PREVIOUS TALKS

Quantum ergodicity on large genus hyperbolic surfaces

07 June 2021

Etienne Le Masson (Université de Cergy)

Abstract : An important observation in quantum chaos is that high frequency waves in chaotic settings delocalise.

In this talk we will consider this question on finite area hyperbolic surfaces (surfaces of curvature -1), a model of chaotic setting. The waves will be eigenfunctions of the Laplacian and we will be interested in both discrete and continuous spectra. It is known since the proof of the Quantum Ergodicity theorem that, due to the ergodicity of the geodesic flow, most high frequency eigenfunctions of the Laplacian equidistribute in this case. We will present a theorem showing that this equidistribution phenomenon happens also for eigenfunctions in a fixed spectral window when the area (or equivalently the genus) of the surface goes to infinity.

Joint work with Tuomas Sahlsten.

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Spectral asymptotics of large quantum graphs

31 May 2021

Maxime Ingremeau (Université de Nice - Côte d'Azur)

Abstract : Since Weyl's work a century ago, a lot of papers have studied the asymptotics of the eigenvalues of the Laplacian (in a domain or on a compact manifold) in the limit where the eigenvalues become large. Recently, an other kind of asymptotics has been of interest: consider a sequence of domains, whose size grow to infinity, and count the asymptotic number of eigenvalues of the Laplacian in these domains in a fixed spectral interval.

In this talk, we will deal with this kind of asymptotics in the case of Quantum Graphs (also known as metric graphs), which are just some compact one-dimensional objects where Laplacians can be defined. We will then move to the realm of Open Quantum Graphs, which are not compact, and where waves can escape to infinity through some semi-infinite leads. The analogue of the Laplace eigenvalues in such open systems are the scattering resonances, which are complex numbers that are much more delicate to study. We will obtain an asymptotic distribution for resonances of large quantum graphs whose number of leads is small compared to the total number of edges.

Part of this is joint work with N. Anantharaman, M. Sabri and B. Winn

Proofs of two conjectures involving sums of normalized Narayana numbers

24 May 2021

Plamen Simeonov (University of Houston Downtown)

Abstract : The Narayana numbers are well-known and have many applications in the field of combinatorics. The Narayana numbers form a triangular array, where the sum of the n-th row is the n-th Catalan number. We normalize the Narayana numbers by dividing each entry in the n-th row by the n-th Catalan number. Then each row of these normalized Narayana numbers defines a discrete probability distribution. We investigate two new properties of these normalized Narayana numbers: instead of summing along the rows, we derive the limit of the sums along the columns and the limit of the sums along the short diagonals.

Break

12 April 2021 - 17 May 2021

Mr. Sandman (Land of Dreams)

Abstract : We give a break to all participants to recharge their batteries and come back with dreams.

The restricted invertibility principle

5 April 2021

Pierre Youssef (NYU Abu Dhabi)

Abstract : We will discuss the restricted invertibility principle first put forward by Bourgain and Tzafriri, and its subsequent refinements. We will also see how it can be used to derive an approximate l1 analogue of Dvoretzky's theorem, a fundamental result in the area called Geometric Functional Analysis.

Ladder relations and shift operators for a class of matrix valued orthogonal polynomials

29 March 2021

Pablo Román (Universidad Nacional de Cordoba)

Abstract : In this talk we will discuss algebraic and differential relations for matrix valued orthogonal polynomials (MVOPs) with respect to a matrix weight of the form $W(x) = e^{−v(x)} e^{xA} e^{xA^\ast}$ on the real line, where v is a scalar polynomial of even degree with positive leading coefficient and A is a constant matrix. Using the theory introduced recently by Casper and Yakimov, we investigate the algebras of differential and difference operators and we obtain ladder operators and discrete string equations for the recurrence coefficients for these MVOPs. Hermite-type matrix valued weights, corresponding to $v(x)=x^2$, will be discussed in detail. This talk will be based on recent joint papers with A. Deaño, B. Eijsvoogel (ladder relations) and M. Ismail, E. Koelink (Hermite-type polynomials).

New Formulas of the High-Order Derivatives of Fifth-Kind Chebyshev Polynomials: Spectral Solutions of the Convection-Diffusion Equation

22 March 2021

Youssri H. Youssri (Cairo University)

Abstract : This work is dedicated to deriving novel formulae for the high-order derivatives of the Chebyshev polynomials of the fifth-kind. The high-order derivatives of these polynomials are expressed in terms of their original polynomials. The derived formulae contain certain terminating $_4F_{3}(1)$ hypergeometric functions. We show that the resulting hypergeometric functions can be reduced in the case of the first derivative. As an important application - and based on the derived formulas - a spectral tau algorithm is implemented and analyzed for numerically solving the convection-diffusion equation. The convergence and error analysis of the suggested double expansion is investigated assuming that the solution of the problem is separable. Some illustrative examples are presented to check the applicability and accuracy of our proposed algorithm.

Random walks on linear groups: Limit Theorems and Stationary Measures

15 March 2021

Richard Aoun (NYU Abu Dhabi)

Abstract : Random walks have shown to be efficient in understanding the action of groups on spaces of geometric nature. For instance, Kesten's amenability criterion shows that a discrete group is non-amenable, if and only if, the symmetric random random on it returns to the origin with a probability that decays exponentially fast to zero. When it comes to linear groups (i.e. subgroups of the general linear group of fixed dimension), then the random walk is nothing than a product of invertible matrices each taken independently with respect to fixed probability measure. We talk then about Random Matrix Products Theory. This theory is at the intersection of Dynamical Systems/Ergodic Theory, Probability Theory and Group Theory. It began in the 60's with Kesten and Furstenberg, with applications to biological models and to Schrödinger Operators. In last ten years, the theory had unexpected applications to homogeneous dynamics thanks to the breakthrough of Benoist--Quint.

In this talk, we first give an overview of this theory, introduce the Lyapunov exponents and indicate the role of stationary measures in the study of these exponents. We then expose recent advances in the topic concerning the uniqueness of stationary measures when the top Lyapunov exponent is simple (joint work with Yves Guivarc'h) and show the law of large numbers of the spectral radius of an i.i.d random walk on the general linear group (joint with Cagri Sert).

Hyers-Ulam and Hyers-Ulam-Rassias Stability of First-Order Linear and Nonlinear Dynamic Equations

8 March 2021

Martin Bohner (Missouri University)

Abstract : We present several new sufficient conditions for Hyers--Ulam and Hyers--Ulam-Rassias stability of first-order linear and nonlinear dynamic equations for functions defined on a time scale with values in a Banach space.

Fractional Transforms and Their Applications

1 March 2021

Ahmed Zayed (DePaul University)

Abstract : Fractional calculus has a long history that goes back to the 17 th century. In contrast, the theory of fractional operators and fractional integral transforms has a relatively short history that may be counted by decades rather than by centuries. The advent of the fractional Fourier transform about 50 years ago, a transform that has proved to have several physical applications, opened the gates for the introduction of many other fractional transforms, such as fractional wavelets, fractional Gabor, and fractional Radon transforms, etc. In this talk I will begin by giving an overview of the theory of fractional integral transforms and some of its applications and conclude by a summary of the state of the art.

Christol's conjecture: between theory and mathematical practice

22 February 2021

Youssef Abdelaziz (PhD from LPTMC - Sorbonne Université)

Abstract : Christol's conjecture has been open since the late 80's. Christol's conjecture states that every D-Finite series (i.e. solution of a linear homogeneous differential equation with polynomial coefficients), is the diagonal of a rational function. Gilles Christol himself, and other authors, came up with a list of potential counter-examples to this conjecture. The fate of these potential counter-examples remained unknown for more than thirty years. I will discuss recent progress on this problem, and compare it to an earlier attempt to approach the problem that proved unsuccessful.

Matrix valued special functions from group representations

15 February 2021

Erik Koelink (Radboud Universiteit)

Abstract : There is an intimate connection between special functions and group representations. For compact groups this relates often to orthogonal polynomials. In this presentation we start by recalling results on spherical functions for so-called Gelfand pairs in connection to orthogonal polynomials.

This concept is then extended to matrix valued spherical functions, which give rise to matrix valued orthogonal polynomials in several variables. The talk will be introductory and focusing on an explicit example related to the compact group SU(n+1) of unitary matrices of determinant 1.

Most of the work described is joint with Maarten van Pruijssen en Pablo Rom\'an.

Dispersion for Schrödinger operators on regular trees

8 February 2021

Mostafa Sabri (Cairo University)

Abstract : This talk is intended as a general lecture for nonspecialists, concerning some aspects of the dynamics of the Schrödinger semigroup exp(itH) when the time t gets large. We will first review some general results like the RAGE theorem. Then we shall narrow the discussion down to the dispersive estimates. We will illustrate some basic examples, before introducing the two models we are interested in. Namely, the adjacency matrix on the infinite regular tree, and the "periodic" Schrödinger operator on the infinite regular *quantum tree* or *metric tree* - namely we now deal with 1d differential operators on the edges. The latter model can be regarded as an extension of the case of periodic Schrödinger operators on the real line. In both cases we obtain a sharp dispersive decay as t^{-3/2}.

Based on joint work with Kaïs Ammari.

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Roots of Laguerre Polynomials

1 February 2021

Kathy Driver (University of Cape Town)

Abstract : The Fundamental Theorem of Algebra (1608-1806) states that every non-zero, single-variable, degree n polynomial with complex coefficients has, counted with multiplicity, exactly n complex roots. The properties (location, multiplicity,...) of the roots of ”classical” orthogonal polynomials (solutions of important second order differential equations) have been extensively studied and have important properties. The roots of orthogonal polynomials are real and distinct (simple) and lie in the interval of orthogonality. Further, the roots of polynomials of consecutive degree n and $n-1$ in any orthogonal sequence $\{p_n(x)\}$, $n = 0,\ldots,\infty$, deg $p_n = n$, are interlacing in the sense that exactly one root of $p_{n-1}(x)$ lies between each pair of consecutive roots of $p_n(x)$ for each $n \in N$, $n \geq 2$. This classical result (Chebyshev, Markov, Stieltjes) plays an important role in Gauss quadrature.

The sequence of Laguerre polynomials $\{L_n^{(\alpha)}(x)\}$, $n = 0,\ldots,\infty$, $\alpha > -1$, is orthogonal on $(0, \infty)$ with respect to the weight function $e^{-x}x^\alpha$. It is known (D-Muldoon 2014) that for each $n \in N$, the roots of $L_n^{(\alpha)}(x)$ and $L_{n-1}^{(\alpha+t)}(x)$, are interlacing for $0 \leq t \leq 2$ and the $t-$ interval $0 < t \leq 2$ is sharp in order for interlacing to hold for every $n \in N$. Using a sharp interlacing result due to Palmai for zeros of Bessel functions, it was proved in (D-Muldoon 2020) that, for each $n \in N$, the roots of the equal degree Laguerre polynomials $L_n^{(\alpha)}(x)$ and $L_n^{(\alpha+t)}(x)$ are interlacing for each t with $0 < t \leq 2$ and the $t-$ interval $0 < t \leq 2$ is sharp in order for interlacing to hold for every $n \in N$.

Here, we consider the simplest cases of a question raised by Alan Sokal at OPSFA 2019: What can we say about the interlacing of roots of the Laguerre polynomials $L_n^{(\alpha)}(x)$ and $L_{n+1}^{(\alpha+1)}(x)$ where $\alpha > -1$? We also prove that there is partial (sometimes full) interlacing of roots of $L_n^{(\alpha)}(x)$ and $L_n^{(\alpha+3)}(x)$, $\alpha > -1$.

This is joint work with Jorge Arvesu Carballo and Lance Littlejohn.

New class of hypoelliptic differential operators

25 January 2021

Omar Mohsen (University of Münster)

Abstract : A hypoelliptic differential operator is a differential operator whose abstract distributional solutions are necessarily smooth. I will start with a brief introduction of hypoelliptic operators and the various methods to ensure hypoellipticity. Then I will present a new criterion which ensures hypoellipticity which generalizes previous criteria by many authors. The starting point is Hormander's sum of squares theorem and Folland and Stein's idea to equip differential operators with an ordering different from the stand ordering. This is based on joint work with Androulidakis, Van-Erp, Yuncken.

Fourier optimization and number theory

18 January 2021

Emanuel Carneiro (ICTP)

Abstract : This is a talk about three problems in the interface of harmonic analysis and analytic number theory, having the Riemann hypothesis in the background. It is going to be a light conversation, accessible to a broad audience.

Remarks on the 2d Euler equation

11 January 2021

Tarek Elgindi (Duke University)

Abstract : The Euler equation is a classical partial differential equation modelling ideal fluids. It is also one of the first PDE's ever written. Despite this, the dynamics of solutions still remains elusive. I will give some introductory remarks about stationary solutions to the 2D Euler equation.

A Bloch-type theorem for monogenic quaternion-valued functions

4 January 2021

Joao Morais (ITAM)

Abstract : Bloch's (1924) classical theorem asserts that if f is a holomorphic function on a region that contains the closed unit disk |z| ≤ 1 such that f(0) = 0 and |f'(0)| = 1, then the image domain contains discs of radius $\frac{3}{2}-\sqrt{2} > \frac{1}{12}$. The optimal value is known as Bloch's constant and $\frac{1}{12}$ is not the best possible. In this talk, we give a generalization of Bloch's theorem to the three-dimensional Euclidean space in the framework of quaternion analysis. We compute explicitly a lower bound for the Bloch constant.

Optimal Control for Fractional Order Epidemic Mathematical Models: Numerical Approach

28 December 2020

Seham El Mekhlafi (Cairo University)

Abstract : Recently, the mathematical models can be considered as a successfully powerful tool to simulate dynamics of the spread and control the infectious diseases . Also, the fractional order models are more suitable to describe the biological phenomena with memory than integer order models. In this talk, a novel mathematical model for Malaria disease of fractional order with modified parameters is presented. The fractional derivative is defined in the Atangana-Baleanu-Caputo sense. The suggested model is ruled by fourteen nonlinear fractional order differential equations. The optimal control of the suggested model is the main objective of this talk. Two control variables are presented in this model to minimize the number of infected population. Necessary control conditions are derived. Two schemes are constructed to simulate the proposed optimal control system. In order to validate the theoretical results numerical simulations and comparative studies are given.

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Applications of the Baire Category Theorem in Logic and Set theory

21 December 2020

Tarek Sayed-Ahmed (Cairo University)

Abstract : Let 2 < n < ω. We study omitting types theorems (OTTs) for Ln, which is first order logic restricted to the first n variables. Our positive results concerning OTTs in Ln that allow quantifier elimination depend on a result of Shelah's in Classification (Stability) Theory. We obtain, using a famous Theorem of Burgess from Descriptive Set Theory, the same possibilities in Morley's Theorem, the best known general result to the still unsettled Vaught's conjecture, namely, $\leq \aleph_0$ or $\aleph_1$ or 2^{$\aleph_0$}.

An example is given for an unstable countable atomic theory T having continuum many models but only one model omitting a countable given family of non-principal types, namely the atomic countable model. We use extensively the Baire Category Theorem in Polish spaces and another equally famous theorem from Descriptive Set Theory on the hierarchy of analytic sets in R. We show that Martin's axiom restricted to countable Boolean algebras is equivalent (in ZF which is ZFC without choice) to the celebrated Baire Category Theorem for Polish spaces, when we replace "countable union" by "less than 2^{$\aleph_0$}"; deducing the independency of a form of the Baire Category Theorem from ZFC.

Fractional Integrals and semigroups and their q-analogues (II)

14 December 2020

Mourad Ismail (University of Central Florida)

Abstract : In the second lecture, we introduce three one parameter semigroups of operators and determine their spectra. Two of them are fractional integrals associated with the Askey--Wilson operator. We also study these families as families of positive linear approximation operators. Applications include connection relations and bilinear formulas for the Askey--Wilson polynomials. We also introduce a q-Gauss--Weierstrass transform and prove a representation and inversion theorem for it.

Fractional Integrals and semigroups and their q-analogues (I)

07 December 2020

Mourad Ismail (University of Central Florida)

Abstract : In the first lecture, we give an overview of the classical fractional calculus and their applications. The theory of semigroups is central to our treatment.

Poster : https://drive.google.com/file/d/1w3kHYGhfi90yZUABL3Ytd8U37rVt_pZq/view?usp=sharing

The Computational and Cognitive Neuropsychology of Parkinson’s Disease

30 November 2020, at 10:00 (exceptional time)

Ahmed Moustafa (Western Sydney University)

Abstract : Parkinson’s disease (PD) is most commonly viewed as a motor disorder associated with reduced levels of dopamine in the basal ganglia and prefrontal cortex. Over the last two decades, research has shown that PD is also associated with cognitive deficits. My research has shown that dopaminergic medications might enhance or impair cognition depending on the cognitive tasks employed and medication status of the patients. In this talk, I will present my empirical and computational research findings on the effects of PD and dopaminergic medications on cognition. I will also present results (and a computational model) on the cognitive basis of “impulse control disorders” in a subset of PD patients. Further, I will also discuss computational modelling results of Deep Brain Stimulation (DBS).

Poster : https://drive.google.com/file/d/1YL2vGDwcdA4tThHw_JTYodHoyrcWjXM5/view?usp=sharing

New indefinite q-integral equations from a method using q-Riccati equations

23 November 2020

Gamila El Sayed (Suez University)

Abstract : In 2018, Conway introduced new methods for obtaining indefinite integrals of special function from the second-order linear equations which define them. The method is formulated in terms of Riccati equations which are nonlinear and first-order.

In this talk we introduce new methods for obtaining large number of interesting new q-integrals of both q-elementary and q-special functions provided the function satisfies linear second-order q-difference equations.

Generalization of q-Bernoulli polynomials generated by Jackson q- Bessel functions

16 November 2020

Sahar Hamdy (Beni Suef University)

Abstract : In this talk our main aim is to generalize the q-Bernoulli polynomials generated by Ismail and Mansour (2019). We will prove some properties of generalized q-Bernoulli polynomials and give some applications.

Subordination and superordination preserving properties for families of integral operators for meromorphic functions

09 November 2020

Hanaa M. Zayed (Menoufeya University)

Abstract : In this talk we obtain subordination, superordination, and sandwich-type results related to certain family of integral operators defined on the space of meromorphic functions in the open unit disk. Also, an application of the subordination and superordination theorems to the Gauss hypergeometric function are considered, and the main new results generalize some previously well-known sandwich-type theorems.

Paper : https://link.springer.com/article/10.1007/s13324-020-00354-7

Mathematics in Cairo, Egypt