Workshop "Dynamical and Quantum Systems"
Nice, Feb. 5-6th, 2026

Thursday, February 5th

9:30-10:05 Jean Dolbeault
Sobolev and Caffarelli-Kohn-Nirenberg inequalities for spinors

The transition between symmetry and symmetry breaking is well understood in simple cases of inequalities involving scalar valued functions like interpolation inequalities on the sphere or Caffarelli-Kohn-Nirenberg inequalities on the Euclidean space. In such cases, the issue is to decide whether optimal functions have the same symmetries as the inequality, or if symmetry is broken. Similar inequalities make sense for spinor valued functions. Although symmetry is then a more subtle property, there are ranges of parameters for which one can decide if optimal spinors are symmetric or not. The lecture will be devoted to a short review of known results.

10:10-10:45 Nabile Boussaid
Construction of solitary wave solutions for Soler-type systems

We use the perturbation theory to build solitary wave solutions to the nonlinear Dirac equation with the Soler-type nonlinear which is continuous but not necessarily differentiable. Due to this lack of regularity, contraction mapping arguments are difficult to use. Instead, we propose to use compactness arguments. As a consequence the uniqueness has to proved separately, we use a shooting type argument.

11:20-11:55 Philippe Gravejat
Solitonic vortices for the Gross-Pitaevskii equation in a strip

The talk deals with the Gross-Pitaevskii equation in a two-dimensional strip. This equation has explicit travelling wave solutions on the line that are called dark solitons and that remain travelling wave solutions on the strip. A natural question is to ask to what extent it is possible to construct mathematically true two-dimensional travelling waves in the strip.

A first answer will be given by a minimization procedure under constraint, but only when the width of the strip is large enough. Next a perturbative approach will provide a rigorous construction of two-dimensional stationary solutions with a fixed number of vortices, that are called solitonic vortices and were first described by numerical simulations and physical experiments in the context of the Bose-Einstein condensation.

This is joint work with André de Laire (University of Lille) and Didier Smets (Sorbonne University) on the one hand, and with Amandine Aftalion (CNRS and University Paris Saclay) and Étienne Sandier (Paris-Est Créteil University) on the other hand.

12:00-12:35 Antoine Levitt
Self-consistent algorithms in mean-field quantum mechanics

I will review old and new work on mathematical understanding and practical algorithms for fixed-point iterations in numerical quantum mechanics, in particular in mean-field models such as the Hartree-Fock or Kohn-Sham equations.

14:20-14:55 Maria J. Esteban
The beginnings of Dirac in the Dauphine group

In this talk I will give an informal historical presentation of how the Dirac operator and questions related to relativistic quantum mechanics became an important part of the works in the nonlinear analysis group at Dauphine University.

15:00-15:35 Federico Cacciafesta
Dispersion for the Dirac-Coulomb model

The aim of this talk is to present the dispersive estimates (local smoothing, Strihartz,..) for the Dirac equation perturbed with a Coulomb potential. This model happens to be particularly relevant as indeed the Coulomb potential, which is widely used in the applications to model particle interactions, is a scaling critical perturbation of the (massless) Dirac operator, and thus it provides a substantial difficulty in the analysis of linear estimates for the flow. The talk is based on joint works with E. Danesi, E. Séré and J. Zhang.

16:20-16:55 William Borelli
Dirac solitons in one-dimensional nonlinear Schrödinger equations

In this talk I will consider a family of one-dimensional NLS equations with periodic potentials, such that the linear part of the equation admits Dirac points in the dispersion relation. This leads to a class of nonlinear Dirac equations (NLD) as effective models, in a suitable energy regime. We prove the existence of standing waves for the NLS whose leading order term is constructed using stationary solutions of the limit NLD, thus justifying the use of the latter as an effective equation in this context. Joint work with Elena Danesi, Simone Dovetta and Lorenzo Tentarelli.

17:00-17:35 Jean-Marie Barbaroux
Magnetic Dirac operators on domains: infinite mass BC versus zigzag BC

For two-dimensional Dirac operators defined on domains, with a perpendicular magnetic field, I will present some general spectral properties depending on the choice of boundary conditions. Then, through a detailed study of the energy dispersion curves in the half-plane case, I will highlight that the infinite-mass case generically captures the profile of these curves for all boundary conditions that interpolate between infinite-mass and zig-zag boundary conditions, but that the pure zig-zag case reveals a different behaviour. I will eventually show that this has an impact on the bulk-edge conductance for the system.

Friday, February 6th

9:30-10:05 Ivar Ekeland
Homoclinic orbits and the mathematical birth of Eric Séré

I will describe the variational theory of homclinic orbits for Hamiltonian systems, as it was developed around 1990, with a strong input from Eric Séré.

10:10-10:45 Anne-Sophie De Suzzoni
PDEs and recursive structures

In this talk, I will explain why the recursive structures of PDEs with polynomial nonlinearities is the same as some type of rooted trees. I will explain why not use this information in general and why use it in some specific cases. Then, I will focus on the cases of two coupled equations and present some derivation results in the framework of wave turbulence. Joint work with Annalaura Stingo and Arthur Touati

11:20-11:55 David Gontier
Non-linear models for moiré materials

In this talk, we discuss non-linear mean-field models for quasi-periodic crystals, which are commonly found in materials such as moiré materials (e.g. twisted bilayer graphene). For Thomas-Fermi like models, the question has been addressed by Blanc, Lebris and Lions in 2007, and we extend their results to Hartree-Fock like models.

12:00-12:35 Umberto Morellini
Norm approximation of bosonic mean-field dynamics by quasifree evolution

In this talk, I will consider the quantum many-body evolution of a homogeneous Bose gas in three dimensions in the mean-field scaling regime. I will study a class of initial data describing finitely many excitations over a quasi-stationary Bose-Einstein condensate. Using a rigorous version of Bogolyubov's theory, I will prove that the many-body evolution can be approximated in the Fock space norm by a quasifree bosonic evolution of the excitations with an error which grows linearly in time. This talk is based on ongoing work with Niels Benedikter (University of Milan) and Chiara Boccato (University of Pisa).

14:10-14:45 Patrick Bernard
Formes de Lyapunov pour un champ de vecteurs