Internship offer 2025/2026

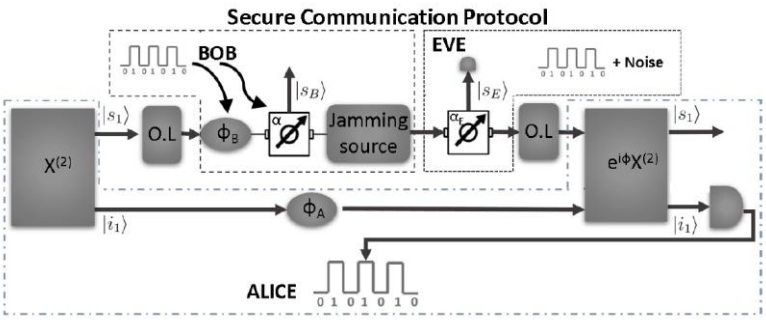
Laboratory: MPQ (Matériaux et Phénomènes Quantiques)
Director: C. Ciuti
Address: : 10, rue A. Domon et L. Duquet 75013 Paris
Person in charge of the internship: Maria Amanti (Team QITE)
e-mail: maria.amanti@u-paris.fr

Secure communication based on sensing of undetected photons

Scientific project:

Communication plays a crucial role in every aspect of our lives, and the preservation of data is indeed important for safeguarding personal and sensitive information. Photons are ideal carriers for communication because of their speed and low sensitivity to interlink interference. Nowadays, a global fiber-optic network, together with free-space optical links, provides high-bandwidth optical communications. In situations where sensitive data are involved, secure channels are imperative to prevent information leakage. Significant resources are invested in developing quantum secure communication technologies relying on the principles of quantum mechanics to create cryptographic systems that are theoretically immune to eavesdropping.

In the proposed work we introduce a protocol to secure classical optical communication leveraging on entangled photon sources [1]. This approach utilizes the age-old concept of concealing messages within seemingly meaningless signals and makes it fundamentally inviolable by means of quantum physics. The proposed scheme is readily compatible with conventional classical communication schemes based on amplitude and phase modulation and with the transfer of spatially encoded messages as twodimensional images. It obviates the requirement of current quantum protocols for generating randomness and employing information reconciliation procedures to evaluate the channel quality. In this work we will implement the writing of a classical message on an inviolable quantum channel. Furthermore, by harnessing nondegenerate entangled photon sources and capitalizing on the necessity for exclusive measurement of one photon in the pair, the proposed scheme offers a means to secure optica communication.



On the side a schematic representation of the communication protocol based on sensing of undetected photons [2].

The two users are Alice and Bob. A quantum source (χ^2) generates two photons on two different modes. $|s_1\rangle$ goes to Bob through an optical link while $|i_1\rangle$ stays at Alice's location. Bob writes the message on the phase (ϕ_B) or on the amplitude (α^2) before sending the message back to Alice. At her location a second quantum source is present ($e^{i\phi}\chi^2$). The bottom panel shows the scheme of the secure communication.

Eve is the eavesdropper who steals α^2_{Eve} of the mode $|s_1\rangle$. OL is the optical link. A jamming source is added by Bob to hide the message.

The interested student will work on the realisation of the experimental measurment of the proposed new secure communication as well as on its theoretical framework.

[1] J. Sternberg, J. Voisin, C. Roux, Y. Chassagneux, M. I. Amanti arXiv:2403.15557
[2] X. Y. Zou, L. J. Wang, and L. Mandel Phys. Rev. Lett. 67, 318

Methods and techniques: Single Photon detection, Quantum Interferometry.