http://www.technologyreview.com/view/427910/chinese-physicists-smash-distance-record-for-teleportation/

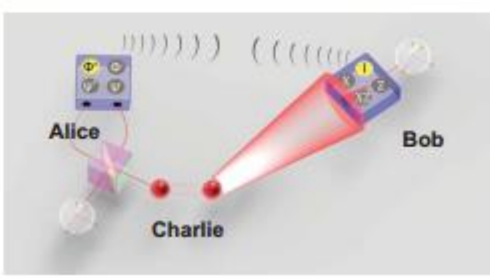
MIT Technology Review

Emerging Technology From the arXiv

May 11, 2012

Chinese Physicists Smash Distance Record For Teleportation

The ability to teleport photons through 100 kilometres of free space opens the way for satellite-based quantum communications, say researchers



Teleportation is the extraordinary ability to transfer objects from one location to another without travelling through the intervening space.

The idea is not that the physical object is teleported but the information that describes it. This can then be applied to a similar object in a new location which effectively takes on the new identity.

And it is by no means science fiction. Physicists have been teleporting photons since 1997 and the technique is now standard in optics laboratories all over the world.

The phenomenon that makes this possible is known as quantum entanglement, the deep and mysterious link that occurs when two quantum objects share the same existence and yet are separated in space.

Teleportation turns out to be extremely useful. Because teleported information does not travel through the intervening space, it cannot be secretly accessed by an eavesdropper.

For that reason, teleportation is the enabling technology behind quantum cryptography, a way of sending information with close-to-perfect secrecy.

Unfortunately, entangled photons are fragile objects. They cannot travel further than a kilometre or so down optical fibres because the photons end up interacting with the glass breaking the entanglement. That severely limits quantum cryptography's usefulness.

However, physicists have had more success teleporting photons through the atmosphere. In 2010, a Chinese team announced that it had teleported single photons over a distance of 16 kilometres. Handy but not exactly Earth-shattering.

Now the same team says it has smashed this record. Juan Yin at the University of Science and Technology of China in Shanghai, and a bunch of mates say they have teleported entangled photons over a distance of 97 kilometres across a lake in China.

That's an impressive feat for several reasons. The trick these guys have perfected is to find a way to use a 1.3 Watt laser and some fancy optics to beam the light and receive it.

Inevitably photons get lost and entanglement is destroyed in such a process. Imperfections in the optics and air turbulence account for some of these losses but the biggest problem is beam widening (they did the experiment at an altitude of about 4000 metres). Since the beam spreads out as it travels, many of the photons simply miss the target altogether.

So the most important advance these guys have made is to develop a steering mechanism using a guide laser that keeps the beam precisely on target. As a result, they were able to teleport more than 1100 photons in 4 hours over a distance of 97 kilometres.

That's interesting because it's the same channel attenuation that you'd have to cope with when beaming photons to a satellite with, say, 20 centimetre optics orbiting at about 500 kilometres. "The successful quantum teleportation over such channel losses in combination with our high-frequency and high-accuracy [aiming] technique show the feasibility of satellite-based ultra-long-distance quantum teleportation," say Juan and co.

So these guys clearly have their eye on the possibility of satellite-based quantum cryptography which would provide ultra secure communications around the world. That's in stark contrast to the few kilometres that are possible with commercial quantum cryptography gear.

Of course, data rates are likely to be slow and the rapidly emerging technology of quantum repeaters will extend the reach of ground-based quantum cryptography so that it could reach around the world, in principle at least.

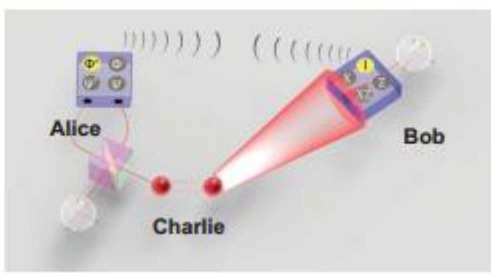
But a perfect, satellite-based security system might be a useful piece of kit to have on the roof of an embassy or distributed among the armed forces.

Something for western security experts to think about.

Ref: arxiv.org/abs/1205.2024: Teleporting Independent Qubits Through A 97 Km Free-Space Channel

Chinese Physicists Smash Distance Record For Teleportation

The ability to teleport photons through 100 kilometres of free space opens the way for satellite-based quantum communications, say researchers



Teleportation is the extraordinary ability to transfer objects from one location to another without travelling through the intervening space.

The idea is not that the physical object is teleported but the information that describes it. This can then be applied to a similar object in a new location which effectively takes on the new identity.

And it is by no means science fiction. Physicists have been teleporting photons since 1997 and the technique is now standard in optics laboratories all over the world.

The phenomenon that makes this possible is known as quantum entanglement, the deep and mysterious link that occurs when two quantum objects share the same existence and yet are separated in space.

Teleportation turns out to be extremely useful. Because teleported information does not travel through the intervening space, it cannot be secretly accessed by an eavesdropper.

For that reason, teleportation is the enabling technology behind quantum cryptography, a way of sending information with close-to-perfect secrecy.

Unfortunately, entangled photons are fragile objects. They cannot travel further than a kilometre or so down optical fibres because the photons end up interacting with the glass breaking the entanglement. That severely limits quantum cryptography’s usefulness.

However, physicists have had more success teleporting photons through the atmosphere. In 2010, a Chinese team announced that it had teleported single photons over a distance of 16 kilometres. Handy but not exactly Earth-shattering.

Now the same team says it has smashed this record. Juan Yin at the University of Science and Technology of China in Shanghai, and a bunch of mates say they have teleported entangled photons over a distance of 97 kilometres across a lake in China.

That's an impressive feat for several reasons. The trick these guys have perfected is to find a way to use a 1.3 Watt laser and some fancy optics to beam the light and receive it.

Inevitably photons get lost and entanglement is destroyed in such a process. Imperfections in the optics and air turbulence account for some of these losses but the biggest problem is beam widening (they did the experiment at an altitude of about 4000 metres). Since the beam spreads out as it travels, many of the photons simply miss the target altogether.

So the most important advance these guys have made is to develop a steering mechanism using a guide laser that keeps the beam precisely on target. As a result, they were able to teleport more than 1100 photons in 4 hours over a distance of 97 kilometres.

That's interesting because it's the same channel attenuation that you'd have to cope with when beaming photons to a satellite with, say, 20 centimetre optics orbiting at about 500 kilometres. "The successful quantum teleportation over such channel losses in combination with our high-frequency and high-accuracy [aiming] technique show the feasibility of satellite-based ultra-long-distance quantum teleportation," say Juan and co.

So these guys clearly have their eye on the possibility of satellite-based quantum cryptography which would provide ultra secure communications around the world. That's in stark contrast to the few kilometres that are possible with commercial quantum cryptography gear.

Of course, data rates are likely to be slow and the rapidly emerging technology of quantum repeaters will extend the reach of ground-based quantum cryptography so that it could reach around the world, in principle at least.

But a perfect, satellite-based security system might be a useful piece of kit to have on the roof of an embassy or distributed among the armed forces.

Something for western security experts to think about.

Ref: arxiv.org/abs/1205.2024: Teleporting Independent Qubits Through A 97 Km Free-Space Channel

http://arxiv.org/abs/1205.2024

Quantum Physics

Title:Quantum teleportation and entanglement distribution over 100-kilometre free-space channels

Authors: Juan Yin, Ji-Gang Ren, He Lu, Yuan Cao, Hai-Lin Yong, Yu-Ping Wu, Chang Liu, Sheng-Kai Liao, Fei Zhou, Yan Jiang, Xin-Dong Cai, Ping Xu, Ge-Sheng Pan, Jian-Jun Jia, Yong-Mei Huang, Hao Yin, Jian-Yu Wang, Yu-Ao Chen, Cheng-Zhi Peng, Jian-Wei Pan
(Submitted on 9 May 2012 (v1), last revised 28 Jan 2013 (this version, v2))
Abstract: A long standing goal for quantum communication is to transfer a quantum state over arbitrary distances. Free-space quantum communication provides a promising solution towards this challenging goal. Here, through a 97-km free space channel, we demonstrate long distance quantum teleportation over a 35-53 dB loss one-link channel, and entanglement distribution over a 66-85 dB high-loss two-link channel. We achieve an average fidelity of {80.4(9)}% for teleporting six distinct initial states and observe the violation of the Clauser-Horne-Shimony-Holt inequality after distributing entanglement. Besides being of fundamental interest, our result represents a significant step towards a global quantum network. Moreover, the high-frequency and high-accuracy acquiring, pointing and tracking technique developed in our experiment provides an essential tool for future satellite-based quantum communication.

Comments:	9 pages, 8 figures
Subjects:	Quantum Physics (quant-ph)
Journal reference:	Nature 488 185-188 (2012)
DOI:	10.1038/nature11332
Cite as:	arXiv:1205.2024 [quant-ph]
	(or arXiv:1205.2024v2 [quant-ph] for this version)

Submission history

Quantum Physics

Title:Quantum teleportation and entanglement distribution over 100-kilometre free-space channels

Authors: Juan Yin, Ji-Gang Ren, He Lu, Yuan Cao, Hai-Lin Yong, Yu-Ping Wu, Chang Liu, Sheng-Kai Liao, Fei Zhou, Yan Jiang, Xin-Dong Cai, Ping Xu, Ge-Sheng Pan, Jian-Jun Jia, Yong-Mei Huang, Hao Yin, Jian-Yu Wang, Yu-Ao Chen, Cheng-Zhi Peng, Jian-Wei Pan
(Submitted on 9 May 2012 (v1), last revised 28 Jan 2013 (this version, v2))
Abstract: A long standing goal for quantum communication is to transfer a quantum state over arbitrary distances. Free-space quantum communication provides a promising solution towards this challenging goal. Here, through a 97-km free space channel, we demonstrate long distance quantum teleportation over a 35-53 dB loss one-link channel, and entanglement distribution over a 66-85 dB high-loss two-link channel. We achieve an average fidelity of {80.4(9)}% for teleporting six distinct initial states and observe the violation of the Clauser-Horne-Shimony-Holt inequality after distributing entanglement. Besides being of fundamental interest, our result represents a significant step towards a global quantum network. Moreover, the high-frequency and high-accuracy acquiring, pointing and tracking technique developed in our experiment provides an essential tool for future satellite-based quantum communication.

Comments:	9 pages, 8 figures
Subjects:	Quantum Physics (quant-ph)
Journal reference:	Nature 488 185-188 (2012)
DOI:	10.1038/nature11332
Cite as:	arXiv:1205.2024 [quant-ph]
	(or arXiv:1205.2024v2 [quant-ph] for this version)

Submission history