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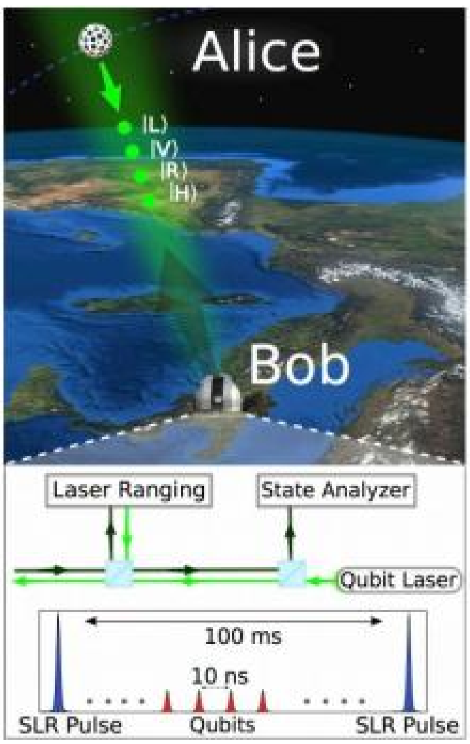
Researchers bounce polarized photons off satellites to show feasibility of space based quantum communications

June 30 2014, by Bob Yirka



Scheme of the Satellite QKD demonstration. Qubit pulses are sent at 100 Mhz repetition rate and are reflected back at the single photon level from the satellite, thus mimicking a QKD source on Space. Synchronization is performed by using the bright SLR pulses at repetition rate of 10 Hz. Credit: arXiv:1406.4051 [quant-ph]

(Phys.org) —A team of researchers working at the University of Padua in Italy has bounced polarized photons off of four in-flight satellites to show that quantum communications between such satellites and ground based stations is possible. The team has uploaded a paper they've written to the preprint server *arXiv*, describing their work and what it might mean for future quantum transmissions through space.

Scientists have figured out how to send quantum communications through fiber cables, but only for short distances as the photons tend to be absorbed by the glass at some point. Other scientists have successfully sent quantum communications directly through the air, but again only for short distances (the record is 144 kilometers) because of interference. In this latest experiment, the team in Italy bounced photons off satellites to show that quantum communications between ground based stations and satellites should be possible.

Up till now, most scientists have believed sending quantum messages between earth and space isn't feasible due to interference in the atmosphere—the error rate threshold has been found to be 11 percent. Above that limit, quantum cryptography won't work. Holding up such research has been the lack of satellites that can be used for testing purposes. In this new effort, the researchers found a way to use existing satellites for their purposes.

The team singled out four currently orbiting satellites with metallic corner-cube retroreflectors—bouncing photons off them, the researchers concluded, would preserve polarization, making them suitable for testing quantum communications possibilities. They also selected another satellite also in orbit that has uncoated corner-cube retroreflectors as a control. They sent photons to all of the satellites from the Matera Laser Ranging Observatory when each was directly overhead (minimizing the distance the photons would have to travel through the atmosphere) and measured what was bounced back to them. In so doing, they found the control satellite had a high error rate, as expected—it was approximately

50 percent. But the other four, the team found, were all below the 11 percent threshold, indicating that satellites sent aloft with the capability of producing coherent photons, should be able to conduct perfectly secure quantum communications (using quantum key distribution) with ground based stations.

More progress is likely to come soon as China plans to send a satellite into orbit in 2016 for the express purpose of conducting quantum communications research. Other countries are working on their own programs as well, with many likely being conducted in secret.

More information: Experimental Satellite Quantum Communications, arXiv:1406.4051 [quant-ph] arxiv.org/abs/1406.4051

Abstract
Quantum Communications on planetary scale require complementary channels including ground and satellite links. The former have progressed up to commercial stage using fiber-cables, while for satellite links, the absence of terminals in orbit has impaired theirs development. However, the demonstration of the feasibility of such links is crucial for designing space payloads and to eventually enable the realization of protocols such as quantum-key-distribution (QKD) and quantum teleportation along satellite-to-ground or intersatellite links. We demonstrated the faithful transmission of qubits from space to ground by exploiting satellite corner cube retroreflectors acting as transmitter in orbit, obtaining a low error rate suitable for QKD. We also propose a two-way QKD protocol exploiting modulated retroreflectors that necessitates a minimal payload on satellite, thus facilitating the expansion of Space Quantum Communications.