ICFO

SEMINAR: Entropic limitations on fixed causal order

MATHEUS CAPELA

October 20, 2026
12:00 to 13:00
Seminar Room

The causal structure of physical processes is usually assumed to be fixed: events occur in a definite order, even when the underlying quantum systems exhibit nonclassical correlations. Quantum theory, however, allows for more general processes in which the causal order itself can be indefinite, as exemplified by the quantum switch. This raises a fundamental question: can the causal structure of a process be characterized purely in terms of the information it can transmit?

In this talk, I will discuss an information-theoretic approach to this question based on information inequalities. We derive a class of inequalities that must hold for any process compatible with a fixed causal order, including both definite causal orders and classical mixtures thereof. Their violation therefore provides a sufficient condition for certifying genuinely non-fixed causal order. Remarkably, the framework is not restricted to the von Neumann entropy, but extends to a broad class of information measures, including Renyi entropies.

I will also discuss how these inequalities can be combined with strong subadditivity to obtain witnesses that require only marginal information, and show how the resulting criteria detect the non-fixed causal structure of the quantum switch. These results highlight a direct connection between information-theoretic constraints and the causal structure of quantum processes.

Hosted by: Prof. Dr. Toni Acin