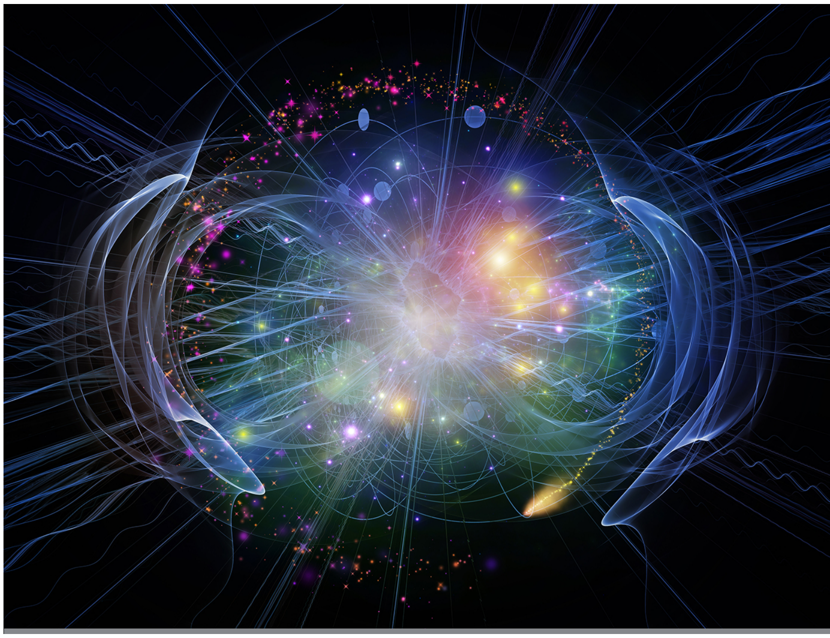


National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Communications

Secure Optical Quantum Communications

Novel production and use of entangled-photon pairs enhances quantum communications capability

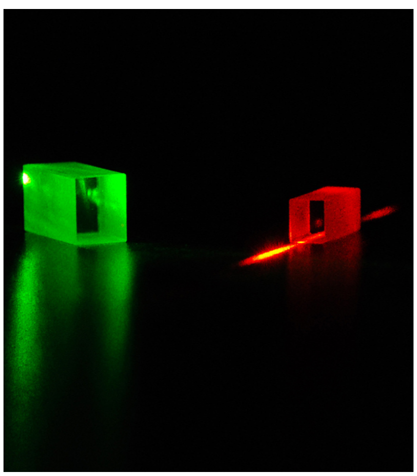
NASA's Glenn Research Center has developed a method of using entangled-photon pairs to produce highly secure mobile communications that require mere milliwatts of power. Conventional gas Argon-ion laser sources are too large, expensive, and power-intensive to use in portable applications. By contrast, Glenn's patented optical quantum communication method produces entangled-photon pairs approximately a million times more efficiently than conventional sources, in a system that is small and light enough to be portable. Furthermore, because this method transmits digital information by detecting small temporal shifts between entangled photons, its superior signal-to-noise ratio facilitates highly secure communications in very noisy free space and fiber-optic environments. Originally developed for micro-robots used for deep space exploration, this technology represents a breakthrough for a wide variety of terrestrial, scientific, military, and other field-deployable applications including fiber-optic and satellite communications.

BENEFITS

- Highly secure: Hides secure code in the difference of the entangled-photon pair, making interception impossible, even with current state-of-the-art technology
- Efficient: Transmits information at very low power levels (less than a nanowatt), while using a limited number of photons
- Versatile: Can be used in free space and with fiber optic cables
- Economical: Permits the use of low-cost, off-the-shelf optical coatings and components
- Compact and transportable: Enables numerous in-field applications not previously possible

THE TECHNOLOGY

In the prior art, the systems that produced photon pairs took up a great deal of space on a laboratory table, weighed several hundred pounds, consumed tens of kilowatts of electrical power, and required cooling water. These limitations greatly restricted the utility of quantum communications systems, which rely on these photon pairs. To address this issue, Glenn's innovators developed a novel system that uses a laser source, a pair of nonlinear crystals in optical contact with each other, and a fiber coupling point configured to receive a pair of single mode fibers. Pairs of polarization-entangled photons are produced through spontaneous parametric down conversion of the laser beam and provided to the fiber coupling point. The optical signal is coded at the transmitter by modulating the inter-beam delay time between pairs of entangled photons. The inter-beam delay will determine whether the photon pairs are absorbed by a fluorescer in the receiver. When absorbed, the photon pairs cause a fluorescent optical emission that a photon detector identifies. One advantage of this system is that it eliminates the need for a coincidence counter to realize the entanglement-based secure optical communications, because the absorber acts as a coincidence counter for entangled photon pairs. In addition, this modulation spectroscopy technique is ultra-secure since the delay times are very short (femtoseconds) and unresolvable by conventional photon detectors. Finally, the system uses solid-state, monolithic construction that allows for cost-effective batch-manufacturing techniques. This technology represents a significant breakthrough in the fields of communications, optics, cryptography, and surveillance.



Glenn's novel method uses crystals to store entangled photons, producing highly efficient and effective quantum communications

This system will provide laser communications services to NASA spacecraft, such as the Orion Crew Exploration Vehicle illustrated above

APPLICATIONS

The technology has several potential applications:

- Fiber optic communication systems
- Free-space laser communication systems
- Satellite communications
- Defense technologies
- Airborne communications
- Surveillance systems
- Communications between micro-robots
- Unmanned aerial vehicle surveillance communications
- Secure line-of-sight optical communication links

PUBLICATIONS

Patent No: 8,717,666; 7,574,137; 8,995,842

technology.nasa.gov

More Information

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