In a major breakthrough, scientists control light propagation in photonic chips

July 10 2011

Researchers at Columbia Engineering School have built optical nanostructures that enable them to engineer the index of refraction and fully control light dispersion. They have shown that it is possible for light (electromagnetic waves) to propagate from point A to point B without accumulating any phase, spreading through the artificial medium as if the medium is completely missing in space. This is the first time simultaneous phase and zero-index observations have been made on the chip-scale and at the infrared wavelength.

The study, to be published on Nature Photonics's website July 10, was led by Chee Wei Wong, associate professor of mechanical engineering, and Serdar Kocaman, electrical engineering PhD candidate, both at Columbia Engineering, in collaboration with scientists at the University College of London, Brookhaven National Laboratory, and the Institute of Microelectronics of Singapore.

"We're very excited about this. We've engineered and observed a metamaterial with zero refractive index," said Kocaman. "What we've seen is that the light disperses through the material as if the entire space is missing. The oscillatory phase of the electromagnetic wave doesn't even advance such as in a vacuum — this is what we term a zero-phase delay."

This exact control of optical phase is based on a unique combination of negative and positive refractive indices. All natural known materials have a positive refractive index. By sculpturing these artificial

subwavelength nanostructures, the researchers were able to control the light dispersion so that a negative refractive index appeared in the medium. They then cascaded the negative index medium with a positive refractive index medium so that the complete nanostructure behaved as one with an index of refraction of zero.

"Phase control of photons is really important," said Wong. "This is a big step forward in figuring out how to carry information on photonic chips without losing control of the phase of the light."

"We can now control the flow of light, the fastest thing known to us," he continued. "This can enable self-focusing light beams, highly directive antennas, and even potentially an approach to cloak or hide objects, at least in the small-scale or a narrow band of frequencies currently."

Provided by Columbia University

Citation: In a major breakthrough, scientists control light propagation in photonic chips (2011, July 10) retrieved 1 May 2024 from
https://phys.org/news/2011-07-major-breakthrough-scientists-propagation-photonic.html