PhD THESIS DEFENSE: "Continuous Variable Quantum Communications: Technologies and Security"

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April 07, 2025
10:00
ICFO Auditorium

With this Thesis, we will focus on diverse technologies as well as techniques relevant for the development of secure communication systems based on Quantum Mechanics. This theoretical analysis involves the application of diverse methodologies, which represent formidable challenges from a purely analytical perspective, as well as from a numerical stance. The contents of this manuscript are divided according to the nature of the particular technology under scrutiny.
As a first step, we will provide a study of Quantum Key Distribution based on continuous variable states and coarse-grained measurements. This inquiry is split according to two chapters. In the first one, a thorough description of our approach will be provided, as well as diverse outcomes regarding the addition of postselection techniques for an improved

perfomance; a study of optimization in infinite dimensions, as well as results in the finite regime under collective attacks. In the second part, we will observe how performing a full discretization on the measurements grants not only full security against any adversary allowed by Quantum Mechanics, but also a new formalism via entropy accumulation approaches that permits the analysis of the statistical fluctuations that emerge when only finite statistics are accessible.

This discussion will be followed by a study of Quantum Random Number Generatio according to a semi Device Independent perspective where the assumptions on th experimental setups are limited. Our discussion will be based on using a truste measurement and imposing a bound on the corresponding expectation value -- whic requires an adaption from the well-known asymptotic limit to the the finite case in order t prevent emerging security pitfalls. This examination is completed with a thorough securit proof against general attacks and diverse results in the finite regime

To conclude, this Thesis finishes with an assessment of Quantum Key Distribution for larg networks based on classical Internet models, which provides insights on the scalability an optimality conditions of Quantum Communications according to the density of users an their connections. In particular, this indagation is mainly based on continuous variabl systems, albeit another approach grounded on discrete variables is also added to the mode in order to enhance its performance

Monday April 7, 10:00 h. ICFO Auditorium
Thesis Director: Prof. Dr. Antonio Acin and Dr. Stefan Bauml
Hosted by: Prof. Dr. Antonio Acin