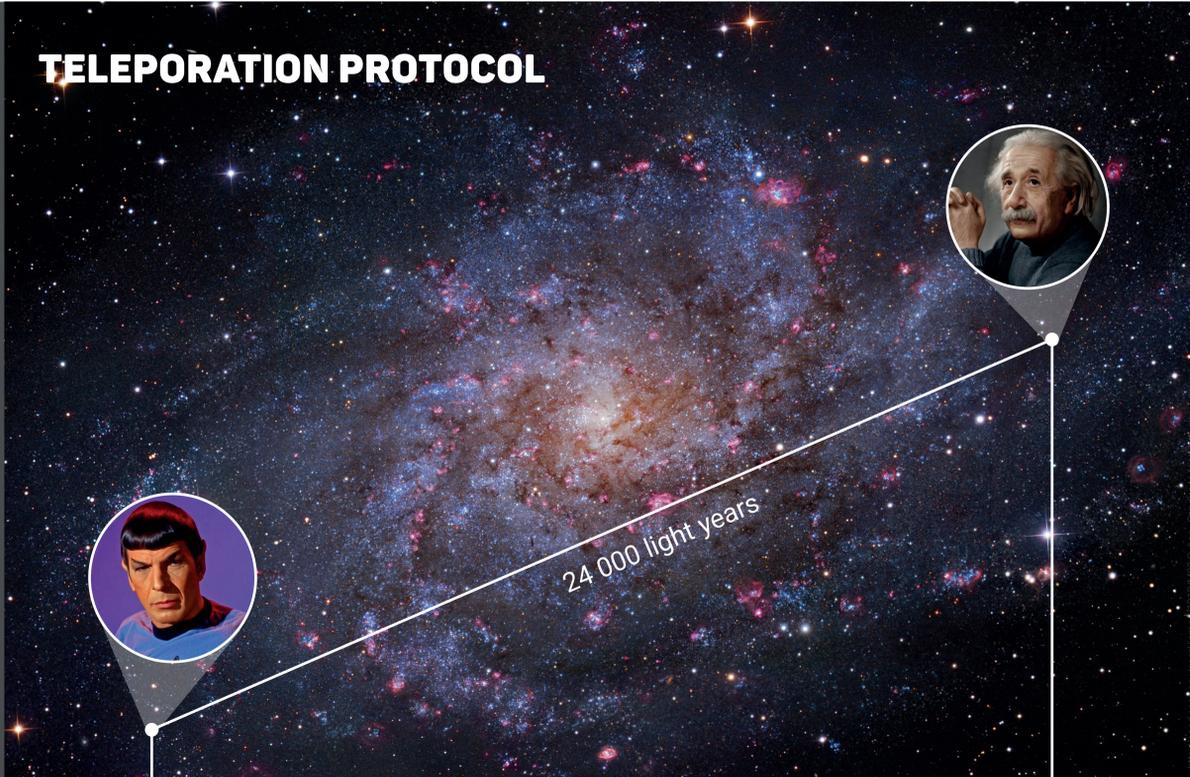


# QUANTUM INFORMATION

Laws of physics teach us that the ultimate information unit is the Quantum Bit. Quantum Bits (Qubits) are much stranger than their classical cousins 0/1.

## TELEPORTATION PROTOCOL



Dr Spock on the edge of our Milky Way galaxy wants to **transfer 1 qubit of information** to Dr Einstein.

They first set up a violet-pink spooky channel.

- Spock makes a special measurement to entangle violet-grey qubits,...

$\otimes \otimes = \begin{matrix} \color{red}\bullet \\ \color{red}\bullet \\ \color{red}\bullet \\ \color{red}\bullet \end{matrix}$  **Niels Bohr** had warned Einstein that there are 4 equally probable outcomes.

- Spock must communicate his outcome (among 00, 01, 10, 11) to Einstein.
- Spock sends his outcome 01 to Einstein with two classical flashes of light.

Einstein knew all along that he would wait 24000 years.

$\color{red}\bullet$  Eventually, Einstein receives 01 and correctly decodes.

Einstein never measures it otherwise the dice would roll.

## QUBIT

1 Qubit = Unit of quantum information stored in a single photon, electron, ion,...

$$|\theta, \varphi\rangle = \begin{matrix} \color{red}\bullet \\ \color{red}\bullet \end{matrix}$$

One day we might use Qubits to communicate and compute in ways that defy our fantasy.

## MEASUREMENTS

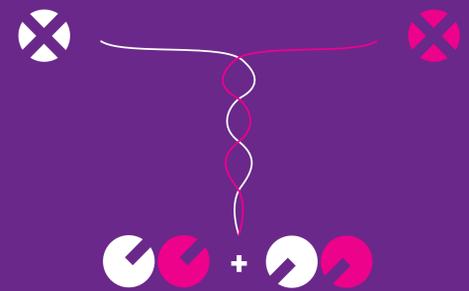
Measurements **randomly** project Qubits



When observing from a certain point of view, 2 measurements can occur, with random probabilities.

## ENTANGLEMENT

Pairs can be **entangled**:



**Quantum entanglement** is a physical phenomenon that occurs when pairs or groups of particles are generated or interact in ways such that the quantum state of each particle cannot be described independently – instead, a quantum state may be given for the system as a whole.

## NEAR FUTURE

- Today **photonic Qubits** are teleported on 10-100km and used in quantum crypto.
- Quantum networks are envisioned.

**Quantum networks** form an important element of quantum computing and quantum cryptography systems. Quantum networks **allow for the transportation of quantum information between physically separate quantum systems**. Secure communication can be implemented using quantum networks though quantum key distribution algorithms.

Optical quantum networks using **fiber optic** links or free-space links play an important role transmitting quantum states in the form of photons across large distances. Optical cavities can be used to trap single atoms and can serve as storage and processing nodes in these networks.

