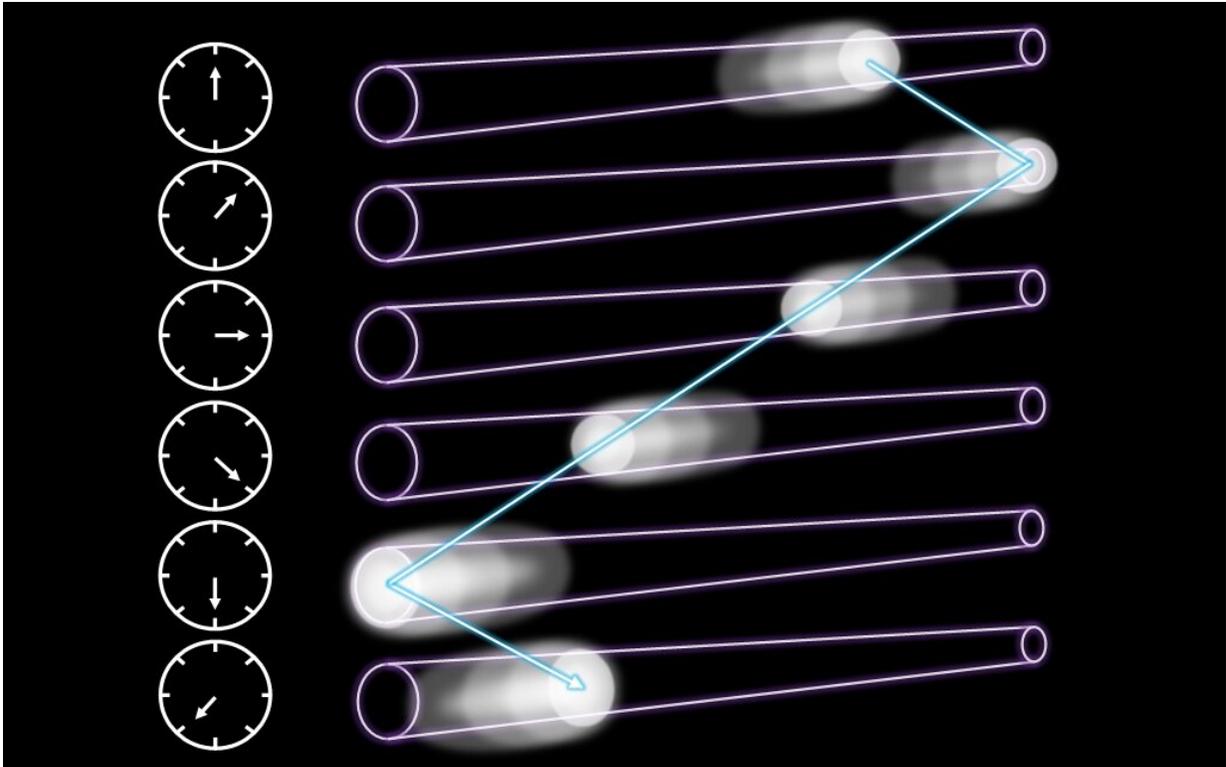


# Laser light makes a comeback (literally)

May 4 2021



Schematic of reciprocating propagation of laser pulse intensity at different observation times. Credit: Osaka University

Straight-line constant-speed propagation in free space is a basic characteristic of light. In a recent study published in *Communications Physics*, researchers from Osaka University discovered the phenomenon of reciprocating propagation of laser pulse intensity in free space.

Spatiotemporal couplings have been recently used to produce light with tunable group-velocity, direction, and trajectory in [free space](#). For example, the flying focus (a moving laser pulse intensity in the extended Rayleigh length), where longitudinal chromatism and temporal chirp are combined to control the spectrum-dependent focus-separation in space and spectrum-dependent pulse-location in time, respectively, has arbitrarily tunable propagating group-velocity and direction in space and time.

However, in the previous result, the flying focus can only propagate along a certain direction either forward or backward, although the propagating group-velocity can be freely controlled.

In this study, by dramatically increasing the Rayleigh length in space and the temporal chirp in time, the newly created flying focus propagates along a reciprocating straight-line trajectory in free space. A clear reciprocating flying focus with a [high spatial resolution](#) is also possible by further increasing the temporal chirp.

"The newly created flying focus propagates along the longitudinal axis first forward, then backward, and lastly forward again, showing a reciprocating straight-line trajectory in space and time. The forward-propagating velocity is the [light speed](#) in the vacuum, while the backward-propagating velocity is subluminal," explains corresponding author Zhaoyang Li.

This intriguing phenomenon changes the traditional understanding of light [propagation](#) and may be applied in both fundamental and applied physics.

"For example, in our radiation pressure simulation, it can produce an on-axis reciprocating trapping or pushing force for a small or big sphere, respectively, in the Rayleigh scattering regime," says Zhaoyang Li.

The article, "Reciprocating propagation of laser pulse intensity in free [space](#)," was published in *Communications Physics*.

**More information:** "Reciprocating propagation of laser pulse intensity in free space," *Communications Physics* (2021). [DOI: 10.1038/s42005-021-00590-8](#)

Provided by Osaka University

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