Postdoctoral position

Anomalous dynamical resonances in small differential systems

Sorbonne Université - Université du Littoral Côte d'Opale - Charles University

Project Summary

This postdoctoral position is about the theoretical study of anomalous dynamical reasonances arising in driven coupled systems of differential equations. A typical example is provided by Shcrödinger's equation with time-dependent Hamiltonian $H(t)$,

$$\dot{U}(t) = H(t)U(t), \quad U(0) = \mathrm{Id}$$

If the Hamiltonian does not commute with itself at different times, the solution matrix $U(t)$ is a time-ordered exponential of $H(t)$, a complicated mathematical object exhibiting unexpected behaviors. In particular for some peculiar parameter values in $H(t)$ the solution $U(t)$ may behave substantially differently as for all other parameter values. We call such occurences *anomalous dynamical resonances*. Such resonances have been confirmed to occur physically, even for small systems: for example in a certain 2×2 matrix $H(t)$ known as the Bloch-Siegert Hamiltonian an anomalous resonance is responsible for the suppression of quantum tunneling. For larger systems, another such resonance is at the origin of electromagnetically induced transparency.

In spite of their relevance, anomalous dynamical resonances have never been systematically studied owing to important mathematical hurdles. The project aims at remedying this by building up a general theoretical framework for the systematic study of such resonances following the partial success of recent research (P.-L. Giscard, C. Bonhomme, *Dynamics of quantum systems driven by time-varying Hamiltonians: Solution for the Bloch-Siegert Hamiltonian and applications to NMR*, Physical Review Research 2, 023081, 2020). The mathematical tools used to that end are novel and will be learnt by the selected candidate while on position. Concretely, the project will start with the study of the 3×3 time-dependent Bloch equations and their formal solutions via the method of path-sums and related $\star$-structures. While the project's core aim is the general mathematical description of anomalous dynamical resonances, physical insights gained from the mathematical results will also be developed in conjunction with quantum chemists.

Context

The postdoctoral position is funded through the MAGICA French National Research Agency research project. MAGICA is dedicated to the use of novel algebraic and combinatorial tools for solving differential ssytems in the context

of quantum chemistry. MAGICA is conducted by three research groups ld by: Professor Christian Bonhomme, Sorbonne University, Paris, France; Lecturer Pierre-Louis Giscard, Université du Littoral Côte d'Opale, Calais, France; and Assistant Professor Stefano Pozza, Charles University, Prague, Czech Republic.

The postdoctoral position fully funded for a duration of **2 years**. The position will be taken at the Université du Littoral Côte d'Opale, Calais, France, with funded travels to Sorbonne University and Charles University, as well as attendance to conferences as necessary.

Profile

The candidate should hold a **PhD in mathematics or mathematical-physics**. A strong mathematical background is necessary with a good working knowledge of differential systems, some knowledge of quantum physics is also desirable.

Period: 09/2023–09/2025

Salary: between 3 887€/month and 4 460€/month gross salary, depending on experience.

Application deadline: 15/06/2023

Application documents: Curriculum Vitae, recommendation(s) letter(s), PhD diploma and short description of your research.

Contacts: Pierre-Louis Giscard, `giscard@univ-littoral.fr`
Christian Bonhomme, `christian.bonhomme@upmc.fr`