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Investigating the interplay of topology and non-Hermitian physics with nonlinear effects

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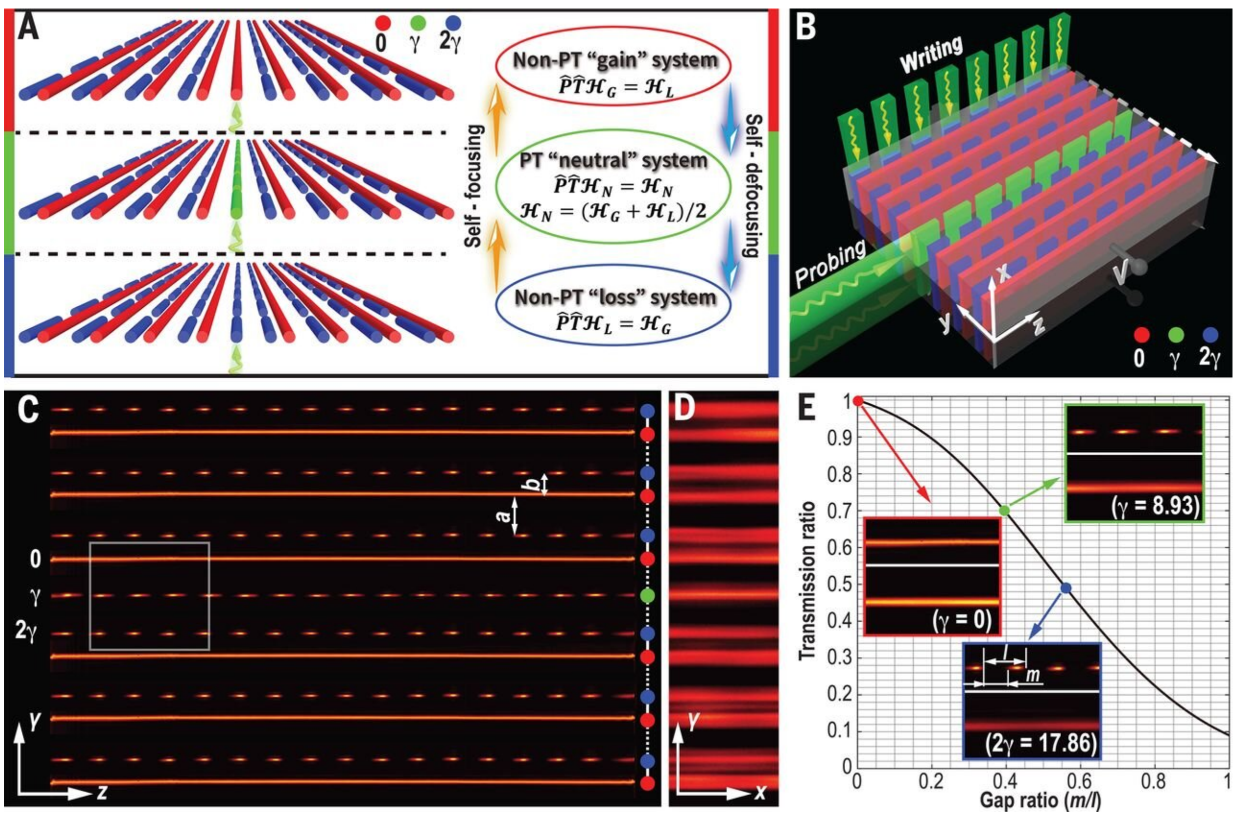

Experimental realization of NNH-SSHs for nonlinear tuning of PT symmetry and topological states. Credit: *Science* (2021). DOI: 10.1126/science.abf6873

An international team of researchers has investigated the interplay of topology and non-Hermitian physics with nonlinear effects. In their paper published in the journal *Science*, the group describes contructing an optical waveguide lattice using a biased photorefractive crystal and experiments introducing nonlinear effects. Piotr Roztocki and Roberto Morandotti with INRS-Énergie, Matériaux et Télécommunications have published a Perspective piece in the same journal issue outlining the benefits of studying nonlinear systems and work by the team on this new effort.

As Roztocki and Morandotti note, nonlinearity has been studied in great depth—its use in artificial networks and other digital electronic applications, for example, has greatly extended the range of such applications. But they also note that there are areas where research is lacking. They point out, for example, that systems that include both non-Hermitian and topological elements have not been studied much at all. In this new effort, the researchers have sought to address these gaps by looking into the interplay of topology and non-Hermitian physics when nonlinear effects are introduced.

The work by the team involved building an optical waveguide lattice (with a Su-Schrieffer-Heeger configuration) using a biased photorefractive crystal. Such platforms have been used in a wide variety of studies because they allow such easy access to its features, most notably reconfiguring the waveguide.

The experiments involved modifying the waveguide nonlinear response, which allowed for focusing and un-focusing and subsequently changing the way that light passed through the lattice. In so doing, they were able to demonstrate both the destruction and restoration of states in the non-Hermitian topology—notably, via nonlinear control.

The researchers also studied the sensitivity of their system in parts they described as exceptional points as opposed to those that were near protected states. They found that the stability of the inherited topological protective states wore away from the protected modes depending on how close they were to the exceptional points.

Roztocki and Morandotti suggest the work has opened the door to further investigation of nonlinear effects in overlapping disciplines, perhaps leading to the development of new kinds of devices.

More information: Shiqi Xia et al. Nonlinear tuning of PT symmetry and non-Hermitian topological states, *Science* (2021). DOI: 10.1126/science.abf6873