Broadband in space thanks to new single-photon detector

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Broadband might be entering into space thanks to a collective team of MIT researchers developing a tiny light detector that could help speed up data transmission from planetary probes to Earth. This is just the latest breakthrough on the nanotechnology front, which could keep costs low in one aspect of space communication.

"Half the battle is getting the probe up in space, but getting information back quickly and not limited is also important -- the reason for the probe to go up there in the first place," said Karl Berggren, assistant professor in the Department of Electrical Engineering and Computer Science.

It can take hours with existing wireless radio frequency to get useful scientific information back from Mars to Earth, but using an optical link can speed up the process, according to Berggren.

In better context, he suggests that with the latest probe to Pluto, it took two weeks to orbit the planet and nine months for data transmission which is slow and could limit data.

As Berggren describes it, this would mean that as a single photon is absorbed and transmitted down to earth, the beam gradually becomes wider, and collecting it using a telescope could compromise or lose data since telescopes only collect a fraction of that wide beam.

But with the light detector, that he and his colleagues developed, information transmission from space to earth could be more efficient and faster.

Berggren along with colleagues from MIT's Research Laboratory of Electronics, Lincoln Laboratory and Moscow State Pedagogical University developed the device featured in the January 23 issue of *Optics Express*.

The space application of nanotechnology came after MIT's Lincoln Laboratory worked with NASA in coming up with the first laser communication link between Mars and Earth in 2004.

And the technology that that team came up with would have been used in the 2010 launch of the Mars Telecommunications Orbiter spacecraft, if it were not for budget problems, canceling the project in July 2005.

According to NASA, the maximum data rate transmission is 128,000 bits per second using radio waves from the Mars Odyssey spacecraft to Earth, but using the researchers' detector could speed up that transmission significantly.

The new detector improves detection efficiency for single photons from 20 percent to 57 percent at a wavelength of 1,550 nanometers, according to researchers.

Current single-photon detectors are either sensitive or too slow.

And while a typical detector could transmit information 100 kilobits per second which is 100,000 bits per second, their detector which could transmit at 300 megabits per second or 300 million bits per second, Berggren said.

Using nanowires and superconductor technology, the detector is able to sense low light or small laser signals in the infrared part of the optical spectrum down to a single photon -- impossible using conventional optical systems, researchers say.

And in order for interplanetary communication to take place and the detector to work accurately, a large laser and a lot of power would be needed to send information at a high rate down to Earth.

But with the single-photon detector sensing small laser signals, this means not much power is required by a spaceship to transmit data and could be more cost-effective for planetary researchers, since the detector acts as a receiver on Earth.

Moreover, to make the detector more efficient, Berggren and his team added a "photon cavity" or type of photon trap to collect photons that reflect or transmit since in order to detect a beam, they must be absorbed.

The photon trap contains a measured gap of glass, a mirror, and a tightly coiled nanowire resembling the metal on the back of refrigerator that would broaden its area of overlap with the laser light.

Also, included is anti-reflection coating to keep light from reflecting off the surface.

The wire, however, must be cooled to above absolute zero in order to become a superconductor, thus allowing for photons to be absorbed.

If it's not absorbed, then the wire permits photons to bounce between the coil and the mirror, so that greater absorption, could take place.

Such technology, the researches hope, could eventually allow for real-time information to be collected in space and sent to Earth.

This could be the answer to enabling quicker transmission of color video between astronauts or robots in space and scientists on Earth.

The researchers, though, are back at work, making the detector more efficient and fast.