, and was previously Professor of Neurobiology at Harvard Medical School. Professor Buck is a Fellow of the American Association for the Advancement of Science and a Member of the US National Academy of Sciences, the Institute of Medicine of the National Academies, and the American Academy of Arts and Sciences.

Professor Buck's research has provided key insights into the mechanisms underlying the sense of smell. In recognition of her contributions, she has received numerous awards, including The Lewis S Rosenstiel Award for Distinguished Work in Medical Research (1997), The Gairdner Foundation International Award (2003), and The Nobel Prize in Physiology or Medicine (2004).

Selection Committee Member



Sir
Tim Hunt

*Life Science and
Medicine Committee*

Sir Tim Hunt works at Cancer Research UK, Clare Hall Laboratories, in South Mimms, Hertfordshire. Sir Tim was born in 1943 and grew up in Oxford, moving to Cambridge in 1961 to read Natural Sciences. In 1968, he obtained his PhD in the Department of Biochemistry. He spent almost 30 years in Cambridge, working on the control of protein synthesis, with spells in the USA; he was a Postdoctoral Fellow with Irving London at the Albert Einstein College of Medicine in 1968–70 and spent summers at the Marine Biological Laboratory, Woods Hole from 1977 until 1985, both teaching and doing research.

In 1982, he discovered cyclins, which turned out to be components of “Key regulators of the Cell Cycle”, and led to a share of the Nobel Prize in Physiology or Medicine in 2001, together with Lee Hartwell and Paul Nurse.

Sir Tim Hunt is a Member of the Scientific Council of the ERC. He was elected as Fellow of the Royal Society in 1991 and became a Foreign Associate of the US National Academy of Sciences in 1999. He was knighted in the Queen's Birthday Honours List of 2006 and was the Chair of EMBO Council from 2006–2010.

Selection Committee Member



**Professor
Tony Hunter**

*Life Science and
Medicine Committee*

Professor Tony Hunter was born in Ashford, Kent, England. He received his BA in 1965 from the University of Cambridge, and his PhD in 1969 for work on mammalian protein synthesis under Asher Korner in the Department of Biochemistry, University of Cambridge. He was a Research Fellow in the Department from 1968 to 1971, and a Postdoctoral Fellow at the Salk Institute from 1971 to 1973 working under Walter Eckhart on polyoma virus DNA replication. He rejoined the Salk Institute as an Assistant Professor in 1975 in the Molecular and Cell Biology Laboratory, where he is currently the Renato Dulbecco Chair in Cancer Research and Director of the Salk Institute Cancer Center.

In 1979, he discovered that polyomavirus middle T antigen and the RSV v-Src oncoprotein both exhibit a previously unknown protein kinase activity that phosphorylates tyrosine. He has spent most of the last thirty years studying protein kinases and phosphatases, and the role of protein phosphorylation in cell growth, the cell cycle, and cancer.

He has received many awards for his work on tyrosine phosphorylation. He is a Fellow of the Royal Society of London, an Associate Member of EMBO, a Member of the US National Academy of Sciences, the Institute of Medicine, and the American Philosophical Society.

Selection Committee Member



**Professor
Randy W Schekman**

*Life Science and
Medicine Committee*

Professor Randy W Schekman is a Professor in the Department of Molecular and Cell Biology at UC Berkeley and an Investigator of the HHMI. Schekman's lab elucidated key components and events of the secretory pathway in *Saccharomyces cerevisiae*. His group discovered that the protein transport machinery is fundamentally conserved from yeast to mammals.

Among his honours are the Eli Lilly Award in microbiology, the Lewis S Rosenstiel Award in basic biomedical science, the Gairdner International Award, the Albert Lasker Award for Basic Medical Research, the Louisa Gross Horwitz Prize of Columbia University, The Dickson Prize, the Massry Prize and the Otto Warburg Prize of the German Biochemical Society. He is a Member of the US National Academy of Sciences, the American Academy of Arts and Sciences, the American Philosophical Society and is a Foreign Associate of the Royal Society of London. Professor Schekman is Past President of the American Society of Cell Biology and was Editor-in-Chief of the Proceedings of the US National Academy of Sciences until 2011. He currently serves as Editor-in-Chief of a new online, open access journal, eLife, supported by the HHMI, the Wellcome Trust and the Max Planck Society.

Selection Committee Member



**Professor
Tony F Chan**

*Mathematical Sciences
Committee*

Professor Tony F Chan received his BS and MS from Caltech and PhD in Computer Science from Stanford University (1978). He taught at Yale before joining UCLA as Professor of Mathematics in 1986. At UCLA, he served as Mathematics Department Chair (1997–2000), Director of the Institute for Pure and Applied Mathematics (2000–2001) and Dean of Physical Science (2001–2006). From 2006 to 2009, he served as Assistant Director of the Mathematical and Physical Sciences Directorate at the US National Science Foundation and managed research funding in astronomy, physics, chemistry, mathematical sciences and material science.

He is an elected Fellow of the Society of Industrial and Applied Mathematics and the American Association for the Advancement of Science. He served on the US National Committee for Mathematics and was one of five US representatives to the International Union of Mathematicians in 2006. He is one of ISI's most cited mathematicians.

Selection Committee Member



**Professor
Yakov Eliashberg**

*Mathematical Sciences
Committee*

Professor Yakov Eliashberg is currently the Herald L and Caroline L Ritch Professor at Stanford University. His research interests lie in symplectic and contact geometry, several complex variables, singularity theory and low-dimensional topology. He is one of the founders of symplectic topology, a new and active area of research which emerged in 1980s and found important applications in other areas of mathematics and theoretical physics.

Professor Eliashberg was born in 1946 in Leningrad (now St Petersburg), Russia. He received his doctoral degree in Leningrad University in 1972 under the direction of V A Rokhlin, and in the same year he joined Syktyvkar University in northern Soviet Union as an Associate Professor. In 1988 he emigrated to the United States and in 1989 became a Professor at Stanford University. He is a Member of US National Academy of Sciences and received a Guggenheim Fellowship in 1995. He was awarded the Oswald Veblen Prize in 2001 from the American Mathematical Society and in 2009 awarded the degree of Doctor Honoris Causa at the École Normale Supérieure de Lyon, France.

Selection Committee Member



**Professor
W Timothy Gowers**

*Mathematical Sciences
Committee*

Professor Timothy Gowers was born in Marlborough, England, in 1963. From 1973 to 76 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 Bèla Bollobàs. 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 Szèmèrèdi's theorem and has subsequently worked in additive combinatorics. For this work he was awarded a Fields Medal in 1998.

Selection Committee Member



**Professor
Claire Voisin**

*Mathematical Sciences
Committee*

Professor Claire Voisin, born in 1962, is a French mathematician. She is currently a CNRS Senior Researcher at École Polytechnique. She received her PhD and permanent position at CNRS in 1986.

Professor Voisin is noted for her work in algebraic geometry. Her work stands at the interface between projective and Kähler geometries, using the theory of Hodge structures to study their topology. On the algebraic geometry side, she also works on algebraic cycles, motives, and Hodge structures.

She is Editor-in-chief of *Publications Mathématiques de l'Institut des Hautes Études Scientifiques*, Editor of *Journal of the European Mathematical Society*, *Communications in Contemporary Mathematics*, *Journal de Mathématiques Pures et Appliquées*.

She received the Sophie Germain Prize in 2003 and the Clay Research Award in 2008. She was a Plenary Speaker at the 4th European Congress of Mathematics, Stockholm (2004) and International Congress of Mathematicians, Hyderabad, India (2010).

Professor Voisin has been elected Member of the Académie des Sciences (2010), and Foreign Member of the Deutsche Akademie der Naturforscher Leopoldina (2009), Istituto Lombardo (2006) and Accademia dei Lincei (2011).

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 gameshow on legal knowledge “Justice for All” brought her career to a new height. She also hosted the 2008 Beijing Olympics for TVB and has been one of the presenters for the Shaw Prize Award Presentation Ceremony since its inception in 2004.

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 music for the movie “Perhaps Love” won him a Golden Horse Award and a Hong Kong Film Award. His song “Ding Feng Bo” for the movie “The Last Tycoon” won Best Original Film Song at the recent 32nd Hong Kong Film Awards. For the stage, he received five Best Score awards for his musicals in Hong Kong. He was the musical director of Jacky Cheung’s 2004 world tour of “Snow, Wolf, Lake”. Recent works include “Takeaway”, the first major British Chinese musical which premiered in London in 2011. 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.



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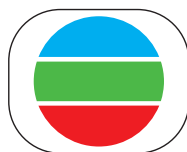
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