WELCOME TO THE

THE Crafoord PRIZE

Crafoord *Days* 2008

21–24 APRIL

Programme

Abstracts

The Crafoord Prize in Mathematics and Astronomy 2008

Anna-Greta and Holger Crafoord Fund

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
- Polyarthritis

Support to research takes the form of an international prize awarded annually to outstandig scientists, and of research grants to individuals or institutions in Sweden. The awards 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
et.c.

The prize in Polyarthritis is awarded only when a special committee 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 USD 500 000. 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.

Content

Crafoord Prize Lectures 2008

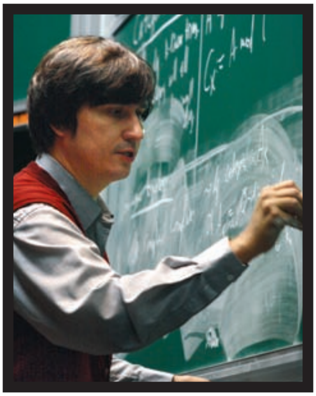
Open to the public

Monday 21 APRIL

ASSEMBLY HALL, , MAIN BUILDING, LUND UNIVERSITY, LUND

13.30	Welcome and Practical Information	Moderator: *Mr Daniel Bengtson*
13.40	Welcome to the Crafoord Days	*Gunnar Öquist*, Permanent Secretary, The Royal Swedish Academy of Sciences
13.45	*Introduction of the Crafoord Laureate in Astronomy 2008, Rashid Alievich Sunyaev*	*Arne Ardeberg*
13.50	*Crafoord Prize lecture* BLACK HOLES AND THE EMERGING UNIVERSE	**RASHID SUNYAEV**
14.20	*Introduction of the Crafoord Laureate in Mathematics 2008, Edward Witten*	*Torsten Ekedahl*
14.25	*Crafoord Prize lecture* PHYSICS INSPIRING MATHEMATICS	**EDWARD WITTEN**
14.55	Break with refreshments in the Atrium	
15.25	*Introduction of the Crafoord Laureate in Mathematics 2008, Maxim Kontsevich*	*Carel Faber*
15.30	*Crafoord Prize lecture* GEOMETRY OF ALGEBRA	**MAXIM KONTSEVICH**
16.00	*The audience´s questions to the Laureates*	
16.45	End	
18.15	Buffet (in honour of the Laureates with invited guests only)	

The Crafoord Prize Laureates in Mathematics and Astronomy 2008



MAXIM KONTSEVICH (MATHEMATICS)
Born 1964 in Khimki, Russia. Ph.D. in mathematics 1992 at University of Bonn, Germany. Professor at Institut des Hautes Études Scientifiques (IHÉS), Bures-sur-Yvette, France.

EDWARD WITTEN (MATHEMATICS)
Born 1951 in Baltimore, MD, USA. Ph.D. in physics 1976 at Princeton University, NJ, USA. Charles Simonyi Professor at School of Natural Sciences, Institute for Advanced Study, Princeton, NJ, USA.

"for their important contributions to mathematics inspired by modern theoretical physics"

RASHID ALIEVICH SUNYAEV (ASTRONOMY)
Born 1943 in Tashkent, Uzbekistan. Ph.D. in astrophysics 1968 at Moscow University, Russia. Director of Max Planck Institute for Astrophysics, Garching, Germany and The Space Research Institute (IKI), The Russian Academy of Sciences, Russia.

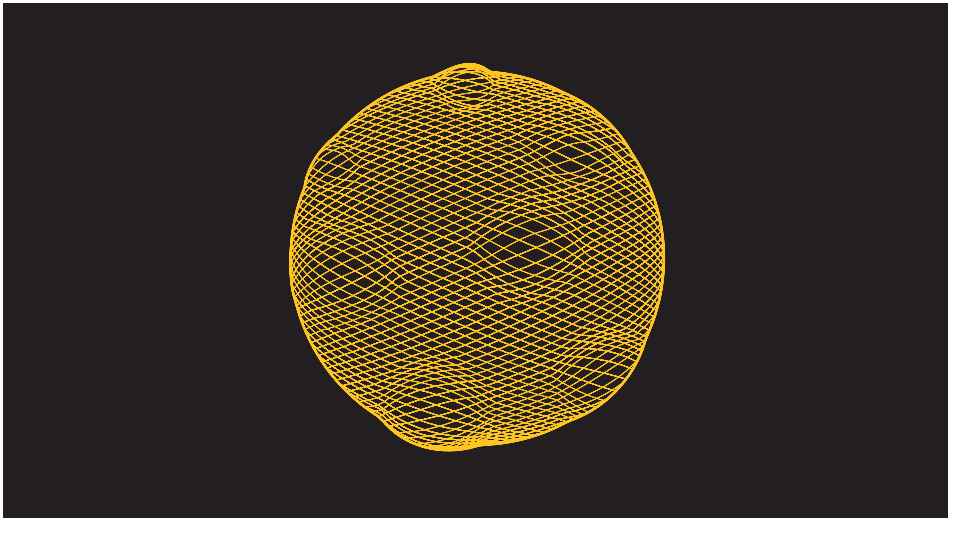
"for his decisive contributions to high-energy astrophysics and cosmology, in particular processes and dynamics around black holes and neutron stars and demonstration of the diagnostic power of structures in the background radiation"

Cross-disciplinary mathematics and the extreme Universe

This year's Crafoord Prize combines abstract mathematics and astrophysics. It is being awarded for mathematical discoveries that are significant for the fundamental laws of nature and for research on black holes and the early Universe.

MATHEMATICS

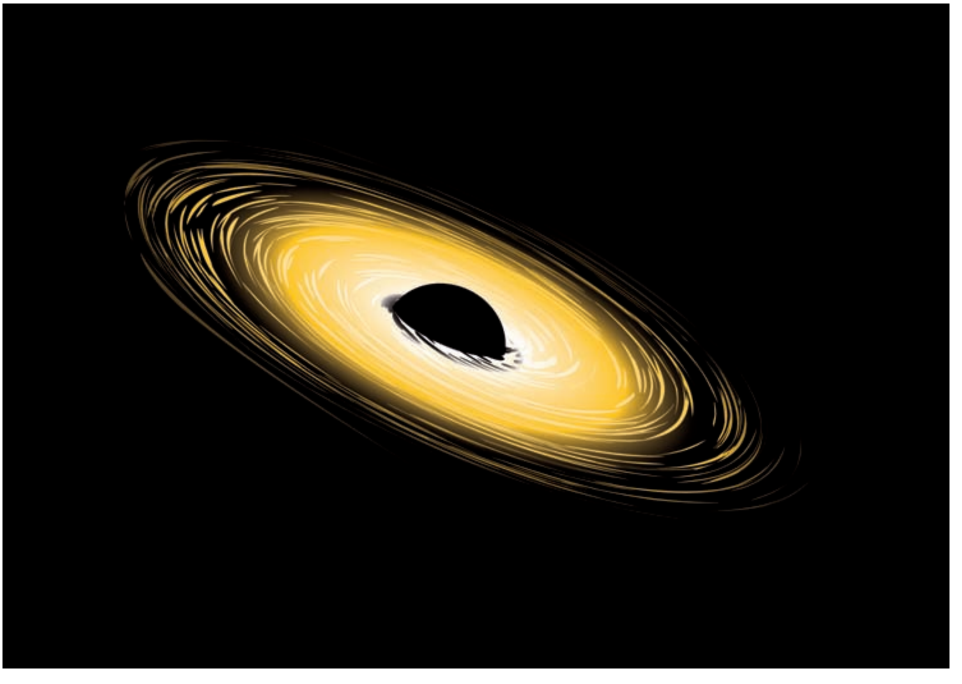
The laureates in mathematics, the mathematician Maxim Kontsevich and the theoretical physicist Edward Witten, have used the methodology of physics to develop a revolutionary new mathematics intended for the study of various types of geometrical objects. Their work is not only of great interest in the discipline of mathematics but may also find applications in totally different areas. Its results are of considerable value for physics and research into the fundamental laws of nature. According to string theory, which is an ambitious attempt to formulate a theory for all the natural forces, the smallest particles of which the Universe is composed are vibrating strings. This theory predicts the existence of additional dimensions and requires very advanced mathematics. The laureates have resolved several important mathematical problems related to string theory and have in this way paved the way for its further development.



Using the methodology it is possible to create surfaces with different shapes and analyze their characteristics, for example in what way they are knobbly. ILLUSTRATION: Typoform

ASTRONOMY

The laureate in astronomy, Rashid Sunyaev, has studied the most extreme processes in the Universe and developed theoretical models of how black holes devour matter and the origin of the structure of the cosmological background radiation. His description of how matter drawn towards a black hole forms a thin, rapidly rotating disc is essential if we are to understand how black holes can be the most powerful sources of radiation in the Universe. Sunyaev's work with the cosmological background radiation has inspired measurements that provide clues to the creation and structure of the Universe. This radiation derives from a period when the Universe was only a few hundred thousand years old and contains information about what happened during Big Bang. On its journey to us it has also been influenced by the distribution of matter in clusters of galaxies billions of years later.



Matter that falls into a black hole forms a thin, rapidly rotating disc (an *accretion disc*). Large black holes surrounded by accretion discs are concealed at the cores of galaxies. ILLUSTRATION: Typoform

Crafoord Prize Symposium Astronomy

HOT TOPICS IN HIGH ENERGY ASTROPHYSICS

Open to the public

Tuesday 22 APRIL

BEIJER HALL, , THE ROYAL SWEDISH ACADEMY OF SCIENCES, STOCKHOLM

11.00	Registration	
11.30	*The Richness and Beauty of the Physics of Cosmological Recombination*	Crafoord Laureate 2008, **RASHID SUNYAEV** MPA, Germany
12.15	*Energy release in the early Universe, CMB spectral distortions and a new way to constrain the thermal history of the Universe*	*Jens Chluba* MPA, Germany
12.45	*Alpha Disks, the Magnetorotational Instability, and Beyond*	*Steven Balbus* Ecole Normale Superieure, France
13.30	Lunch	
14.30	*On the theory of the non-stationary accretion disks and the value of alpha-parameter in X-ray novae*	*Nikolai Shakura,* Sternberg Institute, Russia
15.00	*Populations of accreating X-ray sources in galxies*	*Marat Gilfanov* MPA, Germany
15.30	*Observations of the Sunyaev-Zeldovich Effect: Current Status and Future Plans*	*John Carlstrom* University of Chicago, USA
16.15	Break with refreshments	
16.45	*Sunyaev-Zeldovich Effect: Past, Present and Future*	*Jeremiah P. Ostriker* Princeton University, USA
17.30	*Galaxy clusters and supermassive black holes: cooling against heating*	*Eugene Churazov* MPA, Germany
18.00	*Future of high energy astronomy*	*Günther Hasinger,* MPE, Germany
18.45	End	

The Richness and Beauty of the Physics of Cosmological Recombination

Rashid Sunyaev, CRAFOORD LAUREATE 2008
THE MAX-PLANCK-INSTITUTE FOR ASTROPHYSICS, GERMANY AND
THE SPACE RESEARCH INSTITUTE (IKI), THE RUSSIAN ACADEMY OF SCIENCES, RUSSIA

The physical ingredients to describe the epoch of cosmological recombination are amazingly simple and well-understood. This fact allows us to take into account a very large variety of processes, still finding potentially measurable consequences. In this talk we highlight some of the detailed physics that were recently studied in connection with cosmological hydrogen and helium recombination. The impact of these considerations is two-fold:

(i) The associated release of photons during this epoch leads to interesting and unique deviations of the Cosmic Microwave Background (CMB) energy spectrum from a perfect blackbody, which, in particular at cm and decimeter wavelength, may become observable in the near future. Observing the spectral distortions from the epochs of hydrogen and helium recombination,in principle would provide an additional way to determine some of the key parameters of the Universe (e.g. the specific entropy, the CMB monopole temperature and the pre-stellar abundance of helium).

(ii) With the advent of high precision CMB data, a very accurate theoretical understanding of the ionization history of the Universe becomes necessary for the interpretation of the CMB temperature and polarization anisotropies. Here we show that the uncertainty in the ionization history due to several processes, which until now were not taken in to account in the standard recombination code RECFAST, exceed the level of 0.1% to 0.5%. However, it is indeed surprising how inert the cosmological recombination history is even at percent-level accuracy.

Energy release in the early Universe, CMB spectral distortions and a new way to constrain the thermal history of the Universe

Jens Chluba
THE MAX-PLANCK-INSTITUTE FOR ASTROPHYSICS, GERMANY

Zeldovich and Sunyaev, 1969, 1970 demonstrated that any energy release in early Universe leads only to two types of the Cosmic Microwave Background (CMB) spectral distortions - y-type (SZ-effect) and Bose-Einstein type (myu-type) which both have broad band spectral nature. COBE-FIRAS (J. Mather et al) gave strict observational limits for both y and myu-parameters. Now we discuss how narrow features in the CMB spectrum due to pre-recombinational emission in bound-bound and free-bound transitions of hydrogen and HeII can be used to study the thermal history of the Universe including annihilation of dark matter particles, decay of unknown types of particles, dissipation of nonlinear motions, turbulence etc. with much better time resolution.

Alpha disks, the magnetorotational instability, and beyond

Steven Balbus
DEPARTMENT OF PHYSICS, ECOLE NORMAL SUPERIEURE, FRANCE

The development of what is now the standard model of accretion disks in 1973 by Shakura & Sunyaev was a landmark event in 20th century astrophysics. Known as "alpha disks" from an important parameter in the theory, these models have become an indispensable tool for understanding systems as diverse as protostars, X-ray binaries, and active galactic nuclei. A critical assumption of alpha disk models was that a gaseous fluid in rotation about a central mass would become turbulent. The proof of this assumption posed a stern challenge to theorists that was met in 1991 with the discovery of the magnetorotational instability (MRI) in accretion disks. In this talk, I will review the basic fundamentals of alpha disk theory, present the physics behind the MRI, and explain how the MRI has influenced our understanding of astrophysical gas dynamics even beyond accretion disk theory.

On the theory of the non-stationary accretion disks and the value of alpha-parameter in X-ray novae

Nikolai Shakura
STERNBERG INSTITUTE, RUSSIA

I shortly review the theory of the non-stationary accretion in disks with a focus on the transient phenomena in the binary systems. An analytic (a semi-analytic) model of a non-stationary alpha-disk confronted with observations offers a way to estimate the parameter of turbulent viscosity alpha. I describe a model dedicated to explain X-ray and optical light curves of X-ray Novae. The model incorporates the interception of X-rays by the outer regions of accretion disk and the general relativity effects on light propagation near a Kerr black hole. The resulting alpha is greater than 0.2 .

Populations of accreting X-ray sources in galaxies

Marat Gilfanov
THE MAX-PLANCK-INSTITUTE FOR ASTROPHYSICS, GERMANY

Chandra and XMM-Newton observations of nearby galaxies revealed that populations of high- and low-mass X-ray binaries are proportional to the star-formation rate and stellar mass of the host galaxy and their luminosity distributions obey respective "universal" luminosity functions. There is a qualitative difference between the two LFs, reflecting the difference in the accretion regimes in these two types of X-ray binaries. The numbers of high-mass X-ray binaries observed in star-forming galaxies indicate the rather high probability for a massive star to become an accretion powered X-ray source once upon its lifetime. This explains surprisingly high contribution of accreting neutron stars and stellar mass black holes to the Cosmic X-ray background, ~7-10%.

Finally, I will present the evidence that X-ray binaries may be formed in significant numbers near galactic centers via tidal captures of low mass stars by stellar mass black holes.

Observations of the Sunyaev-Zeldovich Effect: Current Status and Future Plans

John Carlstrom
UNIVERSITY OF CHICAGO, USA

The Sunyaev-Zel'dovich (SZ) effect, first proposed in 1970, is becoming a powerful observational tool for cosmology and astrophysics. The effect is a small spectral distortion of the Cosmic Microwave Background (CMB) radiation caused by the scattering of the CMB photons by electrons in the hot atmospheres of clusters of galaxies. Clusters of galaxies are the largest objects in the universe and are composed mainly of large concentrations of dark matter. Most of the ordinary matter associated with a cluster is contained in the form of a hot, X-ray emitting, gas that is gravitationally bound to the cluster's dark matter. As the SZ effect for a cluster is a measure of the fraction of CMB photons scattered, its observed strength is independent of the distance (redshift) of the cluster. This unique feature of the SZ effect makes it particularly useful for cosmology. Recent studies, for example, have combined SZ measurements with those of other cluster tracers, such as X-ray emission, to determine cluster distances and the expansion rate of the universe. The distance independence of the SZ effect makes it exceptionally well suited for studies of clusters at large distances (high redshifts), where the abundance of clusters is critically sensitive to the underlying cosmology. New instruments such as the 10-meter South Pole Telescope are starting large SZ surveys that are expected to find thousands of galaxy clusters. The yields of these surveys will be used to investigate the nature of the mysterious Dark Energy that dominates the energy-density of the Universe today and is causing the expansion of the universe to accelerate. After a brief review of the history and current status of SZ observations and cosmological results, this talk will focus on the new and upcoming SZ experiments.

Sunyaev-Zeldovich Effect: Past, Present and Future

Jeremiah P. Ostriker
PRINCETON UNIVERSITY, USA

Jeremiah P. Ostriker is a researcher in theoretical astrophysics, with current primary work in the area of cosmology, particularly the aspects that can be approached best by large scale numerical calculations.

Most significantly, Ostriker's research focused on the theories of: Pulsars, Interstellar Medium, Dark Matter and Dark Energy, Lyman-alpha Clouds - the paradigm shift (utilizing numerical simulations), The Warm-Hot Intergalactic Medium (WHIM) and the First Stars and Reionization of the Universe.

Galaxy clusters and supermassive black holes: cooling against heating

Eugene M. Churazov
MAX PLANCK INSTITUTE FOR ASTROPHYSICS, GERMANY AND
THE SPACE RESEARCH INSTITUTE (IKI), THE RUSSIAN ACADEMY OF SCIENCES, RUSSIA

Potential wells of massive clusters are filled with hot X-ray emitting gas. The deepest part of the cluster's potential well is "marked" by a giant elliptical galaxy, whose own potential well is in turn marked with by a supermassive black hole. The cluster gas is densest in these central regions and it takes only a small fraction of the Hubble time for the gas to radiate away all of its thermal energy. Should the gas indeed been able to cool, its temperature would drop from tens of millions to ten of thousands degrees and even lower. The gas would then become a vast source of material for vigorous star formation or for nurturing a truly supermassive black hole at the cluster center.

Yet we do not see this happening in present day clusters. Neither the gas temperature drop below X-ray temperatures, nor the intense star formation or black holes rapid growth are seen in the cores of nearby clusters.

It seems on the contrary that the cluster gas and the supermassive black hole are able to find a "mutually acceptable" configuration when in response to modest feeding by the cooling gas the supermassive black hole returns a sufficient amount of heat to compensate for the gas cooling losses. Such a system can find itself a stable equilibrium with a balance between cooling and heating. X-ray and radio observations proved to be the most instrumental in understanding how this works in nearby clusters, although many details remain unknown.

What is even more important is that a similar process was perhaps operating in young and growing galaxies at high redshifts, where our current sensitivity and angular resolution fall short of revealing all details. This possibility is instead offered to us by the cores of nearby clusters.

The future of High-Energy Astrophysics

Günther Hasinger
Max Planck Institute for Extraterrestrial Physics, Germany

High-Energy astrophysics is a crucial element of modern astrophysics and is particularly well suited to study matter under extreme conditions, black holes and warm/hot baryons in the dark matter potential wells of the cosmic web. Currently several high-energy satellite missions are working successfully in orbit and ground-based Cherenkov telescopes are providing exciting new results. The next decade will see a series of international missions in the gamma and X-ray range, starting with the launch of the NASA GLAST mission. The Russian Spektr-Röntgen-Gamma mission, which is prepared under the leadership of Rashid Sunyaev, will carry a suite of powerful new instruments to study in particular clusters of galaxies and Dark Energy. Finally, XEUS, the X-ray evolving Universe Spectroscopy mission has been selected in the ESA Cosmic Vision programme as one of the candidates for large missions in the next decade. In this presentation I give a short overview of the scientific and technical highlights of these missions.

Crafoord Prize-awarding Ceremony

Open to the public

Wednesday 23 APRIL

BEIJER HALL, THE ROYAL SWEDISH ACADEMY OF SCIENCES, STOCKHOLM

16.00	WELCOME	
	Opening remarks	*Bo Sundqvist*, President of the Royal Swedish Academy of Sciences
	Presentation of the Crafoord Laureates 2008	*Torsten Ekedahl, Carel Faber, Arne Ardeberg*
	The Crafoord Prize in Mathematics and Astronomy 2008	*His Majesty the King* presents **EDWARD WITTEN**, **MAXIM KONTSEVICH** and **RASHID ALIEVICH SUNYAEV**
	The Crafoord 2008 research grant recipients receive their diplomas	
	Music during ceremony performed by: Andrej Power, Victoria Power, Andrej Nikolaev, Mikael Rydh, Klas Edvall and Filip Draglund.	
17.35	End	
18.15	Banquet (in honour of the Laureates with invited guests)	

Crafoord Prize Symposium Mathematics

FROM PHYSICS TO GEOMETRY

Open to the public

Thursday 24 APRIL

BEIJER HALL, THE ROYAL SWEDISH ACADEMY OF SCIENCES, STOCKHOLM

08.30	Registration	
09.00	*Topological Strings*	*Cumrun Vafa*, Dept. of Physics, Harvard University, USA
09.45	*Instanton partition functions*	*Nikita Nekrasov*, Institut des Hautes Études Scientifiques (IHÈS), France
10.30	Break with refreshments	
11.00	*Gauge Theory and Quantum Curves*	*Robbert Dijkgraaf*, Institute for Theoretical Physics, University of Amsterdam, Netherlands
11.45	*Electro-magnetic duality on a half space*	Crafoord Laureate 2008 **Edward Witten**, Institute for Advanced Study, USA
12.30	Lunch	
	The symposia continues at the Mathematical Institution, Stockholm University, Lecture hall 15 (Kräftriket) after lunch.	
14.15	*Non-commutative wall-crossing formulae*	Crafoord Laureate 2008 **Maxim Kontsevich**, Institut des Hautes Études Scientifques (IHÈS), France
15.00	*Non-commutative geometry and quantum field theory*	*Graeme Segal*, Mathematical Institute, University of Oxford, UK
15.45	Break	
16.15	*Triangulation of the Teichmueller spaces*	*Eduard Looijenga*, Mathematics Department, University of Utrecht, Netherlands
17.00	End	

Noncommutative wall-crossing formulae

Maxim Kontsevich, Crafoord Laureate 2008
Institut des Hautes Études Scientifiques (IHÉS), France

I will describe a new structure of a very elementary nature, associated with any Lie algebra graded by a lattice of finite rank. The structure (called the stability datum) is given by an additive map Z from the grading lattice to complex numbers, and a collection of elements in the graded components of the Lie algebra supported on a subset which is far from the kernel of Z in some sense. There exists a natural topology on the set of stability data such that the forgetting map to the space of additive maps Z is locally a homeomorphism. This structure was observed by Y. Soibelman and myself in the study of generalized Donaldson-Thomas invariants of 3-dimensional Calabi-Yau categories, and is analogous to Bridgeland's stability conditions. Explicit formulas for the parallel transport of stability data include certain infinite products over an everywhere dense countable family of walls. Noncommutative wall-crossing formulae can be applied to the counting of BPS states in superstring theory and lead to the mathematical definition of the vectormultiplet moduli space. Combinatorics of formulae is related to extremal black holes. In pure mathematics, wall-crossing formulae lead to many things, including new identities in cluster algebras, and (possibly) a new approach to L-functions in number theory via Arakelov geometry.

Electro-magnetic duality on a half space

Edward Witten, , CRAFOORD LAUREATE 2008
INSTITUTE FOR ADVANCED STUDY, USA

In four-dimensional gauge theory with electric-magnetic duality, what is the dual of Dirichlet boundary conditions? And what is the dual of Neumann boundary conditions? If the gauge group is abelian, then Dirichlet and Neumann boundary conditions are simply dual to each other, but the non-abelian case is much more interesting. The dual of Neumann boundary conditions – at least in the classic case of $N = 4$ supersymmetric Yang-Mills theory – involves the unexpected appearance of an SU(2) group that plays the role of Arthur's SL(2) in the Langlands program of number theory. And the dual of Dirichlet boundary conditions involves a rather unusual three-dimensional conformal field theory. If the gauge group is simply-laced, then this particular conformal field theory is self-mirror in the sense of Intriligator and Seiberg. In general, electric-magnetic duality on a half-space involves an interplay between SU(2) embeddings in the gauge group and three-dimensional conformal field theory. The Coulomb and Higgs branches of the relevant three-dimensional conformal field theories are important spaces in representation theory – nilpotent orbits of complex Lie groups and their Slodowy slices. Mirror symmetry exchanges one orbit with the Slodowy slice of another orbit. The relation between the two is order-reversing. Mirror symmetry in this sense is a three-dimensional analog of the more familiar two-dimensional mirror symmetry. These conformal field theories can be realized in string theory in several different ways – for example via intersecting branes, by studying M-theory at certain singularities, or as a limit of a "Janus solution" of string theory. Many of these systems have been much studied in the string theory literature, and many results that are already known give illuminating special cases of some of the above statements. One classic string theory question whose answer is not yet clear but is likely to involve three-dimensional conformal field theories of the above-discussed type is to describe a system of D3-branes ending on a (p,q) fivebrane. The work presented in this talk has been done in collaboration with D. Gaiotto.

Topological strings

Cumrun Vafa
DEPARTMENT OF PHYSICS, HARVARD UNIVERSITY, USA

Topological strings have become an increasingly important tool in understanding the dynamics of string theory and supersymmetric quantum field theories. Not only is it a very rich mathematical object, but it also turns out to have unexpectedly rich and diverse physical applications. In this talk I provide a brief overview of this vast subject.

Instanton partition functions

Nikita Nekrasov
INSTITUT DES HAUTES ETUDES SCIENTIFIQUES (IHÉS), FRANCE

The instanton partition functions are at the intersection of geometry, algebra, topology, combinatorics, and mathematical physics. I review the gauge and string theory instanton partition functions, both the established results and a few conjectures. Various moduli spaces and their compactifications, random discrete geometries and limit shapes, spectral curves and their quantizations, representation theory of infinite-dimensional algebra, invariants of four-manifolds, integrable systems, non-commutative geometry: all these matters will play a role in our story.

Gauge Theory and Quantum Curves

Robbert Dijkgraaf
INSTITUTE FOR THEORETICAL PHYSICS, UNIVERSITY OF AMSTERDAM, NETHERLANDS

Many properties of four-dimensional super symmetric quantum gauge theories are captured by two-dimensional conformal theories defined on algebraic (spectral) curves. However, more generally one can obtain a quantum deformation of this well-studied system, where the curve is replaced by a non-commutative object (a D-module). The simplest non-trivial example is given by the exact solutions of random matrix models. I will review the circle of physical and mathematical ideas that includes topological strings, integrable hierarchies, and D-branes.

Non-commutative geometry and quantum field theory

Graeme Segal
MATHEMATICAL INSTITUTE, UNIVERSITY OF OXFORD, UK

There is a rough equivalence between the category of commutative rings and the category of topological spaces. It is the basis of the way in which quantum physics describes the world. Thinking about the equivalence leads us towards variants and generalizations of the objects on both sides of the picture. On the algebraic side we can consider non-commutative rings, or rings which themselves have a topology, but also more subtle kinds of algebraic structures. A two-dimensional quantum field theory is an example of such an algebraic structure. These algebraic variants have reflections on the geometrical side of the picture. For example, a commutative ring has a homotopy-type, but a non-commutative ring has a slightly coarser geometric structure, and a topologized non-commutative ring represents yet another kind of geometrical object. I shall describe some different ways of looking at these objects, and how they arise naturally from Floer-type infinite-dimensional variational problems. At the same time I shall explain how some technical-seeming distinctions made in traditional algebraic topology reflect the possible locality properties of quantum field theories.

Triangulation of the Teichmueller spaces

Eduard Looijenga
MATHEMATICS DEPARTMENT, UNIVERSITY OF UTRECHT, NETHERLANDS

About 25 years ago Mumford and Thurston observed that for every genus g and positive integer n (take $n \ggg\!\to 2$ if $g = 0$) the theory of Jenkins-Strebel differentials produces a rather concrete simplical complex endowed with an action of the mapping class group of n-pointed genus g surfaces plus a subcomplex invariant under that group with the property that the complement can be equivariantly identified with the corresponding Teichmueller space. This has had some profound applications, ranging from the homotopy theory of the mapping class groups (work of Harer) to the solution of the Witten conjecture (by Kontsevich). It has also repercussions for topological quantum field theory, Grothendieck's Lego game and the cohomology of the moduli spaces of curves. We shall review some of these uses and state some conjectures inspired by them.

The Royal Swedish Academy of Sciences is an independent, non-governmental organisation whose aim is to promote the sciences and strengthen their influence in society. Traditionally, the Academy takes a special responsibility for the natural sciences and mathematics, but in its work it strives to increase exchanges between different disciplines.

The activities of the Academy are aimed mainly at:

- *spreading knowledge of discoveries and problems in current research*
- *providing support for young researchers*
- *rewarding outstanding contributions in research*
- *stimulating interest in mathematics and the natural sciences in schools*
- *spreading scientific and popular-scientific information in various forms*
- *offering unique research environments*
- *maintaining contact with foreign academies, learned societies and other international scientific organisations*
- *representing the sciences in society*
- *carrying out independent analyses and evaluations, based on scientific grounds, of issues of importance for society*

The Academy has about 400 Swedish members and 175 foreign members. The Swedish members are active within Classes and Committees. They initiate investigations, responses to government proposals, conferences and seminars. Once a month the Academy holds a General Meeting and in connection with this a public lecture. (For more information, please visit www.kva.se.) The Academy´s own institutes offer unique research environments for climate research, botany, ecological economics, the history of science, astrophysics, mathematics and other subjects. Besides the prominent Crafoord Prize, the Academy awards annually a number of prizes, the best known of which are the Nobel Prizes in Physics and Chemistry and the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel. Other important prizes are the Söderberg Prize and the Göran Gustafsson Prizes. The latter are awarded to outstanding young researchers and are a unique combination of a personal prize and a research grant. The Academy also supports researchers who have been researching actively for five to ten years after taking their doctorate by providing a salary for five years through the support of external foundations. Through its various Committees the Academy also works for the development of a society based on scientific grounds. Great interest is paid to educational issues and a major school development program, NTA (Natural Sciences and Technology for All), is organised in collaboration with the Royal Swedish Academy of Engineering Sciences.

KUNGL. VETENSKAPSAKADEMIEN
THE ROYAL SWEDISH ACADEMY OF SCIENCES

BOX 50005, SE-104 05 STOCKHOLM, SWEDEN
TEL: +46 8 673 95 00 FAX: +46 8 15 56 70 , INFO@KVA.SE | WWW.KVA.SE

THE CRAFOORD PRIZE IS AWARDED BY
THE ROYAL SWEDISH ACADEMY OF SCIENCES