Overcoming disordered energy in light-matter interactions

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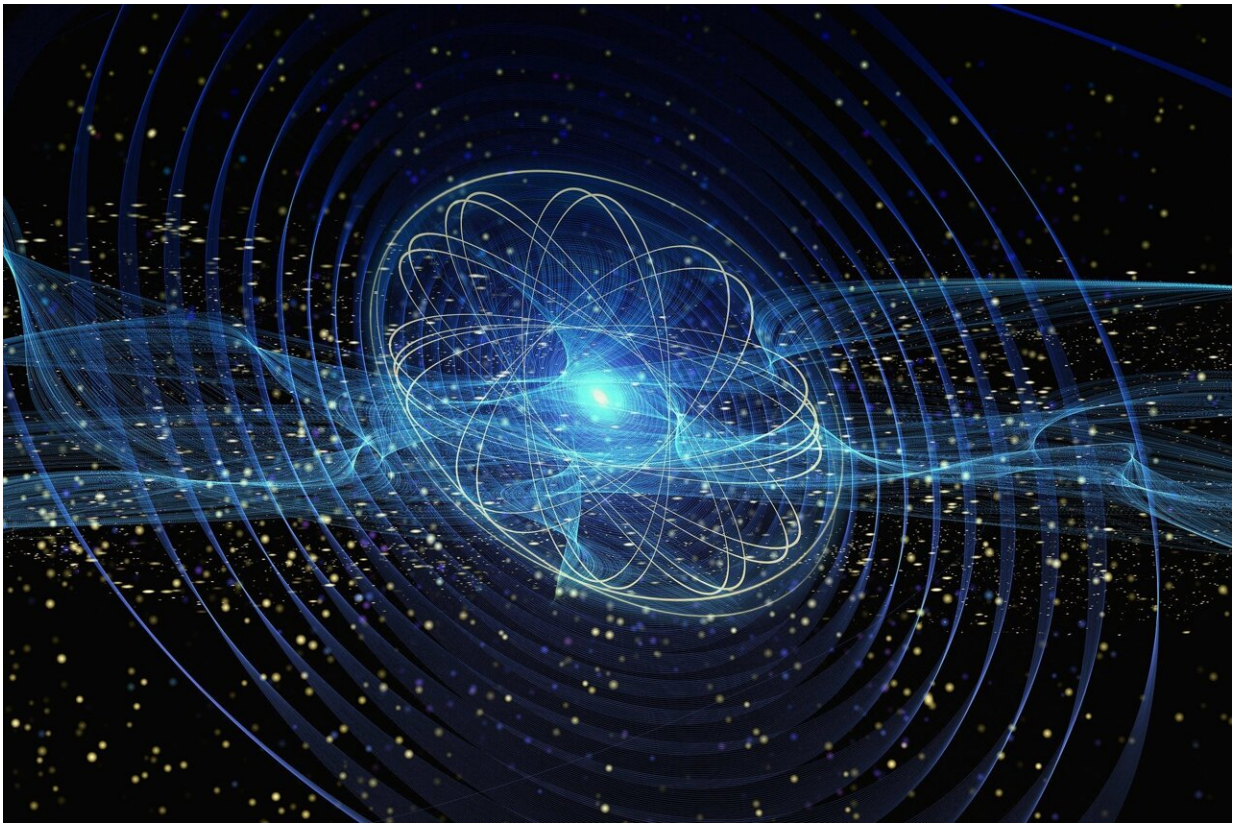

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Polaritons are formed by the strong coupling of light and matter. When they mix together, all the matter is excited simultaneously—referred to as delocalization. This delocalization has the unique ability to relay

energy between matter that is otherwise not possible.

Disordered energy is ubiquitous in nature and the universe. Disordered energy is less organized and less available to do work, such as with heat dissipation. Even in plants, disorder can ruin effective energy transfer.

In the context of polaritons, as disorder increases, it can negatively affect light-matter interactions, including polariton-enabled energy transfers. Overcoming this disorder is an important topic across many scientific fields.

In a new study, researchers from UC San Diego designed experiments to show how disordered energy can limit the energy transfer pathway, and further demonstrated a strategy to overcome this limitation. The research is published in the journal *Science*.

This work establishes a new theoretical criteria beyond which polariton formation can retain its coherent delocalization—a feature that can influence the properties of matter to control chemical reactions, with potential applications in energy technology and photonic engineering.

More information: Guoxin Yin et al, Overcoming energy disorder for cavity-enabled energy transfer in vibrational polaritons, *Science* (2025). DOI: 10.1126/science.adx3137.
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