Contextuality for quantum information networks

Contextuality and non-locality are two fundamental features of quantum mechanics which separate it from all classical theories. In essence they relate to the origin of randomness inherent in quantum measurement, and say that this cannot be reduced to ignorance of the physical set up (the origin of randomness in all classical theories).

In recent years we have understood that these two features have deep implications for quantum information with many applications including device independent security (where assumptions about functionality of devices can be circumnavigated) [1] and communication complexity [2]. Most recently we begin to understand that contextuality appears to be at the heart of computational advantage [3].

In this project the student will explore the role and application of contextuality and non-locality for quantum networks. They will look at how it can be applied for advantage in computational and communication tasks, as well as metrological ones. They will be to build on recent work by our team where we have developed a new family of contextuality witnesses, and their application for bounding dimension of the underlying physical system [4].

At the same time we will explore how proof of principle experiments can be implemented in quantum optics, in collaboration with experimental teams within the QI team in LIP6, and close collaborators

Throughout this theoretical study, the student will also be encouraged to consider and develop proof of principle experimental tests. In particular the QI team in LIP6 has strong theoretical and experimental components, and one of the advantages of this position is that we have good connection to experiments allowing us to demonstrate our ideas in practice, which will be important for their adoption in future quantum networks.

Informations complémentaires (Langue 1)

The project addresses questions of both fundamental and applied nature (foundations of quantum mechanics, applications for quantum networks, security and implementation in quantum optics).

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