2018-00479 - PhD student on inria CORDI-S funding // Developing mathematical tools for efficient approximate analysis and design of open quantum systems

Level of qualifications required: Graduate degree or equivalent
Fonction: PhD Position
Level of experience: Recently graduated

Context
This PhD concerns theoretical developments, in strong collaboration with experimentalists working with our QUANTIC team in Paris as well as at Yale University (USA) in the framework of the TAQUILA project.

The goal is to develop, together with the promotors, explicit mathematical results (“formulas” or systematic procedures) allowing, before resorting to numerical simulations, to analyze approximately and thereby guide the design of complex quantum systems. The development of quantum technologies indeed requires to ensure that a few desirable effects (e.g. target evolution, or “stabilizing” behavior that protects encoded information) dominate other dynamics (perturbations) by several orders of magnitude. Efficient tools are currently needed to characterize these different effects with higher accuracy, evaluate which architectures are more promising and design more powerful components and systems. More specifically, this research will be based on advanced tools from dynamical systems theory and model reduction, adapting them to the particular structure of open quantum systems in order to propose solutions for approximate analysis at various orders of precision.

Depending on the candidate and on the scientific opportunities, one or several visits to Yale University can be organized during the PhD (several weeks to a few months). The candidate will also typically actively participate in leading international conferences of the research field. The travel costs will be covered by inria.

Assignment
Assignments:
With intensive help from the promotors, the candidate will have the goal to develop new mathematical results improving the international state-of-the-art, regarding approximate analysis of open quantum systems properties. The developments will be based on advanced systems theory to take advantage of the particular structure of open quantum systems and of the multiple time scales inherent to the research question. Towards the end of the thesis, the candidate will have developed a set of explicit tools at the disposal of quantum systems designers.

For a better knowledge of the proposed research subject:
The research and working context of the QUANTIC team is reflected by our web site https://team.inria.fr/quantic/ as well as by the publications of our permanent members (for the theoretical topics, see the web or GoogleScholar pages of Pierre Rouchon, Mazyar Mirrahimi and Alain Sarlette).

Responsibilities:
The candidate will be responsible for carrying out a successful research project, with strong scientific support from his/her promotors. He/She can get PhD-level education, both scientific and general-skills, from the associated graduate school. He/She will work with an increasing level of autonomy, starting from pointers and examples given by the promotors, to progressively take own initiatives regarding promising solution methods and research directions within the broad subject of the thesis.

Main activities
Main activities:
- Analyse the state of the art to identify most promising tools to be applied to our goal
- Develop new results for our particular problem (see above) by adapting those tools and carrying them further
- Apply our results to concrete cases to demonstrate their analysis and design power.
- Present the results to the international research community (both oral and written)
- Write a PhD thesis

Complementary activities:

- Provide theoretical and/or computational solutions for ongoing experiments in the lab.
- Inform oneself about and present topics in the more general context of quantum technologies

**Skills**

Technical skills and level required:

Master in applied maths, systems and control theory, dynamical systems theory or equivalent, with a basic quantum physics knowledge.

OR

Master in applied physics, theoretical physics or equivalent, with a basic knowledge of the systems engineering tools and approaches.

Languages: English (mandatory), French (useful)

Relational skills: solid basis on reporting and discussing scientific results in a state-of-the-art context

**Benefits package**

- Subsidised catering service
- Partially-reimbursed public transport

**Remuneration**

Gross Salary per month: 1 982 € the first 2 years and 2 085 € the last year