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# Engineers show light can play seesaw at the nanoscale

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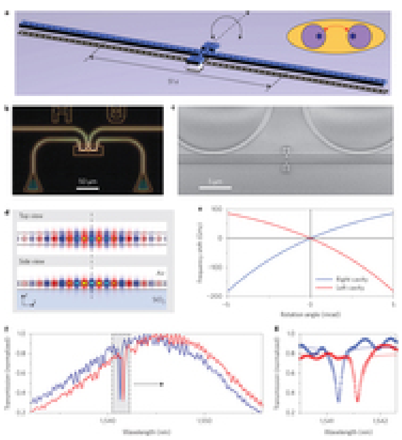

Credit: *Nature Nanotechnology* (2014) doi:10.1038/nnano.2014.200

University of Minnesota electrical engineering researchers have developed a unique nanoscale device that for the first time demonstrates mechanical transportation of light. The discovery could have major implications for creating faster and more efficient optical devices for computation and communication.

The research paper by University of Minnesota electrical and computer engineering assistant professor Mo Li and his graduate student Huan Li has been published online and will appear in the October issue of *Nature Nanotechnology*.

Researchers developed a novel nanoscale device that can capture, measure and transport fundamental particles of light, called photons. The tiny device is just .7 micrometers by 50 micrometer (about .00007 by .005 centimeters) and works almost like a seesaw. On each side of the "seesaw benches," researchers etched an array of holes, called photonic crystal cavities. These cavities capture photons that streamed from a nearby source.

Even though the particles of light have no mass, the captured photons were able to play seesaw because they generated optical force. Researchers compared the optical forces generated by the photons captured in the cavities on the two sides of the seesaw by observing how the seesaw moved up and down. In this way, the researchers weighed the photons. Their device is sensitive enough to measure the force generated by a single photon, which corresponds to about one-third of a thousand-trillionth of a pound or one-seventh of a thousand-trillionth of a kilogram.

Professor Li and his research team also used the seesaw to experimentally demonstrate for the first time the mechanical control of transporting light.

"When we filled the cavity on the left side with photons and leave the cavity on the right side empty, the force generated by the photons started to oscillate the seesaw. When the oscillation was strong enough, the photons can spill over along the beam from the filled cavity to the empty cavity during each cycle," Li said. "We call the phenomenon 'photon shuttling.'"

The stronger the oscillation, the more photons are shuttled to the other side. Currently the team has been able to transport approximately 1,000 photons in a cycle. For comparison, a 10W light bulb emits 1020 photons every second. The team's ultimate goal is to transport only one photon in a cycle so that the quantum physics of light can be revealed and harnessed.

"The ability to mechanically control photon movement as opposed to controlling them with expensive and cumbersome optoelectronic devices could represent a significant advance in technology," said Huan Li, the lead author of the paper.

The research could be used to develop an extremely sensitive micromechanical way to measure acceleration of a car or a runner, or could be used as part of a gyroscope for navigation, Li said.

In the future, the researchers plan to build sophisticated photon shuttles with more traps on either side of the seesaw device that could shuttle photons over greater distances and at faster speeds. They expect that such devices could play a role in developing microelectronic circuits that would use light instead of electrons to carry data, which would make them faster and consume less power than traditional integrated circuits.

**More information:** Optomechanical photon shuttling between photonic cavities, *Nature Nanotechnology* (2014) DOI: 10.1038/nnano.2014.200

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