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Complex optics

If you have ever made your way to work on a foggy winter morning, you will know how severely some water droplets in the air can impair the depth of vision. The physical cause of this is multiple scattering, which randomizes the direction of light entering a disordered medium, such as fog, so that only a small fraction propagates along the original trajectory. This is a critical problem for imaging, optical communications and many other applications.

However, as hard as one may try (and generations of optical engineers have), it is impossible to eliminate disorder. Instead, by flipping the problem on its head and starting from the physics of multiple scattering, one can control the flow of light in complex media.

The aim of this Insight is to showcase the breadth of research undertaken in the field of complex optics. Much of recent progress was enabled by an improved understanding of light transport in complex media, to which Hui Cao, Allard Mosk and Stefan Rotter provide an introduction in their Review Article.

Armed with this formalism, the problem of imaging through turbid media, including fog, could be tackled. Indeed, disordered systems are a fertile playground for optical computation and computational imaging. Even random lasers — one of the earliest applications of multiple scattering — benefit from today's grasp of transport, helping to tame their famously hard to control emission properties. Beyond disorder, complex optics covers systems with a large number of interacting modes, such as multimode fibres. Working with the resulting effects will become increasingly important for optical communications — both classical and quantum.

We hope that this Insight conveys the breadth and depth of a thriving field in which understanding of physical principles goes hand-in-hand with practical applications. Most of all, we hope it inspires further research; there are many more avenues to pursue.

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