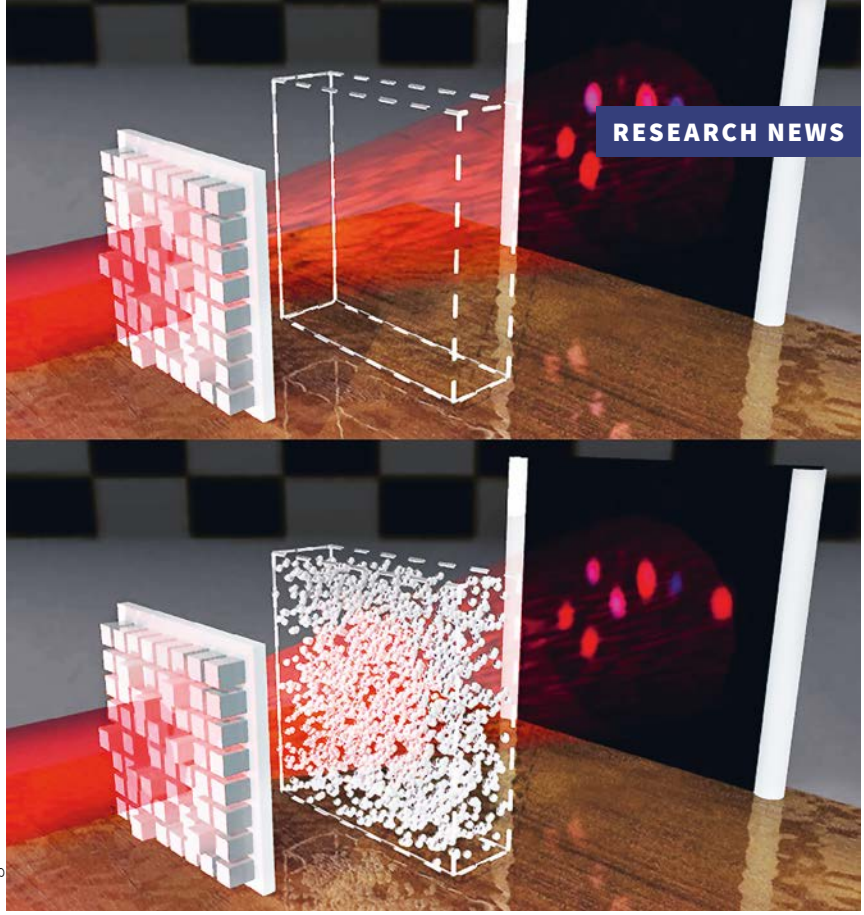

Image credit: Allard Mosk

THE INDESTRUCTIBLE LIGHT BEAM

Why is sugar not transparent? Because light that penetrates a piece of sugar is scattered and deflected in a highly complicated way.

However, as a research team from Utrecht University (Netherlands) and from TU Wien (Austria) has now been able to show, there is a class of very special light waves for which this does not apply: for any specific disordered medium—such as the sugar cube you may just have put in your coffee—tailor-made light beams can be constructed that are practically not changed by this medium, but only attenuated. The light beam penetrates the medium, and a light pattern arrives on the other side that has the same shape as if the medium were not there at all (see figure for a corresponding illustration).

In the experiment in Utrecht, a layer of zinc oxide was used as a light-scattering medium—an opaque, white powder of randomly arranged nanoparticles. First, the transmission matrix of this specific medium was measured interferometrically. With this information at hand, the "scattering-invariant modes" were then determined based on the property that their transmitted field pattern is the same as when they propagate through empty space. This feature was then checked explicitly by injecting the same state through air or through the disordered medium (see top and bottom panel in the figure). The intensity pattern arriving at the screen was observed to be strikingly similar, thereby proving the feasibility of the concept.

In a second step the two research teams also showed that these scattering-invariant modes not only provide interesting new possibilities for imaging across opaque media, but also inside of them. As it turns out, the scattering-invariant modes maintain an unusually strong correlation with the ballistic component of light inside a complex medium, which can be exploited to take a deeper look inside the challenging environment of disordered materials.

REFERENCES

P. Pai, J. Bosch, M. Kühmayer, S. Rotter, A.P. Mosk; Scattering invariant modes of light in complex media, Nature Photonics (2021). https://doi.org/10.1038/s41566-021-00789-9

Link to the freely accessible version: https://rdcu.be/cikbl