Quantum Information and Quantum Noise - 2018-1

Professor: Gabriel Teixeira Landi

General information

- **Lectures:** mondays and wednesdays from 16:00 to 18:00
- **Location:** Room 206, Ala 2.
- **Course website:** `www.fmt.if.usp.br/~gtlandi`
  - All course material will be made available on the QInfo tab.

Contact

- I'm at room 211, Alessandro Volta, Block C.
- Phone: 916776.
- e-mail: gtlandi@if.usp.br
  - Feel free to come to my office to discuss physics anytime.

Grading

Grading will be based on problem sets only. No exams.

Bibliography

In this course I won't follow a specific book, but I will try to mix a several sources. In the website I will publish some lecture notes which I think will help you navigate through the course. In each set of notes I will specify the books and papers which you should read to complement the lectures. Below is also a list of useful books on the subject with comments.

Mathematica

In this day and age you *must* have access to a good numerical library for simple problems, such as finding eigenvalues, computing numerical integrals and so on. Feel free to use any library you prefer (Maple, Matlab, scipy, etc.), but in this course we will use Mathematica. USP has unlimited Mathematica licenses, so you can install it in any computer you want (even your mom can use Mathematica!).

A list of softwares available at USP can be found at

`http://cetirp.sti.usp.br/atendimento/licenca-de-software/`
To install Mathematica, acess

`http://www.cce.usp.br/atendimento/software/mathematicaStudent/`

and follow the instructions. I suggest you sign up on the Wolfram User Portal to get the updates.

Useful sources on how to use Mathematica can be found at

`https://www.wolfram.com/language/elementary-introduction/`

On the website you will also find the library `qulib.nb` which was developed in our group. The library is very simple, but incredibly useful in dealing with the problems we will have to deal in this course. I recommend everyone install it (instructions are given in the Mathematica notebook).

List of useful books

We will cover many research-active topics so not everything can be found in books. There are several good books nonetheless. In particular, each group has its own "bible" depending on their research interests. I would say that the four most widely used bibles are Nielse-Chuang, Breuer-Petruccione, Gardiner-Zoller and Scully-Zubairy. But, of course, I am sure any specialist reading this will disagree with me! The lecture notes of Preskill are also practically a bible. Here is a commented list of these bibles, plus other books which I find useful.

- *Nielsen and Chuang: Quantum Computation and Quantum Information.*

  The official bible of quantum information. It is very good and very accessible. But it deals only with qubits (no continuous variables) and is not so interested in physical implementations.

- *Preskill: Lecture Notes for Physics 229* (can be found online)

  These are very good lecture notes on QInfo, comparable and, in a sense, complementary, to NC.

- *Breuer and Petruccione: The theory of open quantum systems.*

  Bible of open quantum systems. Very good discussions on the formal aspects of quantum master equations, non-Markovianity and decoherence. Not very accessible (most books on open quantum systems are not: it's a difficult subject!).

- *Gardnier and Zoller: Quantum Noise*

Open quantum systems more from a perspective of quantum optics, but also dealing with the formal aspects of the theory. Focus is more on continuous variables. Good reference for phase space methods.

- *Scully and Zubairy: Quantum Optics*

  This book discusses open quantum systems from the perspective of quantum optics, which is a bit more accessible than the formal approaches of BP and GZ. Overall a very good book and considered by many a bible in the field.

- *Serafini: Quantum Continuous Variables*

  A good compendium of more modern results concerning Quantum Information of continuous variable systems.

- *Schlosshauer: Decoherence and the quantum-to-classical transition*

  This book deals with the fascinating (and difficult) subject of quantum-to-classical transition from the point of view of open system dynamics.

There are also many other books. But it doesn't make sense for me to just list a bunch of them. During the course we will also analyze in detail several important papers. In the end of the course I will try to list these papers so that you can store them for future reference.