Instructor: Benoit Collins (Associate Professor, Kyoto University, Mathematics Department)

Title: mathematical aspects of quantum information theory.

Overview:

This intensive course is about some mathematical aspects of quantum information theory.

Hopefully, after taking the intensive lecture, the audience will understand many important paradigms of quantum information theory and will be convinced that it is a rich source of accessible yet exciting open questions for mathematicians.

Although the course is primarily intended for graduate students, a strong and motivated undergraduate student of any level should be able to follow the class.

Prerequisites:

A good knowledge of linear algebra and a basic knowledge of functional analysis / operator algebra is expected. Knowledge of basic probability theory is desirable too.

No knowledge in information theory, computer theory or quantum mechanics / physics is expected, but an interest in these fields is commendable.

Contents:

I expect these classes to be an alternation of (i) definitions and physical motivations, (ii) mathematical results and their proofs, and (iii) statement of easily understandable yet unsolved open questions. I will cover some of the following topics:

-Basic notions (classical information, quantum states, quantum channels, POVM, tensor setup, register, repeated use, partial trace)

-Entanglement, PPT, distillability

-Entropies and capacities

-Bell inequalities

-Quantum typicality

-Quantum marginal problem, majorization

-Tsirelson's problem, commuting operator setup vs tensor Hilbert setup.

Evaluation:

Students who want credit will be asked to attend all classes and to submit a report. The topics will be given during the course.

Language:

I will teach in English. However, for questions and reports, students / audience are welcome to choose English or Japanese.

Reference:

Some of my teaching will be based on the following two books (openly available)

John Watrous: https://cs.uwaterloo.ca/~watrous/TQI/TQI.pdf

Mark Wilde: https://arxiv.org/pdf/1106.1445.pdf