# Researchers develop new theoretical approach to manipulate light

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Credit: Petr Kratochvil/public domain

The quest to discover pioneering new ways in which to manipulate how light travels through electromagnetic materials has taken a new, unusual twist.

An innovative research project, carried out by experts from the University of Exeter, has developed a new theoretical approach to force light to travel through electromagnetic materials without any reflection.

The discovery could pave the way for more efficient communications and wireless technology.

The project focused on finding new kinds of electromagnetic materials where light can travel in only one direction, without any reflection, using Maxwell's equations. These four pivotal equations, published in the 1860s by physicist James Clerk Maxwell, describe how electric and magnetic fields move through space and time. These equations underpin much of modern technology from optical and radio technologies, to wireless communication, radar and electric motors.

These new unusual materials had previously been understood using ideas that won to 2016 Nobel prize, ideas borrowed from an abstract area of mathematics known as topology, which studies the properties of shapes that stay the same when you squeeze and mold them.

The novelty of this work is that it has found these new electromagnetic materials using only a slight twist on the high-school concept of the refractive index.

This finding may simplify the design of materials where light can propagate in only one direction and might, for instance, be used to improve telecommunication where information propagates as pulses, information that is lost when there is reflection.

The study is published in leading journal *Nature Physics*.

Mitchell Woolley, co-author and who carried out the research while studying Natural Sciences at the University of Exeter said: "Our paper tests the limits of how light can behave by using Maxwell's equations and electromagnetic theory to engineer exotic optical materials. I think the novelty here was neither using topology nor traditional methods of numerical simulation and optimization to find these materials."

Dr. Simon Horsley, lead author of the paper and also from the University of Exeter added: "There is a lot of interesting physics and mathematics still to be found in understanding how light moves through matter. It's very satisfying that the simple concept of the refractive index can be used in such unusual materials."

**More information:** S. A. R. Horsley et al, Zero-refractive-index materials and topological photonics, *Nature Physics* (2020). DOI: 10.1038/s41567-020-01082-2

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