Beam up my quantum state, Scotty!

FYST85

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Contents

1 Introduction

Bullet points

- Quantum teleportation protocol
- Why is it needed?
- Areas of application, quantum communications, quantum computers
- what is needed to realize it on a large scale, i.e. quantum repeaters, memory...
- EPR-pairs and bell basis

1.1 Preliminaries

In quantum teleportation the sender and receiver are referred to as Alice and Bob, and are denoted A and B respectively. Sometimes a third party is relevant which will be called Charlie and be denoted C.

1.1.1 EPR-pairs and the Bell Basis

An Einstein-Podolsky-Rosen-pair (EPR-pair) is a maximally entangled state of two qubits [1] which can be written as

$$\left|\Phi^{\pm}\right\rangle = \frac{|00\rangle \pm |11\rangle}{\sqrt{2}} \quad \text{and} \left|\Psi^{\pm}\right\rangle = \frac{|01\rangle \pm |10\rangle}{\sqrt{2}}. \tag{1}$$

When measuring a quantum state the basis of measurement is important as this determines the possible outcome states. Common basis used are the computational basis, consisting of $|0\rangle$ and $|1\rangle$, and the Bell basis consisting of the EPR-pairs, also known as Bell states, seen in Eq. (1). EPR-pairs and projective measurements in the Bell basis play a crucial role in quantum teleportation protocols. [1]

1.2 Quantum Teleportation Protocol

Good source? [2]

2 Experimental Evidence

Experimental evidence for quantum teleportation in quantum communications.

Bullet points

- Quantum teleportation has experimental evidence
- Experimental hurdles

2.1 Satellite Based

1400 km [3]

Bullet points

- Protocol used
- distance
- technical difficulties and innovations
- what does this mean for quantum communications?

2.2 Fibre Network Based

100 km [4]. Metropolitan [5]

Bullet points

- Protocol used
- distance
- technical difficulties and innovations
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3 Teleportation of Complex Quantum Systems

Bullet points

- What is a complex system?
- How does the protocol differ from simple systems?
- Why is it important to be able to teleport complex quantum systems?
- Theoretical and experimental limits

4 Quantum Repeaters and Quantum Memory

Quantum internet [6]

Bullet points

- quantum repeater analogues to normal repeater?
- How to realize quantum memory
- why do we need quantum memory for quantum repeaters
- how much does a quantum repeater reduce attenuation
- how good are today's quantum repeaters?

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