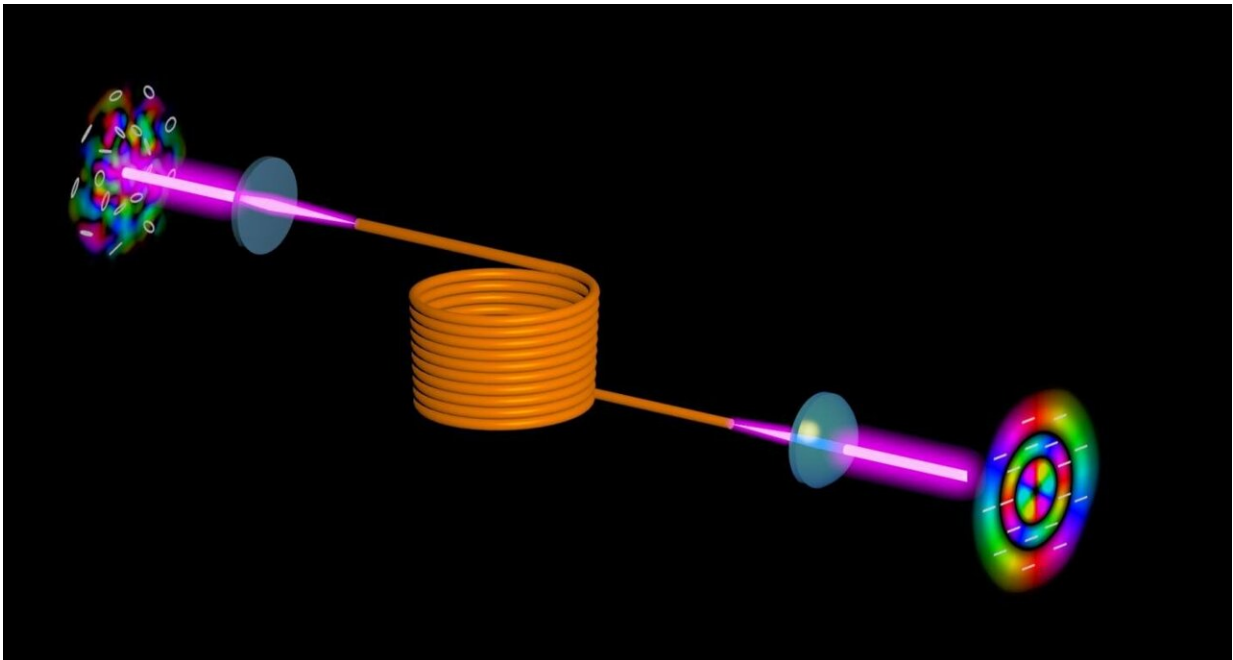


'Flipping' optical wavefront eliminates distortions in multimode fibers

May 10 2021



When a well-defined image propagates from the right-hand side to the left-hand side through a 1-km-long multimode fiber, its spatial profile and polarization will be strongly distorted. By flipping the wavefront of the distorted image for both polarizations simultaneously, a technique referred to as vectorial time reversal, an undistorted beam is formed after it passes from left to right through the optical fiber. Credit: Illustration by Yiyu Zhou

The use of multimode optical fibers to boost the information capacity of the Internet is severely hampered by distortions that occur during the

transmission of images because of a phenomenon called modal crosstalk.

However, University of Rochester researchers at the Institute of Optics have devised a [novel technique](#), described in a paper in *Nature Communications*, to "flip" the optical [wavefront](#) of an image for both polarizations simultaneously, so that it can be transmitted through a multimode fiber without distortion. Researchers at the University of South Florida and at the University of Southern California collaborated on the project.

Lead author Yiyu Zhou, a Ph.D. candidate in the Rochester lab of Robert Boyd, professor of optics, draws an analogy to a multilane highway in describing the challenge the researchers confronted.

"Obviously, a multiple lane highway is faster than a single lane," Zhou says. "But if a courier is forced to change from lane A to lane B, the package will be delivered to the wrong destination. When this happens in a multimode fiber—when one spatial mode is coupled to another during the propagation through the fiber—it's what we call modal crosstalk. And we want to suppress that."

The solution the researchers devised involves digitally pre-shaping the wavefront and polarization of a forward-propagating signal beam to be the phase conjugate of an auxiliary, backward-propagating probe beam—in an experimental realization of vectorial time reversal.

"When an optical beam with perfect wavefronts passes through the multimode fiber, it comes out badly distorted," explains Boyd, who is also the Canada Excellence Research Chair in Quantum Nonlinear Optics at the University of Ottawa.

"If we use a mirror to send the wavefront back, it will become even more distorted. But if we instead reflect it off a mirror, and also flip the

wavefront from front to back, the distortion becomes undone as the waves go back through that distorting medium. In particular, we need perform this procedure for both polarizations simultaneously when the distorting medium is a long multimode fiber."

The researchers demonstrate that this technology can enhance the channel capacity in a 1-km-long multimode fiber.

"Our technique can be used to realize mode-division multiplexing over long, standard multimode fibers to significantly enhance the channel capacity of optical communication links," Zhou says. "It can potentially be used to increase the Internet speed by one or two orders of magnitude."

The technique could also be potentially used to improve endoscopy imaging of the brain and other biological tissues, Zhou says.

More information: Yiyu Zhou et al, High-fidelity spatial mode transmission through a 1-km-long multimode fiber via vectorial time reversal, *Nature Communications* (2021). [DOI: 10.1038/s41467-021-22071-w](https://doi.org/10.1038/s41467-021-22071-w)

Provided by University of Rochester

Citation: 'Flipping' optical wavefront eliminates distortions in multimode fibers (2021, May 10) retrieved 26 April 2024 from <https://phys.org/news/2021-05-flipping-optical-wavefront-distortions-multimode.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.