2ND MEETING OF THE ANR PROJECT SQFT

SPECTRAL AND SCATTERING THEORIES OF QFT MODELS

Porquerolles

June 4–7, 2014

Mini-courses (3h)

Zied Ammari *(Rennes)*

Dietrich Häfner *(Grenoble)*

Talks (1h30)

Sylvain Golénia *(Bordeaux)*

Jacob Schach Møller *(Aarhus)*

Baptiste Schubnel *(Zürich)*

Semjon Wugalter *(Karlsruhe)*

PROJET FINANCÉ PAR L'ANR - PROJECT FUNDED BY THE ANR

Program

Thursday, June 5

8h30 - 10h : Zied Ammari, *Semiclassical Methods in Many-body and Quantum Field Theories (Part I)*
10h30 - 12h : Dietrich Häfner, *Time-dependent scattering theory without positive conserved energy (Part I)*
13h30 - 15h : Baptiste Schubnel, *On the preparation of states in Quantum Mechanics*

Friday, June 6

8h30 - 10h : Zied Ammari, *Semiclassical Methods in Many-body and Quantum Field Theories (Part II)*
10h30 - 12h : Dietrich Häfner, *Time-dependent scattering theory without positive conserved energy (Part II)*
13h30 - 15h : Jacob Schach Møller, *Beyond the Van Hove time scale*

Saturday, June 7

8h15 - 9h45 : Sylvain Golénia, *Positive commutator techniques for high energy estimates*
10h - 11h30 : Semjon Wugalter, *Radiative correction to the binding energy for a spin 1/2 charged particle*

Organization : Jean-Marie Barbaroux (barbarou@univ-tln.fr), Jérémy Faupin (jeremy.faupin@univ-lorraine.fr)

Participants

- Zied Ammari (Rennes)
- Ioannis Anapolitanos (Stuttgart)
- Jean-Marie Barbaroux (Toulon)
- Marco Falconi (Rennes)
- Jérémy Faupin (Metz)
- Sylvain Golénia (Bordeaux)
- Marcel Griesemer (Stuttgart)
- Jean-Claude Guillot (Polytechnique)
- Dietrich Häfner (Grenoble)
- Dirk Hundertmark (Karlsruhe)
- Thierry Jecko (Cergy)
- Jacob Schach Møller (Aarhus)
- Annalisa Panati (Montreal)
- Baptiste Schubnel (Zürich)
- Semjon Wugalter (Karlsruhe)
- Maher Zerzeri (Paris 13)

Abstracts

Zied Ammari, *Semiclassical Methods in Many-body and Quantum Field Theories*
The purpose of this lecture is to present a general approach in the study of quantum systems with a large number of particles. The main idea, inspired by phase-space analysis, relies on semiclassical (Wigner) measures in infinite dimension and it is applicable to a wide variety of models and problems. In this lecture, I will review in particular the mean field and classical approximation in many-body theory and some quantum field theories ; and explain some outcomes of the aforementioned approach.

Dietrich Häfner, *Time-dependent scattering theory without positive conserved energy*
Time-dependent scattering theory has been studied since a long time. In most cases one studies a hamiltonian which is selfadjoint on a Hilbert space. One of the aims is then to compare this "perturbed" hamiltonian to another "free" hamiltonian which is easier to understand. In this context powerful tools such as the Mourre theory have been developed. In many cases however, the hamiltonian is not a selfadjoint operator on a Hilbert space and these methods do not apply or have to be modified. Typical examples are the Klein-Gordon equation coupled to a (strong) electric field or associated to a lorentzian metric which posseses no global timelike Killing vector field. In these lectures we will study two types of situations.
1) The hamiltonian is not selfadjoint on a Hilbert space, but selfadjoint on a so called Krein space. There exists a non degenerate sesquilinear form on a Krein space, but this form is in general not positive. We prove a generalization of the Mourre theorem in the Krein space setting : a positive commutator type estimate gives a limiting absorption principle. Applications to the Klein-Gordon equation are given.
2) In the second part we consider an abstract Klein-Gordon equation which can not be represented by a selfadjoint operator on a Krein space (and in particular not by a selfadjoint operator on a Hilbert space). A typical example is the Klein-Gordon equation on the De Sitter Kerr spacetime which describes rotating black holes. Using meromorphic extensions of different resolvents we show asymptotic completeness results for this system. Applications to the De Sitter Kerr metric are given.
These lectures are based on joint work with Vladimir Georgescu and Christian Gérard.

Sylvain Golénia, *Positive commutator techniques for high energy estimates*
Joint work with Thierry Jecko

Jacob Schach Møller, *Beyond the Van Hove time scale*
We study the effective time evolution of a finite level quantum system, induced by a linear coupling to a massless scalar quantum field. The massless spin-boson model is a prime example of such a system. Using Bach-Fröhlich-Sigal Renormalization Group techniques, we construct the effective dynamics at any time scale. In particular, we recover the Davies generator at the van Hove time scale, but our analysis permits us to go beyond the van Hove timescale. A partular strength of our approach is that we do not have to impose a Fermi Golden Rule assumption.
The talk is based on joint work with Volker Bach and Matthias Westrich.

Baptiste Schubnel, *On the preparation of states in Quantum Mechanics*
We discuss how to prepare a small quantum system in a prescribed state by coupling it weakly with a dispersive reservoir. We illustrate this phenomenon by working on a concrete example, the spin boson model. This model represents an atom (modeled by a N-level system) interacting with the quantized electromagnetic field. Working at zero temperature, we show that the reduced state of the atom converges asymptotically to its internal lowest energy state if the coupling between the atom and the field is (enough) slowly shut down. Our mathematical analysis is inspired by the technic developed by W. De Roeck and A. Kupiainen in two recent papers.

Semjon Wugalter, *Radiative correction to the binding energy for a spin 1/2 charged particle*
In the talk I will discuss how to compute the binding energy of a hydrogen atom in the most comprehensive model in nonrelativistic QED, which includes the Zeeman term, assuming that the fine-structure constant is small. It will be explained why the existence of this term brings additional difficulties to the computation of the binding energy and how these obstacles to ovecome. The talk is based on joint works with J.-M. Barbaroux