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XVI International Congress on Mathematical Physics
Prague, August 3–8, 2009

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Prize Winners and Lectures

Henri Poincaré Prize

sponsored by

the Daniel Iagolnitzer Foundation

The prize is awarded since 1997 to recognize outstanding contributions in mathematical physics, and contributions which lay the groundwork for novel developments in this broad field. The prize was also created to recognize and support young people of exceptional promise who have already made outstanding contributions to the field of mathematical physics. The previous laureates are:

1997: Rudolf Haag, Maxim Kontsevich, Arthur Wightman

2000: Joel Lebowitz, Walter Thirring, Horng-Tzer Yau

2003: Huzihiro Araki, Elliott H. Lieb, Oded Schramm

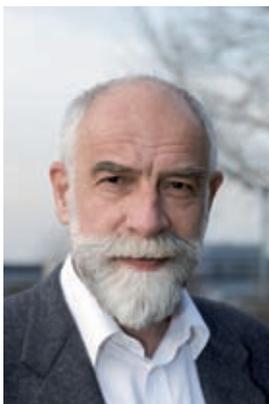*2006:* Ludvig D. Faddeev, David Ruelle, Edward Witten

The prize committee:

Bruno Nachtergaele, chair
Eric Carlen
Giovanni Gallavotti
Krzysztof Gawedzki
Herbert Spohn

Jürg Fröhlich

Citation:

for his fundamental contributions to quantum field theory and statistical mechanics which led to major advances in our understanding of physical systems with many degrees of freedom

Laudatio speaker: Klaus Hepp

Prize lecture: Wednesday August 5, 14.15-15.00, Meridian

Title: PERSPECTIVES IN MATHEMATICAL PHYSICS

Abstract: I will describe some important problems in theoretical physics and illustrate in which way mathematical physics has contributed to progress in solving them. Among such problems are general aspects of quantum theory and quantum field theory, the fundamental laws of thermodynamics, the quantum theory of open systems and transport theory, etc. Special emphasis will be placed on problems related to quantum Brownian motion and quantum friction. It is a common work with with W. De Roeck, A. Pizzo, and I.M. Sigal.

Robert Seiringer

Citation:

for his major contributions to the mathematical analysis
of low temperature condensed matter systems, in
particular for his work on Bose condensation and the
Gross-Pitaevskii equation

Laudatio speaker: Jakob Yngvason

Prize lecture: Thursday, August 6, 12.45-13.45, Meridian

Title: HOT TOPICS IN COLD GASES

Abstract: Since the first experimental realization of Bose-Einstein condensation in cold atomic gases in 1995 there has been a surge of activity in this field. Ingenious experiments have allowed us to probe matter close to zero temperature and reveal some of the fascinating effects quantum mechanics has bestowed on nature. It is a challenge for mathematical physicists to understand these various phenomena from first principles, that is, starting from the underlying many-body Schroedinger equation. Recent progress in this direction concerns mainly equilibrium properties of dilute, cold quantum gases. We shall explain some of the results in this lecture, and describe the mathematics involved in understanding these phenomena. Topics include the ground state energy and the free energy at positive temperature, the effect of interparticle interaction on the critical temperature for Bose-Einstein condensation, as well as the occurrence of superfluidity and quantized vortices in rapidly rotating gases.

Yakov G. Sinai

Citation:

for his ground-breaking works concerning dynamical
entropy, ergodic theory, chaotic dynamical systems,
microscopic theory of phase transitions, and time
evolution in statistical mechanics

Laudatio speaker: Domokos Szász

Prize lecture: Young Researcher Symposium, Saturday August 1, 9.00-10.00, Aula Maxima (103)

Title: RENORMALIZATION GROUP METHOD AND SINGULARITIES OF COMPLEX-VALUED SOLUTIONS OF EQUATIONS OF FLUID-DYNAMICS

Abstract: I shall explain the method of constructing solutions with singularities developed by Dong Li and myself in the case of two-dimensional Burgers system.

Cédric Villani

Citation:

for his innovative work on kinetic theory and optimal
transport with applications to dissipative physical
systems and Riemannian geometry

Laudatio speaker: Joel Lebowitz

Prize lecture: Tuesday, August 4, 14.15-15.00, Meridian

Title: LANDAU DAMPING

Abstract: The celebrated and mysterious Landau damping predicts relaxation of the kinetic distribution of a classical collisionless plasma, without any diffusion or irreversibility.

For the past sixty years, Landau damping has been treated exclusively for the linearized model, with the exception of very partial results. In a joint work with Clement Mouhot, we close this gap by presenting a solution to the nonlinear damping problem. Unexpected mathematical and physical developments will be discussed.

IAMP Early Career Award

The prize was established by the IAMP in 2006 in recognition of a single achievement in Mathematical Physics. The prize is reserved for scientists whose age in years since birth on July 31 of the year of the Congress is less than 35, and it is awarded for the first time.

The prize committee:

Jan Philip Solovej, chair
Jürg Fröhlich
Svetlana Jitomirskaya
Israel Michael Sigal
Horng-Tzer Yau

Mihalis Dafermos

Citation:

for his important contributions to the understanding
of the strong cosmic censorship conjecture and Price law
in general relativity

Prize lecture: Tuesday, August 4, 15.15-16.00, Meridian

Title: THE BLACK HOLE STABILITY PROBLEM IN
GENERAL RELATIVITY

Abstract: Understanding the behaviour of linear waves on black
hole backgrounds is a central problem in general relativity, inti-
mately connected with the nonlinear stability of the black hole
spacetimes themselves as solutions to the Einstein equations–a
major open question in the subject. Nonetheless, it is only very
recently that even the most basic boundedness and quantitative
decay properties of linear waves have been proven in a suit-
ably general class of black hole exterior spacetimes. This talk
will review our current mathematical understanding of waves on
black hole backgrounds, beginning with the classical bounded-
ness theorem of Kay and Wald on exactly Schwarzschild exte-
riors and ending with very recent boundedness and decay theo-
rems (proven in collaboration with Igor Rodnianski) on a wider
class of spacetimes. This class of spacetimes includes in par-
ticular slowly rotating Kerr spacetimes, but in the case of the
boundedness theorem is in fact much larger, encompassing gen-
eral axisymmetric stationary spacetimes whose geometry is suf-
ficiently close to Schwarzschild and whose Killing fields span the
null generator of the horizon.

IUPAP Young Scientist Prize

The Young Scientist Prizes of the International Union of Pure and Applied Physics were established in 2007. The recipients of the awards in a given year should have a maximum of 8 years of research experience following their PhD, and should have performed original work of outstanding scientific quality. The IUPAP Commission C18 for Mathematical Physics awards its Young Scientist Prizes for the first time.

The prize committee:

Pavel Exner, chair
Peter Bouwknegt
Ana Bela Cruzeiro
Antti Kupiainen
Michael Loss

Rupert L. Frank

Citation:

for outstanding results in analysis with application to
quantum systems including solutions to some
longstanding problems

Prize lecture: Monday, August 3, 14.45-15.30, Meridian

Title: HARDY-LIEB-THIRRING INEQUALITIES

Abstract: Lieb–Thirring inequalities estimate moments of negative eigenvalues of Schrödinger operators $-\Delta + V$ in terms of integral norms of the potential V. They are a mathematical key ingredient in understanding properties of fermionic many-body systems. We prove that such inequalities for more general operators of the form $T + V$ are, under certain conditions on the 'kinetic energy' T, equivalent to Sobolev-type inequalities. This allows us to derive analogues of the classical Lieb–Thirring inequalities when the critical Hardy-weight is subtracted from the Laplacian or from a fractional power of it. As an application we prove stability of relativistic matter in magnetic fields up to the critical value of the nuclear charge.

The talk is based on joint work with E. Lieb and R. Seiringer.

Benjamin Schlein

Citation:

for outstanding results in mathematical analysis of
many-body quantum systems, in particular, Bose gases

Prize lecture: Wednesday, August 5, 15.10-15.50, Meridian

Title: DERIVATION OF EFFECTIVE EVOLUTION EQUATIONS FROM MANY BODY QUANTUM DYNAMICS

Abstract: In this talk, I am going to review recent results concerning the derivation of effective evolution equations from many body quantum mechanics. I am going to discuss different methods leading to rigorous derivation of the nonlinear Hartree equation for the time evolution of mean field systems, and to the time-dependent Gross-Pitaevskii equation for the evolution of Bose-Einstein condensates. This talk is based on joint works with L. Erdős, H.-T. Yau, A. Michelangeli, and I. Rodnianski.

Simone Warzel

Citation:

for outstanding results in analysis of problems motivated
by condensed matter physics, in particular, spectral and
dynamical properties of random Schrödinger operators

Prize lecture: Monday, August 3, 15.40-16.25

Title: ON THE HYDRODYNAMIC PERSPECTIVE ON
SPECTRAL FLOWS AND UNIVERSALITY IN A CLASS
OF RANDOM MATRICES

Abstract: The talk will present new universality results on the
spectra of a class of random matrices and on the hydrodynamic
perspective on spectral flows. The analysis utilizes results based
on a statistical mechanical approach to systems of particles with
logarithmic interaction. (Joint work with M. Aizenman and T.
Bodineau).