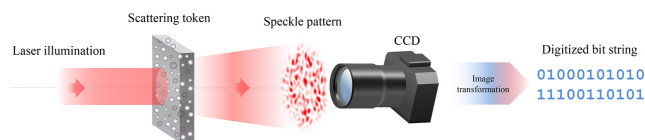


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## Disorder is not necessarily a disadvantage in photonics

Ashley Piccone

**Many photonic devices can employ structural disorder to enhance performance, enable new functionalities, and reduce cost.**



Traditional photonic devices use ordered structures, which are engineered to provide well-defined or predictable responses. Disorder within these devices is typically avoided, because it results in poor control, uncertainty, and unpredictability.

However, in stark contrast to these conventions, Cao and Eliezer discussed how disorder in photonics can be harnessed as an asset instead of an inconvenience.

“Exploring the potential of disordered structures in photonics to achieve a deterministic functionality is not intuitive, nor a straightforward task,” said author Yaniv Eliezer.

Despite its challenge, harnessing disorder can provide more structural possibilities because of its complexity. It has become more feasible recently as post-processing algorithms rapidly advance.

“If we find smart ways of utilizing disorder, it not only can enhance device performance but also enable new functionalities that ordered structures cannot have,” said author Hui Cao. “Moreover, disordered structures are abundant, easy to fabricate, and have low costs.”

The researchers reviewed many applications for disordered devices, including energy harvesting in solar cells, imaging and sensing, and information security and optical computing.

Disordered structures can serve as multifunctional devices, working simultaneously as a lens, a spectrometer, and a polarimeter.

Introducing disorder in a laser device reduces the spatial coherence and suppresses speckle noise. A laser with structural disorder can be used as an illumination source for high-speed, full-field imaging without coherent artifacts.

In a system with billions of nanoparticles, disorder can be used to generate secret keys for encryption and authentication. This disordered system is extraordinarily complex, unique, sensitive, and low cost.

“Engineering disorder can enable new device functionalities,” said Cao. “In between order and disorder, there is a lot of room to explore!”

**Source:** “Harnessing disorder for photonic device applications,” by Hui Cao and Yaniv Eliezer, *Applied Physics Reviews* (2022). The article can be accessed at <https://doi.org/10.1063/5.0076318>.

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