Teleportation for the future of the Internet

Teleportation may sound as something belonging to the realm of Sci-Fi. What if we could make it real and use it? In a recent work published in Nature Photonics, researchers from Gröblacher Lab at the Quantum Nanoscience department of TU Delft and UNICAMP have controlled this effect to design repeaters for the future quantum internet.

Qubits are the basic unit of quantum information, and they promise great advances. One impressive effect is that the properties of one qubit can be transferred instantaneously over arbitrary long distances, an effect that we call **quantum teleportation**. This could lead to building a **Quantum Internet**, where repeaters based on quantum teleportation and quantum memories can help distribute information over large distances. This has been a major challenge over the past years.

In their work, Gröblacher and collaborators achieve quantum teleportation onto two **optomechanical resonators**: 10-micron-sized silicon devices whose vibration can be controlled using light. They use them to store the information from a qubit, without physical interacting with it! In their experiment they prepare the system by splitting a photon into two paths, each containing one mechanical resonator. Depending on the path followed, the photon will emerge with a certain polarization and be entangled with the motion of the resonators.

To use this system to transfer and store quantum information from an input qubit, they make the first photon interfere with this input qubit (also a photon). When this happens, the two resonators are instantaneously projected into the state of the input qubit: the teleportation effect. This way they store the information contained in the input qubit tens of meters away from it and in an instantaneous way. They also show the reliability of the process by retrieving the information of the input qubit by measuring the state of the mechanical resonators afterwards.

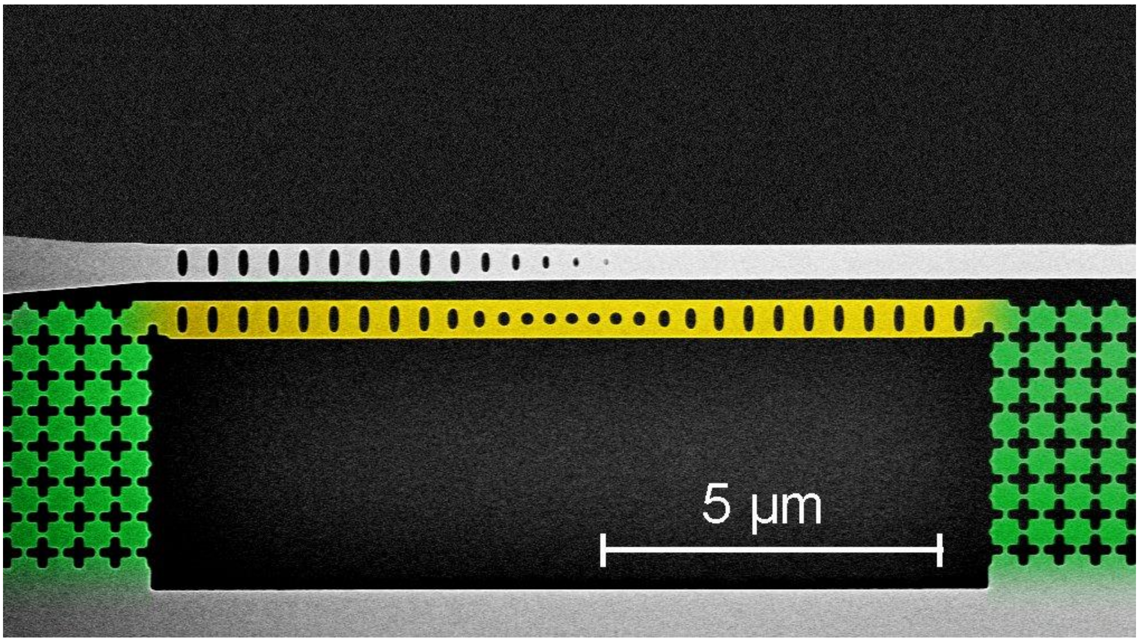
The breakthrough of this work is the use of optomechanical resonators to store quantum information. Their properties are freely designed and fabricated by the team, which make them able to work in the low-loss infrared telecom fibers wavelengths. Moreover, the resonators are massive objects (10 billion atoms each) normally ruled by classical mechanics. Creating a superposition of such a system is interesting from a fundamental perspective, serving as a platform to study the boundary between quantum and classical physics.

This way, their work is a major step in the realization of a Quantum Internet and opens the door to further studies testing quantum physics at a fundamental level. You can read the original paper *Optomechanical Quantum Teleportation* from Nature Photonics:

https://doi.org/10.1038/s41566-021-00866-z

Images:

Sketch of a Quantum Internet network [1].



False color microscope image of the Optomechanical resonators [2].

[1] TU Delft https://www.tudelft.nl/en/2019/tu-delft/kpn-and-qutech-join-forces-to-make-quantum-internet-a-reality

[2] Courtesy of Prof. Gröblacher.