Researchers use laser amplifier to slow light at room temperature

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Researchers at the University of California, Berkeley, have made a dramatic advance in their quest to slow light down for applications in speedier communication networks.
The research team, led by Connie J. Chang-Hasnain, UC Berkeley professor of electrical engineering and computer sciences, has created a device that uses a laser amplifier to slow the speed of light more than one million-fold. The researchers clocked the speed of light at 245 meters per second, or three-quarters the speed of sound in air. Moreover, the team did this at room temperature.

The experiment is described in the journal *Optics Express*, published yesterday (Monday, Oct. 3). The researchers built upon work completed one year ago in which they slowed light by a factor of 31,000 times, or 6 miles per second.

"Last year, UC Berkeley researchers were able to use coherent population oscillation in semiconductors to slow light down, but this method required temperatures as low as 10 degrees Kelvin," said Xiaoxue Zhao, a UC Berkeley graduate student in electrical engineering and computer sciences and lead author of the paper. "This year, we got a state-of-the-art laser and used it as an amplifier to adjust the velocity of light at room temperature, making it more practical and effective."

By lowering the electrical current applied to a vertical cavity surface emitting laser - the same type of laser used in an optical mouse - the researchers were able to use the device as an amplifier to pump up the

signals of the light passing through it. As the electrical current injected into the laser cavity increases, the velocity of light decreases.

"This method has the added benefit of allowing us to significantly vary the speed of light," said Bala Pesala, a UC Berkeley graduate student in electrical engineering and computer sciences and co-author of the paper. "By varying the electrical current, we can adjust the frequency delay by as much as 100 picoseconds for a 2.8 gigahertz broadband signal."

In optoelectronics, adjusting the speed of light is part of an effort to overcome a bottleneck in optical communications. Optical signals speed along fiber networks, but are then jammed as they hit an intersection, or router. At these intersections, light signals are converted to slower moving electronic data to be directed to the correct path before being switched back to light, a process known as optical-electronic-optical (OEO) conversion.

"Controlling the speed of light along these networks could ultimately eliminate the need for these OEO conversions, which are both slow and costly to power," said Chang-Hasnain, principal investigator of the project and director of UC Berkeley's Center for Optoelectronic Nanostructured Semiconductor Technologies. "Without this traffic jam, we could easily transmit 3-D graphics and ultra high-resolution video, among other applications."

Prior experiments have demonstrated that light beams can be slowed through atomic vapor as well as solid-state crystal. But Chang-Hasnain points out that semiconductors have 1 million to 1 billion times broader bandwidth capacity than atomic gas or crystal, making them more practical for network communication applications.

The researchers hope to eventually freeze light in its tracks, which would open doors to a world of optical memory and storage. "Imagine if we

could store the entire contents of the Library of Congress in one flash memory card," said Chang-Hasnain. "That's still many, many years off, but a number of researchers are working towards this objective. In this effort, the words of the poet William Blake seem appropriate. He wrote, 'Hold infinity in the palm of your hand, and eternity in an hour.' That describes what we're trying to do."

Other co-authors of the paper are Phedon Palinginis, a UC Berkeley graduate student in electrical engineering and computer sciences, and Philip Hemmer, associate professor of electrical engineering at Texas A&M University.

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Source: UC Berkeley