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International Master in Photonics

## **MASTER IN PHOTONICS – “PHOTONICS BCN” ERASMUS+ “EUROPHOTONICS”**

### **MASTER THESIS PROPOSAL**

**Dates: April - September 2019**

**Laboratory : Quantum Information Theory Group  
Institution: ICFO-The Institute of Photonic Sciences  
City, Country : Barcelona, Spain**

**Title of the master thesis: Quantum Complex Networks**

**Name of the master thesis supervisor: Daniel Cavalcanti, Antonio Acín**

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**Keywords : Complex networks, quantum networks, quantum information, entanglement.**

**Summary of the subject (maximum 1 page):**

Network science studies how systems are connected and aims at drawing conclusions about the properties of complex systems solely from how it is organised. Important examples of networks are:

- The cellular network describing interactions between genes, proteins, etc.
- The neural network composed by neurons in our brains.
- Social networks, i.e. the professional, friendship, and family ties that describe human behaviour.
- Communication networks, such as the internet and the www.
- The power grid, a network of generators and transmission lines supplying energy to our houses.
- Trade networks describing how we exchange products and goods.

Despite the fact that all these networks are very different in terms of their physical mechanisms, sizes, and purposes, they have many properties in common simply because their constituents interact similarly. One of these properties are the so-called small world property (or the 6-degrees of separation).

A new type of networks is currently under construction: quantum networks. These networks are composed by different laboratories connected by entangled quantum states. Given that quantum systems behave very differently from classical systems, we expect that quantum networks will display different properties than classical networks.

The goal of this project is to investigate quantum complex networks, i.e. networks composed by different laboratories connected by entangled states. The student will first study the basics of complex networks using the book *Network Science* by A. Barabási. Then she/he will consider quantum versions of these models and investigate the main properties, differences, and possible applications of them.

**Additional information :**

- \* Required skills : Basics of statistics and quantum mechanics.
- \* Miscellaneous :