Dynqua meeting 2026

9-11th March 2026
Laboratoire Jean Alexandre Dieudonné

Organisation committee: Maxime Ingremeau, Simona Rota-Nodari

Abstracts

Mini course

Speaker: Julien Sabin
Affiliation: IRMAR, Université de Rennes

Title: *Stability of quantum gases*
Abstract: The goal of this mini-course is to review some results of the last years concerning the large time stability of homogeneous quantum gases. We model the dynamics of these infinitely extended gases by a mean-field evolution equation on the one-body density matrix of the system, which is a generalization of the nonlinear Schrödinger equation. The key concepts for the large time stability that we will be emphasized are: a criterion for the linearized stability, intensive use of the dispersion of free particles through Strichartz estimates. The plan of the course is the following:
Course 1: Introduction of the model, linear stability
Course 2: Strichartz estimates for density matrices
Course 3: Nonlinear analysis

Talks by senior speakers

Speaker: Giulia Basti
Affiliation: Sapienza, University of Rome
Title: The Lee-Huang-Yang formula for a dilute Bose gas of hard spheres: an upper bound
Abstract: In 1957 Lee, Huang and Yang conjectured an asymptotic expansion of the ground state energy density of a dilute Bose gas in the thermodynamic limit. Remarkably, this two-term expansion is universal, depending only on the scattering length of the interaction potential. A lower bound in agreement with the Lee-Huang-Yang prediction has been established recently for a general class of repulsive interactions, including the hard-sphere case. However, a matching upper bound for hard-sphere interactions was missing so far. We complete the derivation of the Lee-Huang-Yang formula providing a trial state for a system of hard-sphere bosons with the correct energy. Based on a joint work with M. Brooks, S. Cenatiempo, A. Olgiati, B. Schlein.

Speaker: Charlotte Dietze
Affiliation: LJLL, CNRS

Title: Spectral theory for singular Riemannian metrics
Abstract: We prove eigenvalue asymptotics and concentration of eigenfunctions of the Laplace-Beltrami operator for certain singular Riemannian metrics. This is motivated by the study of propagation of sound waves in gas planets. The talk is based on joint works with Yves Colin de Verdière, Maarten de Hoop and Emmanuel Trélat, and with Larry Read.

Speaker: Matthieu Léautaud
Affiliation: Laboratoire de mathématiques d'Orsay, Paris-Saclay

Title: Poincaré series of convex bodies
Abstract: We consider the set of distances from a point to a lattice in Euclidean space, for a metric related to a convex body. Associated with these lengths, we construct a Poincaré series: a natural holomorphic function defined in a complex half-plane. The aim of the talk is to study this function: its possible extension to the other half-plane, its poles, its singularities, etc. In doing so, we encounter a multiplication operator by a Morse function on the sphere and describe its spectral theory. This is joint work with Nguyen Viet Dang, Yannick Guedes-Bonthonneau, and Gabriel Rivière.

Speaker: Claire Michel
Affiliation: Institut de Physique de Nice, UniCa

Title: Fluids of light in disordered environment
Abstract: Nonlinear photonics has opened up a fascinating field known as "Quantum Fluids of Light". In this realm, photons take on unique properties, essentially acquiring an effective mass and engaging in precisely controlled effective repulsive interactions. This behavior bears a striking resemblance to how particles behave in quantum fluids, such as Helium-4 [1,2] or atomic Bose-Einstein condensates [3]. It's this intriguing parallel with such original physical systems that has ignited a surge in exploration of the field.
The growing interest in this field is fuelled by the versatility and adaptability of photonic experimental platforms, giving access to features unreachable in genuine systems. Indeed, different setups, including semiconductor micro-cavities [4] and propagating geometries [5], offer the means to control and manipulate the behaviour of photons in the fluids of light framework.
At INPHYNI, we focus on the latter approach, using a photorefractive crystal [6-8] that allows us to manipulate the optical index in a highly flexible and reconfigurable manner [9]. In a significant recent development, our group successfully reported a direct experimental observation of the transition to superfluidity of a fluid of light past an obstacle.
Looking ahead, our research is set to explore the transition from spatial localisation to superfluidity in complex, but fully controlled environments.
In my presentation, I will describe the optical system, present the hydrodynamical analogy, and present some of our latest experimental results.
[1] Allen et al., Nature 141, 75 (1938)
[2] Kapitza et al., Nature 141, 74 (1938)
[3] Bloch et al., Nat. Phys. 8, 267 (2012)
[4] Carusotto et al., Rev. Mod. Phys. 85, 299 (2013)
[5] Carusotto, Proc. R. Soc. A 470, 2169 (2014)
[6] Sun et al., Nat. Phys. 8, 471 (2012)
[7] Michel et al., Nat. Commun. 9, 2108 (2018)
[8] Eloy et al., EPL 134, 26001 (2021)
[9] Boughdad et al., Opt. Express 27, 21, 30360 (2019)

Speaker: Martin Vogel
Affiliation: IRMA, CNRS

Title: Weyl law for the exponentially small singular values of the $\overline{\partial}$ operator
Abstract: We study the exponentially small singular values of the semiclassical $\overline{\partial}$ operator on an exponentially weighted L^2 space on a two-dimensional torus. We will assume that the Laplacian of the exponential weight changes sign along a curve. We will introduce the notion of upper and lower bound weights which give together with the orthogonal Bergman projection precise upper and lower bounds on the number of small singular values. Solving a free boundary value problem we obtain optimal weights which yield Weyl asymptotics for the counting function of exponentially small singular values. We also provide a precise description of the leading term of the Weyl asymptotics in the regime of small exponential decay rates of the singular values.
This talk is based on joint work with J. Söstrand and M. Hitrik.

Talks by junior speakers

Speaker: Lino Benedetto
Affiliation: DMA & Université d'Angers

Title: A Quantum Ergodicity Theorem on Contact Manifolds
Abstract: In this talk, I will present a quantum ergodicity theorem for eigenfunctions of sub-Laplacians associated with metric contact structures, under the assumption that the Reeb flow is ergodic. The result relies on a semiclassical pseudodifferential calculus adapted to filtered manifolds, which I then specialize to the setting of contact manifolds. A key ingredient of the proof is the construction of microlocal projectors, known as Landau projectors, which commute with the sub-Laplacian and allow one to decompose the dynamics into effective components. On each of these components, the sub-Laplacian essentially reproduces the action of the Reeb vector field. Once microlocal Weyl laws are established, the proof of quantum ergodicity then follows the main lines of the classical proof of Schnirelman's theorem.

Speaker: Nicolas Frantz
Affiliation: Université d'Angers

Title: Spectral analysis of a semi-classical Bloch-Torrey operator
Abstract: The Bloch-Torrey operator ($-h^2\Delta + ix$) is the non-selfadjoint differential operator that governs the time-evolution of the magnetization of spin-bearing particles in a body submitted to a magnetic field. This operator is central in the modelling of diffusion MRI (A medical technique especially used for brain imaging). In particular the localization of its eigenfunctions, which is important for applications, is not currently understood. The purpose of this talk is to understand this localization by means of an Agmon estimate. The main tool is the construction of a parametrix using the symbolic calculus of operator-valued pseudodifferential operators. This is a joint work with Martin Averseng, Frédéric Hérau et Nicolas Raymond.

Speaker: Christiane Klein
Affiliation: University of York

Title: Coupled Proca theories – Green-hyperbolicity and application to quantum polarization measurement
Abstract: The Proca equation describes a massive relativistic spin-1 particle, such as the Z-boson appearing in the Standard Model of particle physics. In this talk, we consider various extensions of the Proca equations on curved spacetimes, such as the equation of a charged Proca fields coupled to a background electromagnetic field or the one of a Proca field linearly coupled to a scalar field. We introduce an auxiliary field method to analyse the Green-hyperbolicity of these equations. With this method, we can show that all the variations of the Proca equation we consider are Green hyperbolic.
As an application, we quantize the Proca field coupled to a Klein-Gordon scalar field. We use this theory to develop a measurement scheme sensitive to the Proca field polarization within the meausrement framework of Fewster and Verch, using the scalar field as the probe. For suitable states of the Proca field, we find that the leading-order response agrees with Malus' law. This confirms that this scheme models a ploarization-sensitive detector. This talk is based on joint work with Chris Fewster.

Speaker: Théotime Girardot
Affiliation: Aarhus University

Title: Non-linear Landau levels of the almost-bosonic anyon gas
Abstract: In this talk I will introduce the topic of the anyon gas within its almost-bosonic extended framework. I will then focus on the usual N-body ground state and describe how to approximate it with the use of an effective magnetic Gross-Pitaevskii functional. The second part of the talk will be dedicated to the study the stability and the minimizers of the above mentioned functional. I will show that they belong to non-linear Landau levels and contain vortices. Overall, this talk will perform a review of recent mathematical results related to the almost-bosonic anyon gas.

Speaker: Sascha Lill
Affiliation: University of Copenhagen

Title: Momentum Distributions of Fermi Gases
Abstract: The talk concerns recent progress on the mathematical analysis of the momentum distribution of a fermionic gas in the mean-field and the dilute regime. Properties of the momentum distribution, such as the existence of a discontinuity, may reveal the presence of quasiparticles in the gas, as predicted by Landau's Fermi liquid theory. Although many physical predictions have been achieved assuming this theory, a mathematical proof of the existence of quasiparticles for a 3d Fermi gas in a thermal or ground state remains open since several decades. In our work, we establish formulas for the momentum distribution within trial states that are energetically close to the ground state, both at high and low densities. The formulas agree with predictions from the physics literature and exhibit a discontinuity as expected by Fermi liquid theory. The talk is based on joint works with N. Benedikter, E. Giacomelli, A.B. Lauritsen and D. Naidu.

Speaker: Zacharie Van Herstraeten
Affiliation: INRIA & Département d'Informatique de l'ENS

Title: Extreme non-negative Wigner functions
Abstract: In quantum information, understanding the regimes in which quantum states exhibit genuine nonclassical behavior is of central importance, as these regimes can be exploited in quantum technologies. For continuous-variable systems, nonclassicality is naturally expressed in phase space and is commonly associated with the negativity of the Wigner function. In this talk, we focus on the characterization of Wigner-positive states, that is, quantum states with non-negative Wigner functions. Using tools from convex geometry, we address this problem by studying the extreme points of the set of Wigner-positive states. Our main result is a constructive method that allows one to generate a large class of such states. This construction relies on the introduction of a new quantum map, the Vertigo map, which reveals a remarkable structure underlying mixed states with non-negative Wigner functions. This talk is based on the preprint: http://arxiv.org/abs/2512.14831