Proposal for a doctoral research

Resource distribution for quantum networks

Keywords: Array

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Main scientific domain: Sciences and technologies of information and communication

Abstract of the research project (Language 1)

A key component of future quantum technologies will be quantum networks. With quantum networks, applications beyond point to point quantum key distribution (QKD) will be possible, like multi party quantum communication or cryptography, delegated quantum computing, or even simultaneous QKD with different pairs of clients. Another potential application of quantum networks is the distribution of quantum states between the various components of a quantum computer.

The theoretical study of quantum networks has only started in the last few years, and the methods to characterize them, and even the definition of the relevant figures of merit, is an active subject of research. Despite this, research in this field is highly dynamic, motivated by progresses in many experimental systems for quantum technologies — photonic qubits and continuous variables, cold-atom or solid state based quantum memories, hybrid superconductor–photonic systems, etc. —, which shows that quantum networks will likely be implemented soon.

This doctoral project will be centered around the theoretical study of quantum networks. This will involve the characterization and optimization of the distribution of resource states across a network — including bipartite and multipartite entangled states for quantum cryptography or communication, non-Gaussian or magic states for quantum computation, etc. We will study idealized models and universal figure of merits — e.g. noiseless networks with nodes able to perform arbitrary Clifford operations — in order to achieve an understanding of such systems, and also to bound the powers of networked adversaries in cryptographic protocols. We will also consider the strengths and imperfections of experimentally relevant systems — like e.g. the continuous variable systems developed by Eleni Diamanti in our team or by Nicolas Treps in the neighboring Laboratoire Kastler Brossel — and thus be part of the development of actual quantum networks.

Additional information (Language 1)

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The project addresses questions of both fundamental and applied nature, on a set of technologies which will be crucial for quantum computation and communication. The goal is to define a set of theoretical tools and protocols to characterize and optimize quantum networks, and to use them in proof-of-principle experimental demonstrations.

The doctoral candidate will work in a dynamic international context including multiple collaborations of the hosting QI team with groups in Europe and beyond.

The subject requires knowledge in quantum information theory.