AUB American University of Beirut | Center For Advanced Mathematical Sciences | CAMS | Faculty of Arts and Sciences Department of Physics

POLITECNICO MILANO 1863 DIPARTIMENTO DI MATEMATICA

Mathematics of Condensed Matter and Beyond
February 22 – 25, 2021

Titles and Abstracts

All times are set to Beirut time zone, UTC+2

Monday, February 22, 2021

Jakob Yngvason (11:00 – 12:00)

Title: Emergence of Haldane Pseudo-Potentials in Systems with Short-Range Interactions

Abstract: In the setting of the fractional quantum Hall effect we study the effects of strong, repulsive two-body interaction potentials of short range. We prove that Haldane's pseudo-potential operators, including their pre-factors, emerge as mathematically rigorous limits of such interactions when the range of the potential tends to zero while its strength tends to infinity. This is joint work with Robert Seiringer.

Biography: Jakob Yngvason is emeritus professor of mathematical physics at the University of Vienna. He was born in Iceland but studied at the University of Göttingen in Germany where he obtained his PhD in 1973. Before taking up his position in Vienna in 1996 he was professor at the University of Iceland in Reykjavik.

Xingbin Pan **(12:00 – 13:00)**

Title: On Maxwell-Stokes System

Abstract: In this talk we discuss a nonlinear magneto-static model on a bounded domain in which is multiply-connected and has holes, and under a nonlinear relation between the magnetic induction and the magnetic field. The equation of the model contains topological parameters consisting of a Neumann field and a Dirichlet field, which represent the effects of domain topology. In the case of a general electric current, the equation contains also an unknown gradient, which represents the electric field. Existence results of solutions of the boundary value problems of this model and of a more general nonlinear Maxwell-Stokes system with topological parameters are proved, which exhibit the effects of domain topology on the electromagnetic fields and on the nonlinear systems involving the operator curl.

Biography: Xingbin Pan is currently a professor at School of Science and Engineering, the Chinese University of Hong Kong (Shenzhen), China. He received Ph D degree from Shandong University, China, in 1987. Since then, he worked in Zhejiang University till 2004 (Assistant Professor 1987-1991, Associate Professor 1991-1993, Professor 1993-2004), and in East China Normal University from 2004 to 2020 as Zijiang Distinguished Professor. Xingbin Pan has been working on nonlinear partial differential equations and systems, calculus of variations, mathematical theory of superconductivity, liquid crystals and electromagnetism.

Douglas Lundholm **(15:00 – 16:00)**

Title: Emergence of anyons from polarons and angulons

Abstract: Anyons are effective quasiparticles with quantum statistics intermediate to bosons and fermions. They are a result of constraining the many-body configuration space to lower dimensions, whereby the permutation group for particle exchange is replaced by the braid group. Recent work has clarified how anyons can emerge from systems of bosons and fermions, either in the plane by means of impurities coupled as polarons in a coherent state of vortices, or effectively on the sphere from the coupling between molecular orientation and collective angular momentum states known as angulons. I intend to review some of

this work which is joint with Brooks, Ghazaryan, Lemeshko, Rougerie, Seiringer and Yakaboylu.

Biography: Douglas Lundholm got his PhD in Mathematics from KTH in Stockholm in 2010, and has been a postdoc at the University of Copenhagen, IHES and IHP in Paris, ETH Zurich, INIMS Cambridge, and Institut Mittag-Leffler in Stockholm. He held a young researcher grant at KTH from 2013 to 2018, a substitute professorship at LMU Munich in 2019, and is now at Uppsala University. With a background in Clifford algebras, quantum gravity and supermembrane matrix models, his current research interests are mainly anyons and intermediate/fractional/exotic quantum statistics.

Horia Cornean **(16:00 – 17:00)**

Title: Extending the bulk-edge correspondence to positive temperatures

Abstract: "Let us explain in short what bulk-edge correspondence usually means. Consider a two dimensional electron gas at zero temperature described by a "bulk" Hamiltonian with an isolated spectral island and a corresponding Fermi projection whose Chern number is different from zero. By "cutting" the space in half, the resulting "edge" Hamiltonian will no longer have a gap in the spectrum and the system becomes a conductor along the edge, with an "edge" conductance equal (up to a universal proportionality constant) to the "bulk" Chern number, and so also with the bulk Hall conductance.
It turns out that the same Chern number equals the derivative with respect to the magnetic field of the integrated density of states of the Fermi projection. This is usually known as the Streda formula. This talk will explain how one can generalize the Streda formula to positive temperatures (i.e. instead of a projection we work with a Fermi-Dirac like function of the bulk Hamiltonian) and show how the "bulk" and "edge" Hamiltonians are naturally related through this formula. The classical bulk-edge correspondence is re-obtained by taking the temperature to zero. This talk is based on several joint papers with D. Monaco (Rome), M. Moscolari and S. Teufel (Tübingen)."
Biography: PhD in Theoretical Physics (University of Bucharest, 1999) and Dr. Scient. in Mathematics (Aalborg University, 2012).
Current position: professor of mathematics, Aalborg University, Denmark.
My main research contributions are related to the spectral and scattering properties of Schrödinger operators with long range magnetic fields, the construction of

strongly localized Wannier bases and/or tight frames, and non-equilibrium quantum statistical mechanics in locally interacting quantum systems. More info can be found on my personal homepage .http://people.math.aau.dk/~cornean.

Maher Zerzeri **(17:30 – 18:30)**

Title : Trapped trajectories and asymptotic of resonances.

Abstract : We are interested to the asymptotic of resonances for semiclassical Schrödinger operators on $L^2(\mathbb{R}^N)$, $N \geq 1$. After a brief review of some previous results (free-resonances region, case of a well in a island corresponding to shape rersonances, case of a maximum of potential, case of a hyperbolic periodic trajectory), we will give the asymptotic of the resonances in the case where the set of trapped trajectories is constituted of a finite number of hyperbolic fixed points and homoclinic/heteroclinic orbits. For that, we establish quantification rules for the associated (pseudo-)resonances and we describe their position precisely. We will give two examples: one homoclinic trajectory and three bumps potential.
The approach used here is somewhat unusual, involving a microlocal Cauchy problem, which allows us to have a microlocal description of the resonant state near the hyperbolic fixed point.

References:

• Majoration du nombre de résonances près de l'axe réel pour une perturbation abstraite à support compact du laplacien, Comm. Partial Differential Equations 26(2001), no. 11-12, pp. 2121–2188.

• *with J-F. Bony, S. Fujiié and T. Ramond;* Resonances for homoclinic trapped sets, Astérisque, no. 405(2018), vii+314 pages.

• *avec J. Sjöstrand;* Resonances over a potential well in an island, accepted in Arkiv för Matematik on 28 December 2020, 55 pages.

Federico Luigi Dipasquale **(18:30 – 18:50)**

Title: Topological properties of minimizers in Landau-de Gennes theory of nematic liquid crystals

Abstract: It is known from many numerical simulations carried out over the last 30 years that the minimizers of the (most studied) Landau-de Gennes energy functional in certain very relevant physical conditions have peculiar topological properties (motivating the suggestive name \biaxial torus solutions" for them), which however eluded precise mathematical description for all this time. Here, I will briey explain a new strategy to address this problem, based on the key idea that topology has to be sought in the level sets of an appropriate indicator function, the signed biaxiality parameter. The presentation will be modelled on a special case in which things are more clear and the results are sharper, but more general

results are contained in joint works with Vincent Millot (Paris XIII) and Adriano Pisante (Sapienza).

Giulia Basti **(18:50 – 19:10)**

Title: A new second order upper bound for the ground state energy of dilute Bose gases

Abstract: We study the ground state energy per unit volume of a dilute Bose gas in the thermodynamic limit. In particular we provide an upper bound capturing the correct second order term, as predicted by the celebrated Lee-Huang-Yang formula. The first proof of this result was given in J. Stat. Phys. 136(3) by H.-T. Yau and J. Yin. Our proof allows to consider a wider class of potentials, provides a better rate and, in our opinion, is substantially simpler. Joint work with S. Cenatiempo and B. Schlein.

Alessandro Olgiati **(19:10 – 19:30)**

Title: Stability of the Laughlin Phase in Presence of Interactions

Abstract:

The Laughlin wave function is at the basis of the current understanding of the fractional quantum Hall effect (FQHE) and its associated physical features (fractional charge quasi-particles, anyonic statistics...). Nevertheless, very few rigorous mathematical results on Laughlin theory are available in literature.

After a brief introduction, I will present a model, within Laughlin framework, for the response of FQHE charge carriers to variations of the external potential and of the inter-particle interaction. Our main result is that the energy is asymptotically captured by the minimum of an effective functional with variational constraints fixed by the incompressibility of the Laughlin phase. Moreover, as was already known for the non-interacting case, we show that the one-body density converges to the characteristic function of a set.

This is a joint work with Nicolas Rougerie (ENS Lyon).

Tuesday, February 23, 2021

Mikael Sundqvist **(11:00 – 12:00)**

Title: The ground state of the Pauli operator

Abstract: The Pauli operator describes a spin 1/2 non-relativistic particle. In this talk we discuss some old results such as the Aharonov-Casher theorem, as well as some newer results regarding the bottom of the spectrum of this operator.

Marcel Schaub **(12:00 – 12:20)**

Title: The BCS Functional in a Weak Homogeneous Magnetic Field - its Critical Temperature and Microscopic Derivation of Ginzburg-Landau Theory

Abstract: We provide an asymptotic expansion of the free energy of the BCS model subject to a constant magnetic field. Its leading term is given by the Ginzburg-Landau functional in the weak magnetic field limit. In the same limit, we prove that the critical temperature decreases linearly in the magnetic field strength, where the slope is determined by the linearized Ginzburg-Landau model. The work is a continuation of the pioneering work J. Amer. Math. Soc. 25 (2012), no. 3, 667–713 by Frank, Hainzl, Seiringer, and Solovej. We provide considerable simplifications to proofs in this work and provide a new decomposition result for the Cooper pair wave function. The main challenge is the nonperturbative treatment of the magnetic field, which has been accomplished in J. Spectr. Theory 9 (2019), no. 3, 1005–1062 in a linearized BCS model. We extend the coercivity estimates in there to the full BCS functional. Joint work with A. Deuchert and C. Hainzl.

Niels Benedikter **(12:20 – 12:40)**

Title: Describing Quantum Correlations in the Fermi Liquid by Bosonization

Abstract: The correlation energy is the difference between the many-body ground state energy and its mean-field approximation (i.e., the Hartree-Fock energy). It is therefore the first quantity to analyze in developing a systematic treatment of quantum correlations in the Fermi liquid. I will show that the correlation energy of a high-density Fermi liquid can be rigorously computed using a controlled approximate bosonization method. I will then show that bosonization also provides a norm approximation for the dynamics of excited states.

Marco Olivieri **(12:40 – 13:00)**

Title: Isomerization reactions for pseudo relativistic molecules

Abstract: Isomerizations are chemical reactions where the reactant and the product have the same chemical formula but different chemical structure, i.e., spatial configuration. In this talk we are going to consider isomerization reaction between two heavy molecules described by pseudorelativistic Schrödinger operators. We will show how the problem of finding the activation energy of the reaction is a mountain pass problem between two local stable configurations, where one minimizes over all possible paths the highest value of the energy along the path. Finally, we will prove boundedness of the sequence of minimizing paths. From a joint work with I. Anapolitanos and S. Zalczer.

Shahnaz Farhat **(13:00 – 13:20)**

Title: The motion of charged particles in a Tokamak

Abstract: This short talk is devoted to the motion of charged particles under the influence of a Lorentz force, which is marked by the presence of both an electric field and a strong magnetic field. This induces the presence of a large parameter in a specific system of ODEs. The aim is to elucidate the oscillating dynamics through tools issued from multiscale analysis. Indeed, thanks to normal form procedure (filtering and averaging method), it becomes possible to reach a complete description of the reduced equations which will reflect the main behavior of the motion.

Konstantin Pankrashkin **(15:00 – 16:00)**

Title: Spectral analysis of a diffusion operator with random jumps from the boundary

Abstract: We discuss a Hilbert-space realization and some spectral properties of a diffusion operator with non-self-adjoint non-local boundary conditions given in terms of a probability measure. Under certain assumptions on the measure density, we obtain enclosures for the non-real spectrum and find a sufficient condition for the non-zero eigenvalue with the smallest real part to be real. Based on a joint work with David Krejcirik, Vladmir Lotoreichik and Matej Tusek (Prague).

Biography: Konstantin Pankrashkin obtained his PhD in mathematics at the Humboldt-University of Berlin in 2002, and 2003-2006 he was a postdoc at the same institution. In 2006-2020 he worked in France, first as a postdoc at the Universities Paris-Nord and Paris-Sud (2006-2008) and then as a lecturer at the

University Paris-Sud (2008-2020). Since 2020 he holds the professorship for analysis and its application at the University of Oldenburg in Germany. Homepage: http://uol.de/pankrashkin

Peter Sternberg **(16:00 – 17:00)**

Title: Variational Models for Phase Transitions in Liquid Crystals Based Upon Disparate Values of the Elastic Constants

Abstract: Some of the morphology of different phases in liquid crystals can be well-explained by taking into account the wide disparity between values of the elastic constants associated with the energetic cost of various types of deformations-- splay, twist and bend. In this talk, I will describe an attempt to capture some aspects of this story through the introduction and asymptotic analysis of variational models arising as 'toy' versions of the Landau de Gennes energy for nematic liquid crystals. This work represents collaborations with Dmitry Golovaty (Akron), Michael Novack (UT Austin) and Raghav Venkatraman (Carnegie Mellon).

Zaher Hani **(17:30 – 18:30)**

Title: On the rigorous foundations of the wave turbulence theory

Abstract: Wave turbulence is the theory of non-equilibrium statistical mechanics for nonlinear wave systems. The main character in this theory is played by the so-called wave kinetic equation (WKE). This equation is the wave-counterpart of the Boltzmann equation, which governs the non-equilibrium statistics of particle systems. From the mathematical standpoint, the grand conjecture is to establish that the behavior of “generic" solutions of the relevant nonlinear dispersive PDE is well-approximated (over long timescales) by solutions of the wave kinetic equation (WKE). This approximation is supposed to hold in the limit when the size L of the domain goes to infinity, and the strength α of the nonlinearity goes to 0. We will discuss some recent progress towards settling this conjecture, and the myriad of mathematical ideas that come in to play.

Stephen Gustafson **(18:30 – 19:30)**

Title: Chiral magnetic skyrmions of 2D Landau-Lifshitz equations

Abstract: Landau-Lifshitz equations are the basic dynamical equations in a micromagnetic description of a ferromagnet. They are naturally viewed as geometric evolution PDE of dispersive, Hamiltonian type (``Schrodinger maps"), which scale critically with respect to the physical energy in two space dimensions. We describe here recent results on the structure and stability of topological soliton solutions known as "chiral magnetic skyrmions".

<u>Wednesday, February 24, 2021</u>

<u>Bernard Helffer</u> **(11:00 – 12:00)**

Title: Spectral theory for the Bloch-Torrey operator.

ABSTRACT. We consider the semi-classical Bloch-Torrey operator in $L^2(\Omega, \mathbb{R}^k)$ where Ω is a domain in $\mathbb{R}^d$ and $k \in \{1, \ldots, 3\}$. If the simplest model is some closed realization of $-h^2\Delta + ix_1$, the original model of Bloch-Torrey corresponds to $k = d = 3$ and reads $-\Delta I + B(x)\times$ where $B(x)$ is the magnetic field. Our aim is to analyze, for various domains and in the limit $h \to 0$, the left margin of the spectrum and to establish resolvent estimates.

The presented results have been obtained in collaboration with Y. Almog, D.S. Grebenkov and N. Moutal.

<u>Davide Fermi</u> **(12:00 – 12:20)**

Title: Magnetic perturbations of Aharonov-Bohm and 2-body anyonic Hamiltonian

Abstract: We investigate the effects of magnetic perturbations for a system of two anyons moving in a plane. We use quadratic forms techniques to construct a one-parameter family of self-adjoint realizations of the associated Schrodinger operator, thus characterizing admissible reduced Hamiltonians. We also discuss the implications for the related model describing a quantum particle immersed in a classical magnetic field with a local singularity of Aharonov-Bohm type. In this context, we provide a complete classification of all admissible Hamiltonians for a specific class of magnetic potentials. Joint work with Michele Correggi (Politecnico di Milano).

<u>Domenico Monaco</u> **(12:20 – 12:40)**

Title: (De)localized Wannier functions for quantum Hall systems

Abstract: I will present some recent results concerning the rate of decay of Wannier functions in quantum Hall systems and Chern insulators. More specifically:

— I will show how optimally-localized Wannier functions forming an orthonormal basis for the valence states of the insulator are subject to a localization dichotomy, dictated by the value of the Chern number: either they are exponentially localized (vanishing Chern number), or the second moment of the position operator diverges (non-vanishing Chern number);

— I will then explain how exponential localization can be achieved for any value of the Chern number if one relaxes the orthonormality condition to that of forming a Parseval frame.

The talk will be based on joint works with G. Panati, A. Pisante and S. Teufel, and with H. Cornean and M. Moscolari.

Badreddine Benhellal **(12:40 – 13:00)**

Title: Quantum Confinement induced by Dirac operators with anomalous magneticdelta-sphere interactions

Abstract:

Let $\mathbb{S}^2_R$ be the sphere of radius $R > 0$ and $\upsilon \in \mathbb{R}$. I will consider the coupling $\mathcal{H}_\upsilon = \mathcal{H} + V_\upsilon$, where $\mathcal{H}$ is the free Dirac operator in $\mathbb{R}^3$ and $V_\upsilon = i\upsilon\beta(\alpha \cdot x/|x|)\delta_{\mathbb{S}^2_R}$ is the anomalous magnetic δ-sphere potential. In the first instance, assuming that $\upsilon^2 \neq 4$, we prove that $\mathcal{H}_\upsilon$ is self-adjoint and its domain is included in the Sobolev space $H^1(\mathbb{R}^3 \backslash \mathbb{S}^2_R)^4$. Moreover, a Krein-type resolvent formula and a Birman-Schwinger principle are obtained, and several qualitative spectral properties of $\mathcal{H}_\upsilon$ are given. Finally, we study the self-adjoint realization of $\mathcal{H}_\upsilon$ in the case $\upsilon^2 = 4$. In particular, we show that $\mathcal{H}_\upsilon$ is essentially self-adjoint and the domain of the closure is not included in any Sobolev space $H^s(\mathbb{R}^3 \setminus \mathbb{S}^2_R)^4$, for all $s > 0$. In addition, we show that $\overline{\mathcal{H}_{\pm 2}}$ generates confinement and hence $\mathbb{S}^2_R$ becomes impenetrable. This talk is part of my work [1].

Léo Morin **(13:00 – 13:20)**

Title: Spectral asymptotics for the semiclassical Bochner Laplacian

Abstract: The Bochner Laplacian on a Riemannian manifold M is the analog of the magnetic Schrödinger operator (ihd + A)*(ihd + A) when the magnetic field B is non-exact. We will define this operator, which is acting on sections of a line bundle over M. In this context, the magnetic field is related to the curvature of the given line bundle, and the high-curvature limit is equivalent to the semiclassical limit ``h tends to 0''. We will present new spectral asymptotics for this operator in the semiclassical limit, in the case of discrete magnetic wells. L. Morin. "Spectral asymptotics for the semiclassical Bochner Laplacian of a line bundle with constant rank curvature" (2020), arXiv:2010.00226.

Emanuela Giacomelli **(15:00 – 16:00)**

Title: On the Corner Contribution to Surface Superconductivity

Abstract: In this talk we describe, within the Ginzburg-Landau (GL) theory, the response of a type-II superconducting wire with non-smooth cross section to an external time-independent magnetic field parallel to it.

We focus on fields whose intensity varies in the so called surface superconductivity regime, i.e., superconductivity is confined near the boundary of the sample. A natural question is then how does the ground state of the GL functional depend on the geometry of the boundary?

The results I will present during the talk aim at giving an answer to this question. Based on joint works with Michele Correggi.

Biography: I am a postdoctoral researcher at LMU Munich in the group of Prof. Christian Hainzl since November 2019. In the period November 2017 - October 2019 I was a postdoctoral researcher at the University of Tubingen in the group of Prof. Marcello Porta. I got my PhD degree in Rome, at Sapienza University, under the supervision of Prof. Michele Correggi.

Marco Cicalese **(16:00 – 17:00)**

Title: Does the N-clock model approximate the XY-model?

Abstract: The N-clock model is a two-dimensional ferromagnetic spin model on the square lattice in which the spin field is constrained to take values in a set of N equi-spaced points of the unit circle. It is usually considered as an approximation of the XY model, for which instead the spin field is allowed to attain all the values of the unit circle. In the theory of superconductivity the latter models phase transitions mediated by the formation and the interaction of co-dimension 2 topological defects as in the well-known Ginzburg-Landau theory. A breakthrough result by Fröhlich and Spencer (CMP 1981) shows that the same kind of phase transitions appear in the N-clock model for N large enough. By a variational analysis we find the explicit rate of divergence of N (with respect to the number of interacting lattice points) for which low energy configurations of the N-clock model asymptotically behaves like those of the XY model at zero temperature. We moreover exhaustively discuss all the other regimes of N and we show how Cartesian Currents can detect the energy concentration on sets of co-dimenion smaller or equal than 2.

The results presented are contained in a series of recent papers in collaboration with G. Orlando (TUM) and M. Ruf (EPFL).

Radu Ignat **(17:30 – 18:30)**

Title: Domain walls with nonlocal interaction and their renormalised energy in thin ferromagnetic films

Abstract: "We analyse two variants of a nonconvex variational model from micromagnetics with a nonlocal energy functional, depending on a small parameter $\epsilon > 0$.

The model gives rise to transition layers, called N\'eel walls, and we study their behaviour in the limit $\epsilon \to 0$. The analysis has some similarity to the theory of Ginzburg-Landau vortices. In particular, it gives rise to a renormalised energy that determines the interaction (attraction or repulsion) between N\'eel walls to leading order. But while Ginzburg-Landau vortices show attraction for degrees of the same sign and repulsion for degrees of opposite signs, the pattern is reversed in this model.

First, we show that the N\'eel walls stay separated from each other and we determine the renormalised energy for one of the models. The theory gives rise to an effective variational problem for the positions of the walls, encapsulated in a Gamma-convergence result. Second, we turn our attention to another, more physical model, including an anisotropy term.

We show that it permits a similar theory, but the anisotropy changes the renormalised energy in unexpected ways and requires different methods to find it.This is a joint work with R. Moser (Univ. of Bath)."

References: [1] R. Ignat & R. Moser, Interaction energy of domain walls in a nonlocal Ginzburg-Landau type model from micromagnetics, Arch.

Ration. Mech. Anal. 221 (2016), 419-485

[2] R. Ignat & R. Moser, Separation of domain walls with nonlocal interaction and their renormalised energy by Γ-convergence in thin ferromagnetic films, arXiv:2007.05327 (2020)

<u>Thursday, February 25, 2021</u>

<u>Etienne Sandier</u> **(11:00 – 12:00)**

Title: Vortex filaments in the 3D Ginzburg-Landau model

Abstract: I will describe recent work with C.Romàn and S.Serfaty related to the onset of superconductivity in 3D samples. Using recent advances by Romàn and Contreras-Jerrard, we are able to some extent to make a description at the level of individual vortex filaments versus a description at the level of vortex filament density.

Biography:
Professeur at Université Paris-Est Créteil (UPEC) since 2000.
Education:
1993. PhD, Université Paris 6, supervisor H.Brezis.
2000 : Habilitation à diriger les recherches.
Career:
1993-2000 : Maître de conférences, Université de Tours.
2000- : Professeur, Université Paris Est Créteil (UPEC).
2006: Sabbatical leave, McMaster University, Ontario.
2007-2012: Institut Universitaire de France.
Research areas: Analysis of PDE's, Calculus of variations, Nonlinear analysis, Mathematical models in superconductivity.
Recent publications:
Ge, Yuxin; Sandier, Etienne Lattices with finite renormalized coulombian interaction energy in the plane. Tunis. J. Math. 3 (2021), no. 1, 93–120.
Aftalion, Amandine; Sandier, Etienne Vortex patterns and sheets in segregated two component Bose-Einstein condensates. Calc. Var. Partial Differential Equations 59 (2020), no. 1, Paper No. 19, 38 pp.
Bétermin, Laurent; Sandier, Etienne Renormalized energy and asymptotic expansion of optimal logarithmic energy on the sphere. Constr. Approx. 47 (2018), no. 1, 39–74.
Berlyand, Leonid; Sandier, Etienne; Serfaty, Sylvia A two scale G-convergence approach for random non-convex homogenization. Calc. Var. Partial Differential Equations 56 (2017), no. 6, Paper No. 156, 35 pp.
Sandier, Etienne; Serfaty, Sylvia 1D log gases and the renormalized energy: crystallization at vanishing temperature. Probab. Theory Related Fields 162

(2015), no. 3-4, 795–846. Sandier, Etienne; Serfaty, Sylvia 2D Coulomb gases and the renormalized energy. Ann. Probab. 43 (2015), no. 4, 2026–2083.
Book authored: Sandier, Etienne; Serfaty, Sylvia Vortices in the magnetic Ginzburg-Landau model. Progress in Nonlinear Differential Equations and their Applications, 70. Birkhäuser Boston, Inc., Boston, MA, 2007. xii+322 pp.

<u>Nicolas Rougerie</u> **(12:00 – 13:00)**

Title: Semi-classical limit for almost fermionic anyons

Abstract: Fundamental particles come in two types: fermions and bosons, according to whether they satisfy the Pauli exclusion principle or they do not. However, quasi-particles of certain low-dimensional condensed matter systems may violate this fundamental dichotomy and have an intermediate behavior. Such exotic objects, called anyons, can be described as ordinary bosons and fermions with special long-range magnetic interactions. This leads to intricate models for which well-educated approximations are desirable. In this talk we study a limit situation where the anyon statistics/magnetic interaction is seen as a “perturbation from the fermionic end”. We vindicate a mean-field approximation, proving that the ground state of a gas of anyons is described to leading order by a semi-classical, Vlasov-like, energy functional. Our proof is based on coherent states, Husimi functions, the Diaconis-Freedman theorem and a quantitative version of a semi-classical Pauli pinciple. Joint work with Théotime Girardot.

<u>Nicolas Raymond</u>(15:00 – 16:00)

Title: On the Dirac bag model in strong magnetic fields

Abstract: This talk is devoted to two-dimensional Dirac operators on bounded domains coupled to a magnetic field perpendicular to the plane. It will be focused on the MIT bag boundary condition. I will describe recent results about accurate asymptotic estimates for the low-lying (positive and negative) eigenvalues in the limit of a strong magnetic field. This is a joint work with J.-M. Barbaroux, L. Le Treust and E. Stockmeyer. (see https://arxiv.org/abs/2007.03242)

<u>Siamak Taati</u> **(16:00 – 17:00)**

Title: Quasicrystal phases in a finite-range lattice gas model

Abstract: In a quasicrystal, the arrangement of the atoms is highly ordered (as in an ordinary crystal) but non-periodic (unlike in a crystal). There are various mathematical challenges in connection with quasicrystals. From the point of view of statistical mechanics, the major open problem is to provide a mathematical explanation of the formation and stability of quasicrystals in presence of thermal fluctuations. In this talk, I will present a (toy) lattice gas model with finite-range interactions that has stable quasicrystal phases at positive temperature (i.e., Gibbs measures supported at perturbations of non-periodic tilings). The construction is based on old results on cellular automata and tilings.

Biography: Siamak is an Assistant Professor of Mathematics at the American University of Beirut. He received his MSc from Sharif University of Technology (Iran) in 2004 and his PhD from the University of Turku (Finland) in 2009. His research is largely motivated by problems from statistical mechanics and computer science.

<u>Pavel Exner</u> **(17:30 – 18:30)**

Title: On the spectrum of spiral quantum waveguides

Abstract: We discuss spectral properties of Laplace operator in spiral-shaped regions with Dirichlet boundary, in particular, their discrete spectrum. As a case study we analyze in detail the region generated by the Archimedean spiral. We show that the spectrum is then absolutely continuous away from the thresholds and, in contrast to `less curved' tubular regions, the discrete part is empty; the reason comes from the subtle difference between the radial and perpendicular widths. For more general spiral regions the spectral nature depends substantially on the behavior of their coil width, namely whether it is `expanding' or `shrinking' with respect to the angle; the most interesting situation occurs in what we call asymptotically Archimedean case, where the existence of isolated eigenvalues depends on the sign of the next-to-leading term in the asymptotics.

Biography:
Born: 1946 in Prague, Czechoslovakia
Graduated: 1969 from the Charles University
Degrees: CSc. 1983, DrSc. 1990, both from JINR Dubna
Titles: venia legendi 1991, full professor 2003, both from the Charles U.
Employment: Charles University 1969-78, Joint Institute for Nuclear Research 1978-90, Czech Academy of Sciences since 1991
Present position: Scientific Director, Doppler Institute

Research: spectral and scattering properties of quantum waveguides, quantum mechanics on graphs and manifolds, decay and resonance effects
Teaching: lecturing at Charles and Czech Technical Universities
Offices in international organizations: International Association of Mathematical Physics: Secretary 2006-08, President 2009-11
European Math. Society: Vicepresident 2005-10, President 2015-18
IUPAP: Commission Secr. and Chair 2002-08, Vicepresident 2005-08
European Research Council: Scientific Council Member since 2005, Vicepresident 2011-14
Academia Europaea, Section Vicechair 2012-18, Chair since 2018
Editorial Boards: Journal of Physics A, Journal of Mathematical Physics, Journal of Mathematical Analysis and Applications, etc.
Honours: JINR First Prize 1985, elected member of Academia Europaea 2010, Neuron Prize 2016, etc.
For more details see http://www.ujf.cas.cz/_exner
