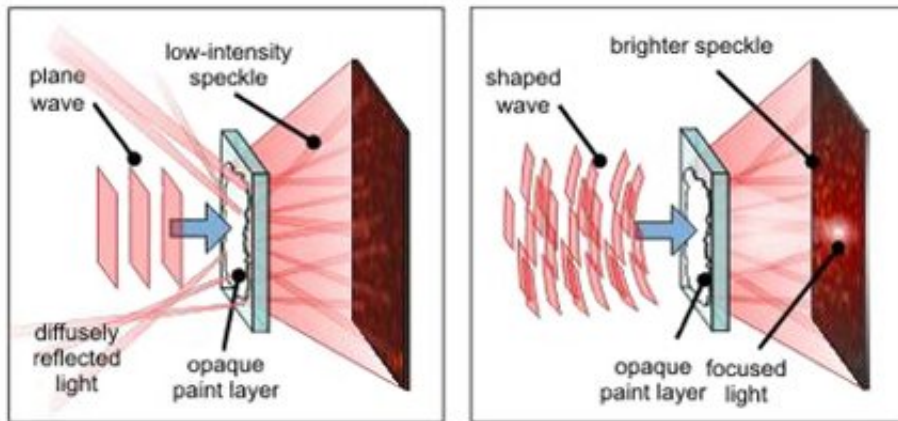


Physicists Transmit Light through Opaque Materials

August 18 2008, by Lisa Zyga



Left: the light falls on the opaque paint layer as a plane wave and little is transmitted. Right: the waveform has been shaped and clear light is transmitted: the open channels have been found. Credit: Mosk and Vellekoop. University of Twente.

No matter how thick an opaque "scattering material" is, physicists have shown how to weave light through tiny open channels in the material, so that the light passes through on the other side.

Materials such as white paint, paper, and milk are considered opaque because they scatter (rather than absorb) light. When light encounters these scattering materials, it undergoes sub-surface scattering, deflecting in every direction. One prime example is the blinding whiteness of freshly fallen snow, which is caused by lots of scattering light.

But theorists have predicted that, no matter how disordered these opaque scattering materials are, they still contain open channels that light could conceivably fit through. In the 1980s, scientists used random matrix theory to show that thicker materials have fewer open channels, but even the thickest materials should have some channels.

Now, physicists Allard Mosk and Ivo Vellekoop of the University of Twente in The Netherlands have shown how to find these open channels, and how to control the shape of incoming light waves so that they can make their way through. Until now, manipulating the light so that the open channels could actually be found has been too complex.

By shaping the light waves in a specific way, the physicists could reinforce the scattering waves with each other through constructive interference, and the light waves could then travel through an open channel in the material.

In their experiments, the physicists focused a laser beam onto an opaque layer of white zinc oxide (a material used by painters such as Van Gogh). With a digital camera, they measured the light emerging from the other side, and used this information to control the shape of the incoming light wave with a computerized feedback loop.

To change the light wave's shape, the scientists slowed parts of the wave with a liquid crystal display. These delayed parts interfered with other parts of the same wave, and ultimately increased the amount of light reaching the camera by at least 44% compared with the initial unshaped wave.

Even when the physicists doubled the opaque layer thickness from 5.7 to 11.3 microns, they still achieved a similar increase in transmission. They calculated that a maximum transmission of two-thirds of the incoming light is possible, which matches theoretical predictions.

"However thick a material is, it should be possible to create a wave that can be transmitted," Mosk said.

The ability to transmit more light through opaque scattering materials may lead to several applications, such as better medical imaging technology. Also, since electrons behave as waves in the theory of quantum mechanics, this new approach may help electrons find and move through open channels in thin wires, such as those on semiconductor chips. Further, the research could lead to a better understanding of radio waves for mobile communication, such as improving cell phone reception and range.

Mosk and Vellekoop's study, called "Universal optimal transmission of light through disordered materials," will be published in an upcoming issue of *Physical Review Letters*. It is also available at arxiv.org.

via: [University of Twente](https://www.utwente.nl) and [ScienceNOW](https://www.sciencenow.com)

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