# PhD THESIS DEFENSE: Correlations and Measurements? as Resources for ?Quantum Information Tasks

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November 25, 2024
10:00 to 11:00
Auditorium

The advent of quantum mechanics, which predicted strange, counter-intuitive effects and phenomena, that could not be mimicked by classical physical theories, revolutionized the scope and understanding of physics research back in the XIX century. As time passed, and quantum theory became better understood, a shift of paradigm occurred: what used to be solely an object of investigation and analysis became also a tool, as it was realized that the extraordinary, exotic features of systems working in the quantum regime could also be harnessed as resources that could be used to our benefit in different tasks. This shift of paradigm marked the beginning of a Second Quantum Revolution, which was characterized by the rise of the Quantum Information Science and Technologies. Central quantum resources such as quantum correlations, including entanglement, and also non-classicality and non-Gaussianity, were shown to be useful for data processing tasks such as communication, computation and parameter estimation, to name a few. In this thesis, we dive into the field of parameter estimation, or Metrology, and discuss the role of physical correations on the precision of the information retrieval of variables encoded in physical systems. We begin by exploring the role of a specific kind of correlations, those that arise indirectly between quantum probes via the interaction with a common environment, in the retrieval of temperature information of a cold bosonic bath. We then analyse the role of restricting the measurement choice of the probes to a limited set, that of Gaussian measurements, and show their usefulness in characterizing the temperature of Gaussian systems. Finally, we go beyond the scope of the field of Metrology and Thermometry, and look for effective ways to certify the presence of a number of relevant quantum resources in states produced by third order light-matter interaction, also known as three photon generation. There, we show that correctly tailored quantum witnesses can effectively certify the presence of quantum phenomena with no classical analog in photonic nonlinear processes.

**Monday November 25, 10:00 h. ICFO Auditorium**
**Thesis Director: Prof. Dr. Antonio Acin**

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**Hosted by:** Prof. Dr. Antonio Acin