



THE  
Crafoord  
PRIZE



# The Crafoord *Prize*

1982–2019



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Anna-Greta and  
Holger Crafoord Fund

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# The Anna-Greta and Holger Crafoord Fund

PHOTO: MARKUS MARCETIC



**BACK ROW:** MARTIN JAKOBSSON, ANNA MANHUSEN, WALTER FISCHER, LENNART NILSSON, MARGARETA NILSSON, ADAM DAHLBERG, STEFAN BENGTSOON AND GÖRAN K. HANSSON. **FRONT ROW:** CHRISTINA MOBERG, SUSAN SOLOMON, H.M. KING CARL XVI GUSTAF OF SWEDEN, H.M. QUEEN SILVIA OF SWEDEN, SYUKURO MANABE AND EBBA FISCHER.

The Fund was established in 1980 by a donation to the Royal Swedish Academy of Sciences from Anna-Greta and Holger Crafoord. The Crafoord Prize was awarded for the first time in 1982. The purpose of the Fund is to promote basic scientific research worldwide in the following disciplines:



**MATHEMATICS AND  
ASTRONOMY**



**GEOSCIENCES**



**BIOSCIENCES  
WITH EMPHASIS ON ECOLOGY**



**POLYARTHRITIS**

Support to research takes the form of an international prize awarded annually to outstanding scientists, and of research grants to individuals or institutions in Sweden. Both awards and grants are made according to the following order:

- year 1: Mathematics and Astronomy
- year 2: Geosciences
- year 3: Biosciences
- year 4: Mathematics and Astronomy
- year 5: Geosciences
- year 6: Biosciences
- etc.

The prize in Polyarthrititis is awarded only when an investigation by the Academy's Class for medical sciences has shown that scientific progress in this field has been such that an award is justified. Part of the Fund is reserved for appropriate research projects at the Academy's institutes.

The Crafoord Prize presently amounts to 6 million Swedish krona, the prizes in Mathematics and Astronomy are awarded with 6 million Swedish krona each. In addition to the prize, financial support is granted to other researchers in the same field in which the prize is awarded for that year. Announcement of the Laureate/-s is made in mid-January each year.

## Nominations

The Academy invites scientists from all over the world to nominate candidates for the prize. The received nominations are then reviewed and assessed by a prize committee consisting of members from the appropriate Academy classes. The prize should be awarded to one recipient, but may, if necessary, be divided among up to three recipients. At the same time, grant allocations are announced, and may be applied for both by individuals and by institutions in Sweden. Grant applications can be made for scientific equipment and research, publication of scientific works, scientific conferences and symposia, studies outside of Sweden for Swedish researchers, and activities to further research within the field of research covered by the prize.

On the basis of reports from the prize committee and the appropriate Academy class, decisions concerning laureate(s) and grant discipline are made by the Academy in mid-January of the year in which the prize is to be awarded.

## Crafoord Days

The Crafoord Prize is presented at a ceremony held by the Royal Swedish Academy of Sciences during the Crafoord Days in May.

During the Crafoord Days the Academy organises an international scientific symposium on a subject from the chosen discipline of the year, and the Laureate/-s gives a public lecture, the Crafoord Prize Lecture.

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# The Crafoord Prize in Biosciences 2019

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PHOTO: ALAN SILFEN



**SALLIE W. CHISHOLM**

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, MIT, MA, USA



**SALLIE W. CHISHOLM**, Massachusetts Institute of Technology, MIT, MA, USA,  
*“for the discovery and pioneering studies of the most abundant photosynthesising organism  
on Earth, Prochlorococcus”.*



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# Prizes awarded

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## 2018 GEOSCIENCES

**SYUKURO MANABE**, born 1931.

Senior meteorologist, Atmospheric and Oceanic Sciences Program (AOS), Princeton University, NJ, USA and **SUSAN SOLOMON**, born 1956. Lee and Geraldine Martin

Professor of Environmental Studies, Department of Earth, Atmospheric and Planetary Sciences (EAPS), Massachusetts Institute of Technology, MIT, Cambridge, MA, USA, “*for fundamental contributions to understanding the role of atmospheric trace gases in Earth’s climate system*”.



SYUKURO MANABE

SUSAN SOLOMON

PHOTO: MARKUS MARCETIC

## 2017 POLYARTHRITIS

**SHIMON SAKAGUCHI**, born 1951.

Professor, Osaka University, Japan.

**FRED RAMSDELL**, born 1961.

Head of Research, Parker Institute

for Cancer Immunotherapy, San Francisco, CA, USA and **ALEXANDER**

**RUDENSKY**, born 1956. Professor,

Memorial Sloan Kettering Cancer

Center, New York, NY, USA, “*for their discoveries*

*relating to regulatory T cells, which counteract harmful immune reactions in arthritis and other autoimmune diseases*”.



SHIMON SAKAGUCHI  
FRED RAMSDELL  
ALEXANDER RUDENSKY



PHOTO: MARKUS MARCETIC

## 2016 MATHEMATICS

**YAKOV ELIASHBERG**, born 1946 in S:t Petersburg, Russia, Ph.D. at Leningrad State University 1972.

Herald L. and Caroline L. Ritch Professor of mathematics at Stanford University, CA, USA,

“*for the development of contact and symplectic topology and groundbreaking discoveries of rigidity and flexibility phenomena*”.



YAKOV ELIASHBERG

PHOTO: MARKUS MARCETIC

## 2016 ASTRONOMY

**ROY KERR**, born 1934 in Kurow, New Zealand. Ph.D. 1959 at University of Cambridge, UK. Emeritus Professor at University of Canterbury, New Zealand and **ROGER BLANDFORD**, born 1949 in Grantham, UK. Ph.D.

1974 at University of Cambridge, UK. Luke Blossom Professor in the School of Humanities and Sciences, Stanford University, CA, USA, *“for fundamental work concerning rotating black holes and their astrophysical consequences”*.



ROY KERR

ROGER BLANDFORD

PHOTO: MARKUS MARCETIC

## 2015 BIOSCIENCES

**RICHARD LEWONTIN**, US citizen. Born 1929 in New York, USA. Ph.D. 1954 from Columbia University, NY, USA. Emeritus Professor at Harvard University, MA, USA and **TOMOKO OHTA**, Japanese citizen. Born 1933 in Miyoshi, Japan. Ph.D. 1967 from North Carolina State University, NC, USA. Emeritus Professor at the National Institute of Genetics, Mishima, Japan, *“for their pioneering analyses and fundamental contributions to the understanding of genetic polymorphism”*.



RICHARD LEWONTIN  
TOMOKO OHTA

PHOTO: LEWONTIN: HARVARD UNIVERSITY  
PHOTO: OHTA: MARKUS MARCETIC

## 2014 GEOSCIENCES

**PETER MOLNAR**, US citizen. Ph.D. 1970 from Columbia University, NY, USA. Professor in Geological Sciences at University of Colorado Boulder, CO, USA, *“for his ground-breaking contribution to the understanding of global tectonics, in particular the deformation of continents and the structure and evolution of mountain ranges, as well as the impact of tectonic processes on ocean-atmosphere circulation and climate”*.



PETER MOLNAR

PHOTO: MARKUS MARCETIC

## 2013 POLYARTHRITIS

**PETER K. GREGERSEN**, The Feinstein Institute for Medical Research, Manhasset, NY, USA, **ROBERT J. WINCHESTER**, Columbia University, New York, NY, USA and **LARS KLAESKOG**, Karolinska Institutet, Stockholm, Sweden, *“for their discoveries concerning the role of different genetic factors and their interactions with environmental factors in the pathogenesis, diagnosis and clinical management of rheumatoid arthritis”*.



## 2012 MATHEMATICS

**JEAN BOURGAIN**, Institute for Advanced Study, Princeton, NJ, USA and **TERENCE TAO**, University of California, Los Angeles, CA, USA, *“for their brilliant and groundbreaking work in harmonic analysis, partial differential equations, ergodic theory, number theory, combinatorics, functional analysis and theoretical computer science”*.



JEAN BOURGAIN

TERENCE TAO

PHOTO: BOURGAIN AND TAO:  
JAN NORDEN

## 2012 ASTRONOMY

**REINHARD GENZEL**, Max-Planck-Institut für extraterrestrische Physik, Garching, Germany and **ANDREA GHEZ**, University of California, Los Angeles, CA, USA, *“for their observations of the stars orbiting the galactic centre, indicating the presence of a supermassive black hole”*.



REINHARD GENZEL

ANDREA GHEZ

PHOTO: GENZEL AND GHEZ:  
JAN NORDEN

## 2011 BIOSCIENCES

**ILKKA HANSKI**, University of Helsinki, Finland, *“for his pioneering studies on how spatial variation affects the dynamics of animal and plant populations”*.



ILKKA HANSKI

PHOTO: MARKUS MARCETIC

## 2010 GEOSCIENCES

**WALTER MUNK**, Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA, USA, *“for his pioneering and fundamental contributions to our understanding of ocean circulation, tides and waves, and their role in the Earth’s dynamics”*.

## 2009 POLYARTHRITIS

**CHARLES DINARELLO**, University of Colorado School of Medicine, Denver, CO, USA, **TADAMITSU KISHIMOTO**, Osaka University, Japan and **TOSHIO HIRANO**, Osaka University, Japan, *“for their pioneering work to isolate interleukins, determine their properties and explore their role in the onset of inflammatory diseases”*.

## **2008 MATHEMATICS AND ASTRONOMY**

**MAXIM KONTSEVICH**, IHÉS, France, and **EDWARD WITTEN**, Institute for Advanced Study, Princeton, NJ, USA, *“for their important contributions to mathematics inspired by modern theoretical physics”*, and **RASHID ALIEVICH SUNYAEV**, Max-Planck-Institute for Astrophysics, Garching, Germany, *“for his decisive contributions to highenergy astrophysics and cosmology, in particular processes and dynamics around black holes and neutron stars and demonstration of the diagnostic power of structures in the background radiation”*.

## **2007 BIOSCIENCES**

**ROBERT L. TRIVERS**, Rutgers University, New Brunswick, NJ, USA, *“for his fundamental analysis of social evolution, conflict and cooperation”*.

## **2006 GEOSCIENCES**

**WALLACE S. BROECKER**, Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY, USA, *“for his innovative and pioneering research on the operation of the global carbon cycle within the ocean atmosphere-biosphere system, and its interaction with climate”*.

## **2005 MATHEMATICS AND ASTRONOMY**

**JAMES E. GUNN** and **P. JAMES E. PEEBLES**, Princeton University, NJ, USA, and **SIR MARTIN J. REES**, Cambridge University, UK, *“for contributions towards understanding the large-scale structure of the Universe”*.

## **2004 POLYARTHRITIS**

**EUGENE C. BUTCHER**, Stanford University, CA, USA, and **TIMOTHY A. SPRINGER**, Harvard Medical School, Boston, MA, USA, *“for their studies on the molecular mechanisms involved in migration of white blood cells in health and disease”*.

## **2003 BIOSCIENCES**

**CARL R. WOESE**, University of Illinois (UIUC), IL, USA, *“for his discovery of a third domain of life”*.

## **2002 GEOSCIENCES**

**DAN P. MCKENZIE**, University of Cambridge, UK, *“for fundamental contributions to the understanding of the dynamics of the lithosphere, particularly plate tectonics, sedimentary basin formation and mantle melting”*.

#### **2001 MATHEMATICS AND ASTRONOMY**

**ALAIN CONNES**, IHÉS and Collège de France, France, *“for his penetrating work on the theory of operator algebras and for having been a founder of the non-commutative geometry”*.

#### **2000 POLYARTHRITIS**

**RAVINDER N. MAINI** and **MARC FELDMANN**, both of the Kennedy Institute of Rheumatology, London, UK, *“for their definition of TNF-alpha as a therapeutic target in rheumatoid arthritis”*.

#### **1999 BIOSCIENCES**

**JOHN MAYNARD SMITH**, University of Sussex, UK, **ERNST MAYR**, Harvard University, Cambridge MA, USA, and **GEORGE C. WILLIAMS**, State University of New York (SBU), NY, USA, *“for their fundamental contributions to the conceptual development of evolutionary biology”*.

#### **1998 GEOSCIENCES**

**DON L. ANDERSON**, California Institute of Technology, Pasadena CA, USA, and **ADAM M. DZIEWONSKI**, Harvard University, Cambridge MA, USA, *“for their fundamental contributions to our knowledge of the structures and processes in the interior of the Earth”*.

#### **1997 MATHEMATICS AND ASTRONOMY**

**FRED HOYLE**, University of Cambridge, UK, and **EDWIN E. SALPETER**, Cornell University, Ithaca, NY, USA, *“for their pioneering contributions to the study of nuclear processes in stars and stellar evolution”*.

#### **1996 BIOSCIENCES**

**LORD ROBERT M. MAY**, University of Oxford, UK, *“for his pioneering ecological research concerning theoretical analysis of the dynamics of populations, communities and ecosystems”*.

#### **1995 GEOSCIENCES**

**WILLI DANSGAARD**, Københavns Universitet, Denmark, and **NICHOLAS SHACKLETON**, University of Cambridge, UK, *“for their fundamental work on developing and applying isotope geological analysis methods for the study of climatic variations during the Quaternary period”*.

#### **1994 MATHEMATICS AND ASTRONOMY**

**SIMON DONALDSON**, University of Oxford, UK, “*for his fundamental investigations in four-dimensional geometry through application of instantons, in particular his discovery of new differential invariants*”, and **SHING-TUNG YAU**, Harvard University, Cambridge, MA, USA, “*for his development of non-linear techniques in differential geometry leading to the solution of several outstanding problems*”.

#### **1993 BIOSCIENCES**

**SEYMOUR BENZER**, California Institute of Technology, Pasadena, CA, USA “*for his pioneering genetical and neurophysiological studies on behavioural mutants in the fruit fly, *Drosophila melanogaster**”, and **WILLIAM D. HAMILTON**, University of Oxford, UK, “*for his theories concerning kin selection and genetic relationship as a prerequisite for the evolution of altruistic behavior*”.

#### **1992 GEOSCIENCES**

**ADOLF SEILACHER**, Institut und Museum für Geologie und Paläontologie, Tübingen, Germany, “*for his innovative research concerning the evolution of life in interaction with the environment as documented in the geological record*”.

#### **1991 MATHEMATICS AND ASTRONOMY**

**ALLAN R. SANDAGE**, The Observatories of the Carnegie Institution of Washington, Pasadena, CA, USA, “*for his very important contributions to the study of galaxies, their populations of stars, clusters and nebulae, their evolution, the velocity-distance relation (or Hubble relation), and its evolution over time*”.

#### **1990 BIOSCIENCES**

**PAUL R. EHRLICH**, Stanford University, CA, USA, “*for his research on the dynamics and genetics of fragmented populations and the importance of the distribution pattern for their survival probabilities*”, and **EDWARD O. WILSON**, Harvard University, Cambridge, MA, USA, “*for the theory of island biogeography and other research on species diversity and community dynamics on islands and in other habitats with differing degrees of isolation*”.

#### **1989 GEOSCIENCES**

**JAMES VAN ALLEN**, University of Iowa, Iowa City, IA, USA “*for his pioneering exploration of space, in particular the discovery of the energetic particles trapped in the geomagnetic field which forms the radiation belts – the Van Allen belts – around our planet Earth*”.

#### **1988 MATHEMATICS AND ASTRONOMY**

PIERRE DELIGNE, Institute for Advanced Study, Princeton, NJ, USA and ALEXANDRE GROTHENDIECK, Université des Sciences et Techniques du Languedoc, France, *“for their fundamental research in algebraic geometry”*.  
(Mr Grothendieck declined his prize.)

#### **1987 BIOSCIENCES**

EUGENE P. ODUM, University of Georgia, Athens, GA, USA and HOWARD T. ODUM, University of Florida, Gainesville, FL, USA, *“for their pioneering contributions within the field of ecosystem ecology”*.

#### **1986 GEOSCIENCES**

CLAUDE J. ALLÉGRE, Université de Paris, France, and GERALD J. WASSERBURG, California Institute of Technology, Pasadena, CA, USA, *“for their pioneering studies of isotope geochemical relations and the geological interpretations that these results permit”*.

#### **1985 MATHEMATICS AND ASTRONOMY**

LYMAN SPITZER JR, Princeton University, NJ, USA, *“for his fundamental pioneering studies of practically every aspect of the interstellar medium, culminating in the results obtained using the Copernicus satellite”*.

#### **1984 BIOSCIENCES**

DANIEL H. JANZEN, University of Pennsylvania, Philadelphia, PA, USA, *“for his imaginative and stimulating studies on co-evolution which has inspired many researchers to further work in this field”*.

#### **1983 GEOSCIENCES**

EDVARD N. LORENZ, Massachusetts Institute of Technology, Cambridge, MA, USA, and HENRY STOMMEL, Woods Hole Oceanographic Institution, MA, USA, *“for their fundamental contributions to the field of geophysical hydrodynamics, which in a unique way have contributed to a deeper understanding of the large-scale motions of the atmosphere and the sea”*.

#### **1982 MATHEMATICS AND ASTRONOMY**

VLADIMIR I. ARNOLD, Moscow State University, Soviet Union, and LOUIS NIRENBERG, New York University, NY, USA, *“for their outstanding achievements in the theory of non-linear differential equations”*.

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# Anna-Greta and Holger Crafoord

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Holger Crafoord (1908–1982) was prominent in Swedish industry and commerce. He began his career with AB Åkerlund & Rausing and devoted a larger part of his working life to this company. In 1964, Holger Crafoord founded Gambro AB in Lund, Sweden, where the technique of manufacturing the artificial kidney was developed. This remarkable dialyser soon became world famous. Since then, a series of medical instruments has been introduced on the world market making Gambro a leading company in this field.



In 1980, Holger Crafoord founded the Crafoord Foundation, which annually contributes greatly to the Anna-Greta and Holger Crafoord Fund.



HOLGER AND ANNA-GRETA CRAFOORD

Holger Crafoord became an honorary doctor of economics in 1972 and in 1976 an honorary doctor of medicine at Lund University.

Anna-Greta Crafoord (1914–1994) took, as Holger Crafoord's wife, part in the development of Gambro AB. Through generous donations and a strong commitment in the society around her, she contributed to the scientific and cultural life. In 1986 she founded the Anna-Greta Crafoord foundation for rheumatological research and in 1987 Anna-Greta Crafoord became an honorary doctor of medicine at Lund University.

Over the years, the Crafoords have furthered both science and culture in many ways and it is noteworthy that research in the natural sciences has received an important measure of support from the Anna-Greta and Holger Crafoord Fund.



## THE ROYAL SWEDISH ACADEMY OF SCIENCES

was founded in 1739 and is an independent non-governmental organisation, whose overall objective is to promote the sciences and strengthen their influence in society. The Academy has a particular responsibility for natural science and mathematics, but its work strives to increase interaction between different disciplines. The activities of the Royal Swedish Academy of Sciences primarily focus on:

- being a voice of science in society and influencing research policy (policy for science)
- providing a scientific basis for public debate and decision-making (science for policy)
- recognizing outstanding contributions to research
- being a meeting place for science, within and across subject boundaries
- providing support for young researchers
- stimulating interest in mathematics and natural science in school
- disseminating knowledge to the public
- mediating international scientific contacts
- preserving scientific heritage

**THE ACADEMY** has around 460 Swedish and 175 foreign members who are active in classes, committees and working groups. They initiate enquiries, consultation documents, conferences and seminars. The Academy has General Meetings eight times a year. Open lectures are held in association with these (read more at [www.kva.se/kalendarium](http://www.kva.se/kalendarium)). They can also be watched via [www.kva.se/video](http://www.kva.se/video).

**THE ACADEMY'S** institutes offer unique research environments in ecological economics, botany, the history of science and mathematics.

Every year, the Academy awards a number of prizes and rewards. The best known are the Nobel Prizes in Physics and Chemistry and the Sveriges Riksbank Prize in Economic Science in Memory of Alfred Nobel (the Prize in Economic Sciences). Other major prizes are the Crafoord Prize, Sjöberg Prize, Göran Gustafsson Prizes, Söderberg Prize and the Tobias Prize. The Göran Gustafsson Prizes are awarded to outstanding young researchers and are a combination of a personal prize and research funding. Since 2012, the Academy of Sciences has been one of the academies involved in implementing the Wallenberg Academy Fellows career programme, which provide long-term funding to the most promising young researchers. As well as a comprehensive range of scholarships, the Academy is also involved in appointments to research posts in a number of programmes funded by external foundations.

Through its working groups and committees, the Academy also works to promote sustainable, science-based societal development in the area of energy and the environment, among others. Issues relating to education and conditions for teachers are another major interest. The Academy organises Science Meetups, holiday schools at which recent arrivals to Sweden and Swedish upper-secondary school pupils learn more about natural science together. In the 1990s, the Academy and the Royal Swedish Academy of Engineering Sciences founded one of Sweden's biggest school development programmes, NTA – Naturvetenskap och teknik för alla (Science and Technology for all).



KUNGL.  
VETENSKAPS-  
AKADEMIEN

THE ROYAL SWEDISH ACADEMY OF SCIENCES

THE CRAFOORD PRIZE IS AWARDED IN PARTNERSHIP BETWEEN THE ROYAL SWEDISH ACADEMY OF SCIENCES AND THE CRAFOORD FOUNDATION IN LUND. THE ACADEMY IS RESPONSIBLE FOR SELECTING THE CRAFOORD LAUREATES.

[WWW.CRAFOORDPRIZE.SE](http://WWW.CRAFOORDPRIZE.SE)

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