THE SHAW PRIZE 邵逸夫獎

Press Conference HK 2019. 5 . 21

Life Science & Medicine

Astronomy

Mathematical Sciences

邵逸夫獎基金會 The Shaw Prize Foundation

Telephone: (852) 2994 4888 Facsimile : (852) 2994 4881 Website : http://www.shawprize.org

The Shaw Prize 2019

Prize Announcement Press Conference

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Welcome Address by Professor Kenneth Young, Chairman of The Shaw Prize Council

Good afternoon, ladies and gentlemen. Welcome to this Press Conference, and thank you all for helping to bring the announcement of the Shaw Prize 2019 to the world at large.

The Shaw Prize was established in the year 2002.

I think most of those present know the history, and the marvelous work done by the late Mr and Mrs Shaw, and now carried on by the Foundation.

Since 2004 the Prize has been awarded annually for distinguished and significant achievements in the three scientific disciplines, namely, Astronomy, Life Science and Medicine, and Mathematical Sciences. Each Prize consists of a medal, a certificate and a monetary award of US\$1.2 million.

The Shaw Prize is an international award, dedicated to honouring individuals, regardless of race, nationality, gender and religious belief, who have achieved significant breakthroughs in academic and scientific research or applications, and whose work has resulted in a positive and profound impact on mankind.

Recipients of the Prize are all internationally acclaimed scholars and scientists. Thanks to the effort of members of the Selection Committees and colleagues of the Foundation, the Prize has built up its prestige worldwide within a short period of time.

We look forward to greater success of the Prize in the years to come.

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 works were recently achieved and who are currently active in their respective fields.

Background

Established in November 2002 under the auspices of **Mr Run Run Shaw**, the Prize honours individuals, regardless of race, nationality, gender and religious belief, who have achieved significant breakthroughs in academic and scientific research or applications and whose works have resulted in positive and profound impacts on mankind.

The Shaw Prize is an international award managed and administered by The Shaw Prize Foundation based in Hong Kong. **Mr Shaw** also founded 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.

Press Release

Announcement of The Shaw Laureates 2019

The Shaw Prize in Astronomy is awarded to

Edward C Stone

David Morrisroe Professor of Physics and Vice Provost for Special Projects, California Institute of Technology (Caltech), USA

for his leadership in the Voyager project, which has, over the past four decades, transformed our understanding of the four giant planets and the outer solar system, and has now begun to explore interstellar space.

The Shaw Prize in Life Science and Medicine is awarded to

Maria Jasin

Member, Memorial Sloan Kettering Cancer Center (MSK) and Professor, Weill Cornell Graduate School of Medical Sciences, Cornell University, USA

for her work showing that localized double strand breaks in DNA stimulate recombination in mammalian cells. This seminal work was essential for and led directly to the tools enabling editing at specific sites in mammalian genomes.

The Shaw Prize in Mathematical Sciences is awarded to

Michel Talagrand

Former Senior Researcher, French National Centre for Scientific Research (CNRS), France

for his work on concentration inequalities, on suprema of stochastic processes and on rigorous results for spin glasses.

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Tuesday, 21 May 2019. At today's press conference in Hong Kong, The Shaw Prize Foundation announced the Shaw Laureates for 2019. Information was posted on the website **www.shawprize.org** at Hong Kong time 15:30 (GMT 07:30).

The Shaw Prize consists of three annual prizes: Astronomy, Life Science and Medicine, and Mathematical Sciences, each bearing a monetary award of US\$1.2 million. This will be the sixteenth year that the Prize has been awarded and the presentation ceremony is scheduled for Wednesday, 25 September 2019 in Hong Kong.

Announcement

The Shaw Prize in <u>Astronomy 2019</u>

is awarded to

Edward C Stone

for his leadership in the Voyager project, which has, over the past four decades, transformed our understanding of the four giant planets and the outer solar system, and has now begun to explore interstellar space.

Biographical Note of Edward C Stone

Edward C Stone was born in 1936 in Knoxville, Iowa, USA and is currently David Morrisroe Professor of Physics and Vice Provost for Special Projects at the California Institute of Technology (Caltech), USA. He obtained his Master degree and his PhD in Physics from the University of Chicago in 1959 and 1964 respectively. He then joined Caltech, where he was successively Research Fellow (1964–1966), Senior Research Fellow (1966–1967), Assistant Professor (1967–1971), Associate Professor (1971–1976) and Professor (1976–1994). Since 1994, he has been appointed David Morrisroe Professor and has served as Vice Provost for Special Projects from 2004. At Caltech, he was also appointed Chairman of Division of Physics, Mathematics and Astronomy from 1983 to 1988, Vice President for Astronomical Facilities (1988–1990) and Vice President and Director of the Jet Propulsion Laboratory (1991–2001). He is a member of the US National Academy of Sciences.

The Shaw Prize in <u>Astronomy 2019</u>

Press Release

The Shaw Prize in Astronomy 2019 is awarded to **Edward C Stone**, David Morrisroe Professor of Physics and Vice Provost for Special Projects, California Institute of Technology, USA for his leadership in the Voyager project, which has, over the past four decades, transformed our understanding of the four giant planets and the outer solar system, and has now begun to explore interstellar space.

The Voyager project consists of two spacecraft launched by NASA in August and September 1977 to explore the outer solar system. Both spacecraft flew past Jupiter and Saturn in the period 1979–1981 and Voyager 2 also visited Uranus in 1986 and Neptune in 1989. For the foreseeable future Voyager 2 will remain the only spacecraft to visit Uranus and Neptune. These unique data are particularly important for the study of exoplanets, since Uranus and Neptune now appear to be more representative of the bulk of the exoplanet population than the other solar-system planets.



The highlights of the encounters and from Voyager's journey include:

- the discovery that Jupiter's satellite Io has many volcanos, powered by tidal heating of Io's interior;
- the first images of the rings of Jupiter, Uranus, and Neptune, and the discovery of complex structure in Saturn's rings including gaps, narrow

The Shaw Prize in Astronomy 2019 Press Release (Cont'd)

ringlets, density and bending waves, and transient "spokes";

- the first high-resolution images of the four giant planets in the solar system as well as their larger satellites, and the discovery of almost two dozen new satellites;
- the discovery that Uranus and Neptune have magnetic fields, and these fields differ from those of other solar-system planets in that the magnetic pole is strongly tilted and offset relative to the north pole or spin axis. Voyager also provided our first data on the magnetospheres extended atmospheres of ionized gas surrounding these planets, including size, density, composition, and plasma waves. It also showed that Jupiter, Saturn and Neptune all have aurorae in their upper atmospheres;
- the first detailed measurements of the atmospheres of Saturn's satellite Titan and Neptune's satellite Triton;
- the discovery that Neptune radiates about 2.5 times as much energy as it receives from the Sun. The nature of this energy source is not yet understood;
- measurements of the composition, winds, temperature and pressure profiles of the planetary atmospheres; in particular Voyager showed that Neptune's atmosphere has winds of up to 2,000 km/h and a vast storm system called the Great Dark Spot;
- Voyager dramatically improved our knowledge of the masses, sizes, shapes, and gravitational fields of all the giant planets and many of their satellites.
- Each spacecraft carried a 'golden record' containing sounds and images selected to portray the diversity of life and culture on Earth and intended to be played only if Voyager encountered an advanced spacefaring civilization.
- Voyager 1 looked back to take a famous 'family portrait' of the planets including the image of Earth known as the 'pale blue dot', which became an icon for how small we are in the larger universe.

The Shaw Prize in Astronomy 2019 Press Release (Cont'd)

Voyager 1 is now 145 times as far from us as the Sun, and has become the most distant human artifact. Voyager 2 is not quite as far away. Many of their instruments continue to send back valuable data, more than forty years after the launch date. After this long voyage, the spacecraft have finally reached the outer boundary of the solar system.

There are several possible ways to define the 'boundary' of the solar system, but the most natural one is the heliopause. The heliopause marks the end of the heliosphere, where the wind of ionized gas emitted by the Sun is finally halted by the pressure from interstellar gas. Inside the heliopause, space is filled by low-density material from the Sun, while outside the heliopause it contains material from other stars. Voyager 1 and 2 crossed the heliopause in 2012 and late 2018, respectively, and returned data on the velocity, density, temperature and other properties of the ambient plasma as the spacecraft crossed into interstellar space. This was the final major milestone of the Voyager mission.

Although many scientists and engineers have devoted much or most of their careers to Voyager, the dominant figure in the mission is **Edward Stone**, who has served as Project Scientist from 1972 to the present — over 45 years — and is also in charge of one of the spacecraft's 11 instruments. During the planetary flybys, he became internationally known as the public spokesman for Voyager and explained Voyager's scientific discoveries to the public with remarkable lucidity and scientific authority.

Astronomy Selection Committee The Shaw Prize

Announcement

The Shaw Prize in Life Science and Medicine 2019

is awarded to

Maria Jasin

for her work showing that localized double strand breaks in DNA stimulate recombination in mammalian cells. This seminal work was essential for and led directly to the tools enabling editing at specific sites in mammalian genomes.

Biographical Note of Maria Jasin

Maria Jasin was born in 1956 in Detroit, Michigan, USA and is currently Member, Memorial Sloan Kettering Cancer Center (MSK) and Professor at the Weill Cornell Graduate School of Medical Sciences, Cornell University, USA. She obtained her Bachelor's degree in Biology from the Florida Atlantic University, USA in 1978 and received her PhD in Biochemistry from the Massachusetts Institute of Technology, USA in 1984. She was a Postdoctoral Fellow at the University of Zürich, Switzerland (1984–1985) and Stanford University, USA (1985–1990). She then joined MSKCC and Cornell University, where she was successively Assistant Professor (1990–1996), Associate Professor (1996–2000) and Full Professor (2000–). She is a member of the US National Academy of Sciences, the US National Academy of Medicine and the American Academy of Arts and Sciences.

The Shaw Prize in Life Science and Medicine 2019

Press Release

The Shaw Prize in Life Science and Medicine 2019 is awarded to **Maria Jasin**, Member at the Memorial Sloan Kettering Cancer Centre (MSK) and Professor at the Weill Cornell Graduate School of Medical Sciences, Cornell University, USA, for her work showing that localized double strand breaks in DNA stimulate recombination in mammalian cells. This seminal work was essential for and led directly to the tools enabling editing at specific sites in mammalian genomes.

We stand at a moment of great promise in the ability to modify the genomes of virtually all organisms on Earth using the precision tools of gene editing. In the near future, it will be possible to treat human and animal genetic diseases and to improve agricultural productivity by the introduction of specific changes at precise locations within chromosomes. The preferred tool of this revolution is called CRISPR/Cas9, and its development has been attributed to many investigators around the world. But, the origin of this technological advance relies upon a crucial discovery that was made by **Maria Jasin** in 1994 when she showed that the site-specific introduction of a double-stand break in a mammalian chromosome may be repaired by two different normal cellular process of recombination and chromosome end-joining.

Human chromosomes often undergo breakage due to agents that damage the DNA. It is critical to repair such breaks, to maintain genome integrity and to prevent mutations that can give rise to cancer. All cells have the capacity to repair such breaks by a process called homologous recombination, which restores the continuity of the genome without introducing mutations. Another recombination process, called non-homologous end-joining, often introduces mutations and thus is only used by a cell when homologous recombination is not possible. **Maria Jasin** pioneered genetic and physical assays for recombination in human cells and she was the first scientist to directly demonstrate the importance of both homologous recombination and non-homologous end-joining

The Shaw Prize in Life Science and Medicine 2019 Press Release (Cont'd)

for repair of chromosomal breaks. Her discovery has important implications for both normal cellular function and for the etiology of diseases such as cancer. In the course of this work, **Jasin** demonstrated that breaks in chromosomes greatly increase the frequency of recombination at the site of the break. This important discovery laid the groundwork for efficient modification of mammalian genomes by site-specific nucleases, an approach that is currently being widely exploited for gene therapy and basic research.

In **Jasin**'s groundbreaking 1994 work, her laboratory devised an ingenious method to create a double strand break in the mouse genome. To do this, she used a specialized nuclease enzyme from yeast that had a well characterized unique 18 nucleotide long DNA recognition sequence. The gene encoding the yeast enzyme was introduced into the mouse genome and the companion recognition sequence, which is not normally present in any mouse chromosome, was genetically engineered into another mouse gene that could be scored for its function or loss of function in the animal. When the recognition sequence is cut by the yeast enzyme, the mouse gene loses its function unless the damage is patched up by the normal cellular process of repair.

Using this strategy, **Jasin** performed the first specific genome editing and most importantly, she showed that introduction of a site-specific double strand break into the genome of mammalian cells produced a 1000-fold increase in the targeting of a homologous fragment of DNA to that site. This groundbreaking work laid the foundation for all subsequent gene editing studies, because now it was clear that a double strand break is the critical step in gene targeting for homologous recombination.

Jasin's discovery forms the basis for subsequent work on more highly specific nucleases — Zinc fingers, TALENs, and CRISPR — that are currently being used for genome modification. All of these methods describe new and

The Shaw Prize in Life Science and Medicine 2019 Press Release (Cont'd)

increasingly refined ways to introduce enzymes and double strand breaks into DNA. Nonetheless, they all rely fundamentally on **Jasin**'s discovery of the stimulation of homologous recombination by a double strand DNA break and the strategy to introduce a DNA cleaving enzyme to make the precise break. In her visionary 1994 paper, **Jasin** modestly concluded: "This could facilitate the creation of subtle genetic alterations at targeted loci".

Using the methods developed in her lab and now applied worldwide, **Jasin** also discovered that the two major familial breast/ovarian tumor suppressor genes, BRCA1 and BRCA2, are required for homologous recombination, a finding that explained how the loss of either of these two genes increases the frequency of potentially carcinogenic genetic alterations (note the 2018 Shaw Prize in Life Science and Medicine to Mary-Claire King for the discovery of the BRCA1 and 2 genes in breast cancer). The importance of these results cannot be overstated, and they are being exploited in novel therapies for the treatment of breast, ovarian, and other cancers with BRCA1 and BRCA2 mutations, and potentially cancers with mutations in other homologous recombination genes.

Maria Jasin's research has contributed to the textbook view of how cells survive breaks in their chromosomes, which is critical for the life of all cells. Equally important, her insights paved the way for today's current revolution in genome editing.

Life Science and Medicine Selection Committee The Shaw Prize

Announcement

The Shaw Prize in Mathematical Sciences 2019

is awarded to

Michel Talagrand

for his work on concentration inequalities, on suprema of stochastic processes and on rigorous results for spin glasses.

Biographical Note of Michel Talagrand

Michel Talagrand was born in 1952 in France. He obtained his PhD in Mathematical Sciences in 1977 from the University of Paris VI, France. From 1974 until his retirement in 2017, he was part of the Functional Analysis Team of the Institute of Mathematics of the University Paris VI. He was successively Research Trainee, Research Associate, Researcher and Senior Researcher for the French National Centre for Scientific Research (CNRS). He is a member of the French Academy of Sciences.

The Shaw Prize in Mathematical Sciences 2019

Press Release

The Shaw Prize in Mathematical Sciences 2019 is awarded to **Michel Talagrand**, Former Senior Researcher, French National Centre for Scientific Research (CNRS), France, for his work on concentration inequalities, on suprema of stochastic processes and on rigorous results for spin glasses.

Michel Talagrand has made profound contributions to probability and high-dimensional geometry, at least three of which could be described as revolutionary.

A first major theme of **Talagrand**'s research is the study of suprema of stochastic processes. A stochastic process is a collection of interacting random variables. When one is given a large such collection, it is often of crucial importance to obtain information about how its maximum value is distributed. Starting with the case of Gaussian processes (here the random variables each have a Gaussian distribution, given by the famous "bell curve", and can be correlated in a certain way) and then for more general cases, **Talagrand** has developed tools, such as majorizing measures or generic chaining, that provide powerful and very useful bounds for how these maximum values behave.

The second group of contributions concerns a phenomenon known as concentration of measure. Broadly speaking, this says that many functions that depend on a large number of reasonably independent random variables are extremely likely to take values close to their average. For example, if one tosses a coin a thousand times, then the probability that the number of heads will be between 450 and 550 is roughly 99.7 percent, and the probability that it will be more than 600 is approximately two millionths of one percent. In such a situation, we say that the number of heads is concentrated. This phenomenon, often associated with the name of the mathematician Vitali Milman, is remarkably general and has a multitude of applications in areas as diverse as the geometry of

The Shaw Prize in Mathematical Sciences 2019 Press Release (Cont'd)

convex bodies, graph theory, and theoretical computer science. One of **Talagrand**'s great achievements has been to examine this phenomenon in detail and hugely improve our understanding of it. In particular, he proved famous inequalities, using completely new techniques, that give new concentration results that are widely used in many different important settings.

A third family of results for which he is famous concern objects known as spin glasses, which provide a mathematical model of a physical phenomenon involving very disordered systems. Unlike many models from statistical physics, spin glasses have a double layer of randomness. First, the way in which different random variables (the spins in the spin glass language) will interact is chosen at random, which creates a very complex energy landscape, and then the random variables themselves are sampled randomly. One would then like to understand this large family of randomly interacting random variables and describe its typical features. Spin glasses have a short and simple definition, but they are notoriously hard to analyze. A significant advance was made by the theoretical physicist, Giorgio Parisi, who proposed a formula for the free energy of a spin glass, which is an important quantity that encapsulates information about this random energy landscape. However, turning predictions of statistical physicists into mathematically rigorous arguments is often extremely hard, and a rich source of fascinating mathematical problems. Finding a complete rigorous proof in this case seemed to be way beyond what was it was realistic to hope for, despite remarkable insights and progress by Francesco Guerra, but Talagrand managed to do it, thereby providing for the first time a complete mathematical underpinning for this extremely important physical theory.

One notable feature of **Talagrand**'s career that marks him out from many other mathematicians is that when he solves a problem, he does not just leave it and move on. Rather, he continues to work on it, improving his understanding and reworking his arguments until he has a well-developed theory that can be more

The Shaw Prize in Mathematical Sciences 2019 Press Release (Cont'd)

easily used by other mathematicians. He has written monumental and highly influential textbooks on all the three topics just mentioned, and these have played a very significant part in the spread of his ideas, which are now central to the work of large numbers of other mathematicians. **Talagrand** is a true one-off, nearly always working on his own, and obtaining extraordinary and highly unexpected results that have changed the mathematical landscape.

Mathematical Sciences Selection Committee The Shaw Prize

The Shaw Prize 2019 <u>Board of Adjudicators</u>									
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	Vice Chairman Professor Kenneth YOUNG The Chinese University of Hong Kong								
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Baylor College of Medicine, USA

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The Shaw Prize

Council Members

Professor Kenneth Young (Chairman) Mr Raymond Chan Professor Wai-Yee Chan Professor Pak-Chung Ching Professor Yuet-Wai Kan Professor Frank H Shu

Members' Biographical Notes

Professor Kenneth Young is Chairman of the Council and Vice Chairman of the Board of Adjudicators of The Shaw Prize, and Emeritus Professor of Physics at The Chinese University of Hong Kong.

Mr Raymond Chan is Member of Board of Advisor of The Sir Run Run Shaw Charitable Trust, Chairman of The Shaw Foundation and The Shaw Prize Foundation and Managing Director of Shaw Group of Companies.

Professor Wai-Yee Chan is Pro-Vice-Chancellor / Vice President, Master of CW Chu College, Professor of Biomedical Science and Acting Director of School of Biomedical Sciences, Faculty of Medicine, The Chinese University of Hong Kong.

Professor Pak-Chung Ching is Director of Shun Hing Institute of Advanced Engineering and Choh-Ming Li Professor of Electronic Engineering at The Chinese University of Hong Kong.

Professor Yuet-Wai Kan is Louis K Diamond Professor of Hematology at the University of California, San Francisco, USA.

Professor Frank H Shu is Chairman of the Board of Adjudicators of The Shaw Prize and Professor Emeritus of Physics at the University of California, San Diego, USA.

The Shaw Laureates (2004 - 2019)

YEAR	Astronomy	Life Science and Medicine	Mathematical Sciences	YEAR	Astronomy	Life Science and Medicine	Mathematical Sciences
2004	P James E Peebles (<i>Canada</i>)	 Two prizes awarded: (1) Stanley N Cohen (USA) Herbert W Boyer (USA) Yuet-Wai Kan (USA) (2) Richard Doll (UK) 	Shiing-Shen Chern (<i>China</i>)	2012	David C Jewitt (USA) Jane Luu (USA)	Franz-Ulrich Hartl (<i>Germany</i>) Arthur L Horwich (<i>USA</i>)	Maxim Kontsevich (France)
				2013	Steven A Balbus (<i>UK</i>) John F Hawley (<i>USA</i>)	Jeffrey C Hall (USA) Michael Rosbash (USA) Michael W Young (USA)	David L Donoho (USA)
2005	Geoffrey Marcy (USA) Michel Mayor (Switzerland)	Michael Berridge (UK)	Andrew John Wiles (UK)	2014	Daniel Eisenstein (<i>USA</i>) Shaun Cole (<i>UK</i>) John A Peacock (<i>UK</i>)	Kazutoshi Mori (<i>Japan</i>) Peter Walter (<i>USA</i>)	George Lusztig (USA)
2006	Saul Perlmutter (<i>USA</i>) Adam Riess (<i>USA</i>) Brian Schmidt (<i>Australia</i>)	Xiaodong Wang (USA)	David Mumford (<i>USA</i>) Wentsun Wu (<i>China</i>)	2015	William J Borucki (USA)	Bonnie L Bassler (<i>USA</i>) E Peter Greenberg (<i>USA</i>)	Gerd Faltings (<i>Germany</i>) Henryk Iwaniec (<i>USA</i>)
2007	Peter Goldreich (USA)	Robert Lefkowitz (USA)	Robert Langlands (USA) Richard Taylor (UK)	2016	Ronald W P Drever (<i>UK</i>) Kip S Thorne (<i>USA</i>) Rainer Weiss (<i>USA</i>)	Adrian P Bird (<i>UK</i>) Huda Y Zoghbi (<i>USA</i>)	Nigel J Hitchin (<i>UK</i>)
2008	Reinhard Genzel (Germany)	Ian Wilmut (<i>UK</i>) Keith H S Campbell (<i>UK</i>) Shinya Yamanaka (<i>Japan</i>)	Vladimir Arnold (<i>Russia</i>) Ludwig Faddeev (<i>Russia</i>)	2017	Simon D M White (Germany)	Ian R Gibbons (<i>USA</i>) Ronald D Vale (<i>USA</i>)	János Kollár (<i>USA</i>) Claire Voisin (<i>France</i>)
2009	Frank H Shu (USA)	Douglas L Coleman (USA) Jeffrey M Friedman (USA)	Simon K Donaldson (<i>UK</i>) Clifford H Taubes (<i>USA</i>)	2018	Jean-Loup Puget (France)	Mary-Claire King (USA)	Luis A Caffarelli (USA)
2010	Charles L Bennett (USA) Lyman A Page Jr (USA) David N Spergel (USA)	David Julius (USA)	Jean Bourgain (USA)	2019	9 Edward C Stone (United States)	Maria Jasin (United States)	Michel Talagrand (France)
2011	Enrico Costa (<i>Italy</i>) Gerald J Fishman (<i>USA</i>)	Jules A Hoffmann (<i>France</i>) Ruslan M Medzhitov (<i>USA</i>) Bruce A Beutler (<i>USA</i>)	Demetrios Christodoulou (<i>Switzerland</i>) Richard S Hamilton (<i>USA</i>)	2019			

Note: Award may not be shared equally. For details, please refer to Announcement and Citation on the Shaw Prize website (www.shawprize.org)