PhD THESIS DEFENSE: Non-classical states of light: generation via strong-field processes and applications in quantum key distribution

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10:00

Auditorium and Online (Teams)

The dawn of the last century marked the onset of the first quantum revolution, a period characterized by groundbreaking discoveries culminating in the establishment of quantum mechanics. Over time, the abstract concepts introduced by this new branch of Physics, evolved into indispensable practical devices shaping our daily lives. This technological evolution spurred our actual era, centered around information exchange and acquisition, laying the foundation for what is now termed the second quantum revolution. This phase

aims to leverage quantum information science, which harnesses quantum mechanics' properties to propel advancements in information processing, communication, and computation, leading to revolutionary quantum technologies.
At the heart of advancing quantum technologies lies the exploration of what are known as non-classical states --physical manifestations exhibiting behaviors diverging from classical physics, necessitating the framework of quantum mechanics for explanation. Manipulating and generating these states delineates the frontier of progress in quantum technology. Therefore, it is crucial to devise methodologies for generating and controlling non-classical states. Photonics emerges as a promising platform within this context due to its robustness and exceptional manageability of this kind of states.
For the above reasons, this Thesis adopts a dual focus. Firstly, we delve into the generation of non-classical states of light through strong-field processes. These processes entail interactions between light and matter, where light intensities contend with the binding forces that keep electrons bound to their respective nuclei. Our exploration demonstrates the utility of strong-field phenomena in generating non-classical states of light, exhibiting intriguing features dependent on specific process dynamics and the materials involved in excitation. Secondly, we investigate the constraints and prerequisites of non-classical states of light sources --beyond those derived from the aforementioned strong-field processes-- for the advancement of quantum communication. In particular, we analyze quantum key distribution, aiming to create a secret key exclusively known by the communicating parties for encrypting and decrypting messages.
Therefore, this Thesis can be understood as a zeroth step towards leveraging strong-field physics as a prospective tool for quantum information science applications, as well as an exploration about the advances and limitations of photonic-based setups for quantum key distribution.

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