

Quantum non-locality and its applications - Syllabus

This course explores quantum information processing through the lens of quantum correlations. We will develop an understanding of quantum correlations and the main mathematical tools to characterise them: from the well-known Bell-nonlocality and self-testing to new techniques based on graph inflation. We will discover direct applications and insights that can be gained from this approach, including results on communication complexity and non-local computation. We will further explore deep problems that leverage variations of the acquired techniques, such as parallel repetition theorems, Tsirelson's problem and marginal problems in general.

Lecture 1:

Bell-nonlocality, Tsirelson bound, nonlocal games.

Lecture 2:

Self-testing.

Lecture 3:

Parallel repetition theorems, introduction to the Tsirelson problem.

Lecture 4:

From nonlocality to information processing and computation, communication complexity, information causality, nonlocal computation. Physical principles for quantum theory.

Lecture 5:

Non-signalling, information processing and computation beyond quantum theory (GPTs).

Lecture 6:

The multipartite setting, entanglement swapping, entangled measurements vs. LOCC measurements, networks.

Lecture 7:

Tools to analyse networks, entropy cone and non Shannon entropy inequalities, covariance matrices, Inflation.

Lecture 8:

Marginal problems.