Georgia Tech

Research News

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NO GOGGLES REQUIRED: RELIABLE INEXPENSIVE EYE-SAFE LIDAR OPENS NEW APPLICATIONS FOR ATMOSPHERIC STUDY

Researchers at the Georgia Institute of Technology have successfully demonstrated a reliable and relatively inexpensive eye-safe lidar which could open up new applications for the increasingly important light detection and ranging technology.

Lidars are used to study atmospheric chemistry, cloud layers, wind velocities, dust clouds and other phenomena. But because they use high-powered lasers, great care must be taken to prevent damaging the eyes of researchers, occupants of passing aircraft, or others who may encounter the intense light beam. These safety restrictions severely limit use of the lidars.

But by firing their laser through a tube of pressurized methane gas -- using a procedure known as Stimulated Raman Scattering -- the Georgia Tech researchers shift their laser light from an eye-damaging wavelength to one that will not harm the eyes.

"This could be used in almost any situation where you want to use lidars that are pointing away from vertical, or anywhere there is possibility of having people in the path," said Ed Patterson, senior research scientist in Georgia Tech's School of Earth and Atmospheric Sciences.

In field tests, the Georgia Tech eye-safe lidar has measured clouds 11 kilometers in altitude (about 37,000 feet), and atmospheric aerosols as much as four kilometers away. Patterson believes that range would be sufficient for a number of applications, including:

* Continuous monitoring near airports to detect potentially damaging wind shear and other turbulence. Eye-safe airport lidars could also measure visibility and cloud ceiling, giving pilots a more accurate picture of conditions.

Visibility is now measured at ground level, but an airport lidar could make those measurements at higher elevations -- closer to where the pilots are actually flying.

* Monitoring atmospheric visibility during military field tests of new sensor systems.

"We want to measure aerosols and haze along the same line-of-sight path that the sensor is using," explained Gary Gimmestad, principal research scientist in Tech's Electromagnetics Laboratory. "We want to point our lidar system along the same path to calculate the transparency of the atmosphere to understand sensor performance."

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Because of danger to aircraft pilots and other personnel present for the tests, current lidars cannot be used.

* Continuous monitoring of pollution sources such as factories to detect the types and amounts of chemicals released. Such monitoring would require the ability to scan the lidar -- dangerous without an eye-safe device.

* Autonomous operation, where the lidar takes consistent measurements to develop long-term data sets.

Eye-safe carbon dioxide lidars have existed for years, but they are bulky and require frequent maintenance. Detection equipment used to measure atmospheric backscatter from the carbon dioxide lasers must be cooled with liquid nitrogen.

By contrast, the eye-safe lidar developed at Georgia Tech uses commercially available components which operate reliably at room temperature. The Raman shifted lidar also operates at a wavelength close to what the eyes actually see -- useful when measuring visibility, Gimmestad noted.

The Raman Scattering shifts a neodymium-YAG laser from a wavelength of 1.06 microns to 1.54 microns. Because light at that particular wavelength passes through the atmosphere with little absorption, it is ideal for lidar use.

"It's in a region that is close to the visible, and it's in a region to which detectors are quite sensitive," explained Patterson. "We can get a sensitive lidar that is useful for visibility measurements, and for infrared bands of interest with various sensor systems."

Because of its wavelength, light from the eye-safe lidar would be absorbed by the eye's aqueous humor and cannot be focused on the retina where it could do damage. It can therefore be operated at much higher power levels than lidars operating in visible light wavelengths. When using lasers operating at wavelengths that can be transmitted to the retina, researchers must wear bulky protective goggles and have rooftop spotters or radars ready to interrupt the beam if aircraft approach.

Lidars shoot concentrated light beams high into the atmosphere, then measure the "backscatter," or light reflected from particles there. By collecting this backscatter in a telescope, researchers can learn about the atmosphere.

Lidars have replaced balloons or sounding rockets in many cases, and perform many of the same functions as radar, which relies on radio waves instead of light.

The more powerful the laser, the more sensitive can be the measurements, Patterson noted: "Within the limits of the standards, which are based on medical and tissue tests, you can use 20,000 times more power at these eye-safe wavelengths than in the visible wavelengths."

Preliminary data was presented at the Conference on Lasers and Electro Optics in April and more information was presented to the Annual Meeting of the Optical Society of America October 19. An article has been accepted for December publication in Applied Optics.

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