RIEMANN INTERNATIONAL SCHOOL OF MATHEMATICS

BOOKLET

Event schedule and Presentations abstracts

RIEMANN PRIZE WEEK | JUNE 29 | JULY 03 2026

Conference | Leonardo da Vinci Lecture | Riemann Prize Ceremony

SOMMARIO

EVENT SCHEDULE

MONDAY 29th – VILLA TOEPLITZ

Time	Title	Speaker
14:30	Opening	
15:00	Bogoliubov theory for dilute quantum systems	Benjamin Schelin
16:00	Coffee break	
16:30	Gaussian Multiplicative Chaos and Random Matrices	Gaultier Lambert
17:30	On the spectral geometry of Liouville quantum gravity	Nathanaël Berestycki
18:30	Euclidean quantum field theories as limits of many-body quantum mechanics	Nicolas Rougerie

TUESDAY 30th – VILLA TOEPLITZ

Time	Title	Speaker
9:30	Range Expansion by Growth and Congestion	Henri Berestycki
10:30	Coffee break	
11:00	Rigidity results in multi-bubble dynamics for non-radial energy-critical heat equation	Frank Merle
12:00	Minimizing entire solutions to vector Allen-Cahn equations	Etienne Sandier
13:00	Lunch	
14:30	Allard type theorem for fractional circle-valued harmonic maps	Joaquim Serra
15:30	Critical Points of the Area of Surfaces in Sub-Riemannian Geometries. The Regularity Question	Tristan Rivière
16:30	Mathematics of the periodic table	Jan Philip Solovej

WEDNESDAY 01st – VILLA TOEPLITZ

Time	Title	Speaker
9:30	The gnocchi phase in nuclear pasta	Mathieu Lewin
10:30	Coffee break	
11:00	(Looking for a) phase transition in the 2DOCP	Thomas Leblé
12:00	TBA	Maryna Viazovska
13:00	Lunch	

WEDNESDAY 01st – ISTITUTO LOMBARDO (MILAN)

Time	Title	Speaker
16:30	Leonardo da Vinci Lecture	Sylvia Serfaty

THURSDAY 02nd – VILLA TOEPLITZ

Time	Title	Speaker
12:00	Two-dimensional singular harmonic maps intoone-dimensional singular manifolds	Fabrice Bethuel
13:00	Lunch	

14:30	On the black hole stability problem	Jeremie Szeftel
15:30	Laudatio of Sylvia Serfaty, highlights of her scientific work	Luigi Ambrosio
16:30	Coffee break	
17:00	Random matrix universality	Paul Bourgade
18:00	Random matrices and logarithmically correlated fields	Ofer Zeitouni

FRIDAY 03rd – SALONE ESTENSE – CITY HALL VARESE

Time	Title
10:00	Opening with music tribute
10:30	Interview to the awardee *Umberto Bottazzini interviews the laureate, Sylvia Serfaty*
11:00	Riemann Prize Ceremony *Delivery of the Riemann Prize & the Riemann Medal*
11:15	Riemann Lecture *By Sylvia Serfaty*
12:00	Debate with local press and citizens
12:30	Closing with music tribute

ABSTRACTS

AMBROSIO

HIGHLIGHTS FROM THE SCIENTIFIC WORK OF SYLVIA SERFATY

The work of Sylvia Serfaty covers many areas of Mathematical Analysis and Mathematical Physics.

I will focus just on some of them.

BERESTYCKI H.

RANGE EXPANSION BY GROWTH AND CONGESTION

Many biological populations expand despite the absence of active individual motion. Motivated by the growth of immotile cell colonies, we introduce a nonlinear nonlocal model in which spatial expansion results solely from proliferation and competition for space. In a singular congestion limit, the model converges to a nonlocal free-boundary problem that describes the evolution of saturated regions. After discussing the motivation and introducing a general model, I will present the derivation of this singular limit and discuss its main mathematical properties. The resulting framework provides a new perspective on invasion phenomena driven by growth and congestion. Joint work with Antoine Mellet and Gabi Steinbach.

BERESTYCKI N.

SPECTRAL GEOMETRY OF LIOUVILLE QUANTUM GRAVITY

Liouville quantum gravity, which originates from the work of Polyakov in the 1980s in the context of string theory, defines a certain canonical random geometry in two dimensions. Its recent rigorous formulation is at the centre of many major current developments in probability theory. In this talk we will discuss the spectral geometry of the Laplace-Beltrami operator associated to this geometry.

In particular we study the heat trace. At the first order this yields an almost sure Weyl law for the eigenvalues. More recently we showed that the second order term (which should capture boundary effects) is governed by a nontrivial exponent, given by the KPZ relation of Knizhnik, Polyakov and Zamolodchikov. I will also discuss some conjectures which suggest a connection to “quantum chaos”

BETHUEL

TWO-DIMENSIONAL SINGULAR HARMONIC MAPS INTOONE-DIMENSIONAL SINGULAR MANIFOLDS

The presentation is devoted to some recent results concerning singular harmonic maps into the wedge of two cercles S 1 ∨ S 1 . I will emphasize various aspects of the problem, in particular its renormalized energy and show that it is felated to to prescribing periods of meromorphic differential on specific compact Riemann surfaces. The results are mostly from the recent thesis of Mehdi Trense and I will also focus on a number of open problems.

BOURGADE

RANDOM MATRIX UNIVERSALITY

I will survey the standard dynamical method to prove local eigenvalues statistics for random matrices, and its applications. I will then explain a recent work with Jiaoyang Huang, characterizing the universal local point processes of random matrix theory by loop equations, or equivalently the equilibrium BBGKY hierarchy.

LAMBERT

GAUSSIAN MULTIPLICATIVE CHAOS AND RANDOM MATRICES

The goal of this talk is to give an overview of some recent developments on the relationship between the fluctuations of the eigenvalues of some random matrix models and Gaussian multiplicative chaos (GMC) measures. I will first give an introduction to GMC and then discuss some applications in random matrix theory, including eigenvalue rigidity, the Fyodorov-Bouchaud and Fyodorov-Hiary-Keating conjectures.

LEBLÉ

(LOOKING FOR A) PHASE TRANSITION IN THE 2DOCP

The theory of two-dimensional melting has been a major topic in statistical physics for half a century. The main question is to describe how a two-dimensional system transitions from a lattice, to a crystalline phase, then a liquid phase.

In particular, a series of papers in the 1980s physics literature discusses the existence and nature of a melting transition in the two-dimensional one-component plasma (2DOCP), a system of classical particles with Coulomb (logarithmic) interactions.

On the mathematical side, those questions remain elusive. I will present some tools, developed by Serfaty and her co-authors, that could help tackle them.

LEWIN

THE GNOCCHI *PHASE* IN NUCLEAR PASTA

The gnocchi phase in nuclear pasta" Abstract We provide the first rigorous justification for the so-called "gnocchi phase" in the liquid drop model at low density. Joint work with Rupert L. Frank and Robert Seiringe.

MERLE

RIGIDITY RESULTS IN MULTI-BUBBLE DYNAMICS FOR NON-RADIAL ENERGY-CRITICAL HEAT EQUATION

This result obtained with Kim Kihyun concerns the classification of asymptotic behaviors in multi-bubble dynamics for the energy-critical nonlinear heat equations in large dimensions $N \geq 7$ without symmetry. This multi-bubble dynamics appears naturally at least for a sequence of times in view of soliton resolution. The case of one soliton was previously established and in particular there is no blow-up. We consider the case of $J \geq 2$ solitons, where we expect only infinite-time blow-up. We are able to identify three different scenarios, where we have a continuous-intime resolution.

RIVIÈRE

CRITICAL POINTS OF THE AREA OF SURFACES IN SUB-RIEMANNIAN GEOMETRIES. THE REGULARITY QUESTION

The study of the variation of the area of sub-manifolds under pointwize constraints on the tangent plane has numerous motivation from various branches of mathematics such as control theory, elasticity, symplectic and calibrated geometry or minimal surface theory. We will explain the difficulties for developing the analysis of the PDEs such variational problems are generating and expose various regularity results obtained in this direction so far. We will then come to a recent work in collaboration with Alessandro Pigati in which we are proving that surfaces which are critical points of the area under Legendrian constraint, that is surfaces which are tangent to a non integrable plane distributions and critical point of the area under this sub-riemannian constraint, are smooth away from isolated conical singularities.

We will then come to the still mysterious problem relative to the location of these conical singularities and address the issue whether there is or not some renormalized energy behind these configurations. Finally, if time permits, I will explain why the presence or the absence of these conical singularities is relevant to fundamental questions in differential geometry which have to do with the realization or not of special homology classes by calibrated surfaces.

ROUGERIE

EUCLIDEAN QUANTUM FIELD THEORIES AS LIMITS OF MANY-BODY QUANTUM MECHANICS

Many-body bosonic Gibbs states converge to nonlinear Schrödinger-Gibbs measures in a certain mean-field limit where the temperature and the particle number both diverge to infinity, with correspondingly scaled interactions. This provides a derivation from microscopic models of these measures. In cold-atoms physics, this is for example how one computes interaction-induced corrections to the critical density for Bose-Einstein condensation. On the PDE side, this gives some background to the low-regularity random data Cauchy theory for NLS, which exploits the invariance of these measures.

I will review some of the recent developments in this context, in particular the case where one starts from a many-body canonical ensemble and derives a Gibbs measure conditioned on the L^2 mass, which is joint work with Van-Duong Dinh.

SANDIER

MINIMIZING ENTIRE SOLUTIONS TO VECTOR ALLEN-CAHN EQUATIONS

I will report on a joint work with Peter Sternberg and recent joint works with Lia Bronsard and Peter Sternberg, as well as with Luana Jost. The common point of these results is that they aim at describing minimizing entire solutions to the vector Allen-Cahn type equations, and in particular address the question of their relation to their possible blow-down limits.

SCHLEIN

BOGOLIUBOV THEORY FOR DILUTE QUANTUM SYSTEMS

In this talk, I am going to present a rigorous version of Bogoliubov theory that has been developed in the last years and I am going to explain how it can be used to obtain precise information about equilibrium and non-equilibrium properties of dilute quantum gases.

SERRA

REGULARITY OF SINGULAR SETS FOR NONLOCAL CIRCLE-VALUED HARMONIC MAPS

We will present an Allard-type regularity theorem for the singular sets of stationary s-harmonic maps into S 1 , with s ∈ (1/2, 1). The result shows that topological singularities attaining the fundamental energy level are an (n − 2)-dimensional manifold of class C 1,α. As a consequence, for s sufficiently close to 1, if u is a minimizing s-harmonic map into S 1 defined on a domain in R n , then the singular set of u is a C 1,α submanifold outside a closed set of Hausdorff dimension at most n − 3. This result is reminiscent of Leon Simon's description of singular sets for classical harmonic maps into spheres, and has analogies with regularity results for vortices in the Abelian Higgs model. Finally, we discuss the interpretation of our results as a regularity theory for codimension-two nonlocal minimal surfaces.

Joint work with Alessandro Audrito and Maria Medina.

SERFATY – LEONARDO DA VINCI LECTURE

FROM SPHERE PACKING TO SUPERCONDUCTORS: CRYSTALLIZATION AND RELATED QUESTIONS

The physicist Abrikosov predicted that in certain superconductors, one should observe triangular lattices of vortices, now called Abrikosov lattices. When studying ground states of Coulomb gases, which is motivated by questions in approximation theory, random matrix theory and statistical physics, one also expects the same

lattices to appear. This crystallization phenomenon turns out to be related to the CohnKumar conjecture about the universal minimality of certain special lattices in dimensions 2, 8 and 24 and recently solved in dimensions 8 and 24.

SERFATY – RIEMANN LECTURE

PATTERN FORMATION, DYNAMICS, AND ENTROPY IN PHYSICAL VARIATIONAL MODELS

Many variational models from physics give rise to striking patterns whose structure emerges in suitable asymptotic regimes. These patterns can often be understood as optimal compromises between competing contributions to the energy. The method of Gamma-convergence provides a framework for identifying such limiting behavior, combining general lower-bound arguments with matching upper bounds constructed explicitly. We will illustrate the implementation of such ideas through examples from interface formation, superconductivity, and micromagnetics, among others.

We will then present methods for deriving effective laws governing the dynamics of these patterns, for instance under steepest descent of the energy.

Finally, we will consider systems at positive temperature, where the competition between energy and entropy leads to new phenomena, illustrated by examples from Coulomb gas models.

SOLOVEJ

MATHEMATICS OF THE PERIODIC TABLE

A very natural question is whether the periodic table of the elements is indeed periodic and whether this can be proved mathematically. From a mathematical point of view this is more interesting if we allow ourselves to extrapolate beyond the naturally existing atoms to arbitrarily large atomic numbers. This relates to the famous ionization conjecture in mathematical physics. It states that quantities such as the radius, maximal ionization, and ionization energies of atoms remain bounded as the atomic number tends to infinity. This conjecture is still open in the full non-relativistic manybody description of atoms but has been proved in the Hartree-Fock model.

A generalization of the ionization conjecture asks whether there is even a limiting behavior as the atomic number tends to infinity. In this talk I will describe another approximate model, the Thomas-Fermi mean-field model, in which there indeed is a limiting behavior of large atoms. It leads to an exactly periodic “limiting periodic table”. The infinite atoms are described by a periodic family of self-adjoint realizations of a very singular Schrödinger operator corresponding to a Weyl limit circle. I will also discuss how the Thomas-Fermi mean-field model gives the correct leading asymptotic behavior of the angular momentum distribution for true non-relativistic many-body atoms. Surprisingly this disagrees with the expected behavior given in the periodic table.

This is partly based on joint work with A. Bjerg, S. Fournais, and P. Hearnshaw.

SZEFTEL

BLOW UP FOR SUPERCRITICAL DEFOCUSING NLS AND COMPRESSIBLE FLUIDS

I will present results concerning finite time blow up for the defocusing supercritical NLS equation and for compressible fluids.

VIAZOVSKA

SPHERE PACKINGS, CYCLOTOMIC FIELDS, AND SUBCONVEXITY BOUNDS

In this lecture I will talk about lattice packings constructed from number fields. I will present recent joint work with Nihar Gargava, Vlad Serban and Ilaria Viglino. We analyse the number of short vectors in the ideal and modular lattices.

ZEITOUNI

RANDOM MATRICES AND LOGARITHMICALLY CORRELATED FIELDS

The characteristic polynomial of a matrix contains much information concerning the spectrum of a matrix; for example, for Hermitian matrices, the imaginary part of the logarithm of the characteristic polynomial just above the real line contains information on fluctuations of the eigenvalue counting function and on extreme gaps. For a large natural family of random matrices, the logarithm of the characteristic polynomial is asymptotically a Gaussian random distribution belonging to the family of logarithmically correlated fields. I will review the progress obtained in the last decade on this topic, and describe some recent progress in the cases of the GβE and CβE.

Riemann International School of Mathematics

Thanks for your participation

SPEAKERS

Luigi Ambrosio
Scuola Normale Superiore

Henri Berestycki
École des Hautes Études en Sciences Sociales

Nathanael Berestycki
University of Wien

Fabrice Bethuel
Université Paris VI

Paul Bourgade
New York University

Gaultier Lambert
University of Zurich

Thomas Leblé
Université de Paris-Cité

Mathieu Lewin
Université Paris Dauphine

Frank Merle
IHES – Université Paris-Saclay

Tristan Rivière
ETH Zurich

Nicolas Rougerie
ENS Lyon

Etienne Sandier
Université Paris XII

Benjamin Schlein
University of Zurich

Joaquim Serra
ETH Zurich

Jan Philip Solovej
University of Copenhagen

Jeremie Szeftel
Sorbonne University

Maryna Viazovska
EPFL

Ofer Zeitouni
Weizmann Institute

VENUES

Villa Toeplitz, Varese
Mon Jun 29th – Thu Jul 2 · Conference

Istituto Lombardo, Milan
Wed Jul 1st · Leonardo da Vinci Lecture
Sylvia Serfaty

Salone Estense, Varese
Fri Jul 3rd · Riemann Prize Ceremony

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