

How to exploit quantum principles **Bell non-locality** to advance communication technologies?

Lecture 0: Introduction

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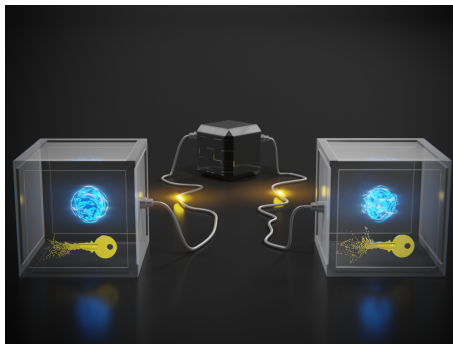


Figure 1: Illustration of a recently published article reporting on quantum key distribution certified by Bell's theorem (Nature 607, 681 (2022)). Credits : Scixel

This year's Nobel prize is for experimental work related to Bell tests. Two of this year's laureates, John Clauser and Alain Aspect, are honored for work that initiated a new era, often referred to as the "Second Quantum Revolution". Their experiments opened the eyes of the physics community to the importance of entanglement, and provided techniques for creating, processing and measuring Bell pairs in ever more complex and mind-boggling scenarios. The experimental work of the third Laureate, Anton Zeilinger, stands out for its innovative use of entanglement and Bell pairs, both in curiosity driven fundamental research and in applications such as quantum cryptography. As an example, Bell test based Quantum Key Distribution now provides security guarantees even if Eve has access to the quantum hardware that runs the key distribution.

These sentences are from the Royal Swedish Academy of Sciences. More precisely, they are slight modifications of the sentences that can be found in the report written by the Nobel committee to support their decision, see Scientific background.

The aim of this course is to show how Bell tests can be used to advance communication technologies. We will not only present the consequences of a Bell inequality violation, but also discuss how it can be used to certify randomness or guarantee the privacy of a key. This course will be a success if the attendees get an understanding of the importance of Bell-nonlocality, from the pioneer work of Aspect, Clauser and Zeilinger up to the most recent publications in which Bell tests were used for more applied physics. If the attendees feel that they can contribute to future developments along this line, please go ahead. I am convinced that the most exciting discoveries are to come.