Researchers pave the way to designing omnidirectional invisible materials

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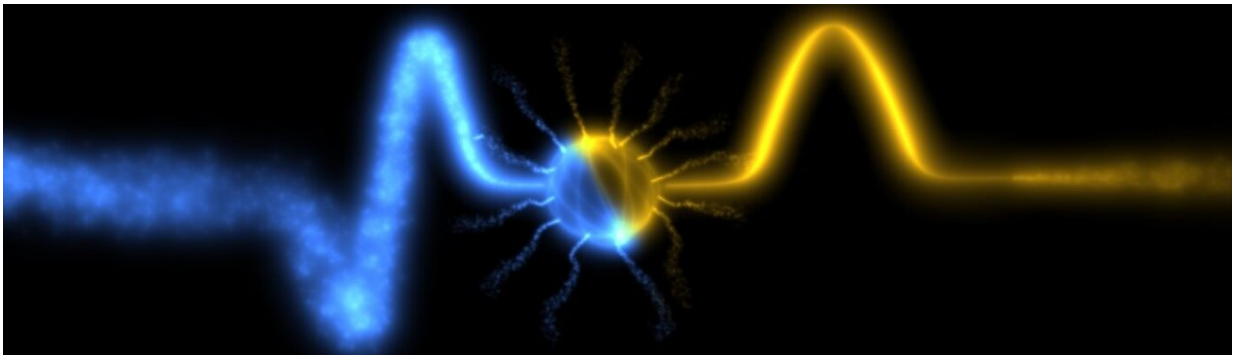

A team at UPV's Nanophotonics Technology Center has discovered a new fundamental symmetry in electromagnetism, acoustics and elasticity laws: a temporal supersymmetry Credit: UPV

Researchers at the Universitat Politècnica de València (UPV), belonging to the Nanophotonics Technology Center, have taken a new step in designing omnidirectional invisible materials. At their laboratories, they have discovered a new fundamental symmetry in the laws of electromagnetism, acoustics and elasticity: A temporal supersymmetry. This finding has been published in *Nature Communications*.

According to Carlos García Meca and Andrés Macho Ortiz, researchers at NTC-UPV, this new symmetry allows the conservation of the linear moment between dramatically different physical systems. This paves the

way to designing pioneering optical, acoustic and elastic devices, including invisible omnidirectional, polarization-independent materials, ultra-compact frequency shifters, isolators and pulse-shape transformers.

"These devices allow us to unusually modify different properties of light signals inside photonic circuits to process the spread of information. This is vital in communication systems. Moreover, we can adapt the functionality of those devices to the requirements at any time, as they are dynamically configurable," explained Carlos García Meca.

For designing these new devices, the key lies in changing the refraction index, which in this case is not generated in space but in time. "The supersymmetry technique tells us how to vary the refraction index of an object to have the light completely transmitted, avoiding undesired reflections," said Andrés Macho Ortiz.

The property of non-reflection is particularly useful for designing new photonic circuits. "Its implementation allows us to increase the speed of communications inside and makes them more compact and configurable without the signal that transports information bits being reflected back," explained Carlos and Andrés.

In general, the reflection of materials whose properties vary in time does not depend on the direction of light propagation. Therefore, "the absence of reflection in the proposed materials is linked to a total transparency, which results in the concept of omnidirectional invisibility: whatever the direction of light hitting those materials is, their presence is undetectable," concluded the authors.

Symmetries

The discovery of symmetries in nature is a cornerstone in physics that allows us to find the conservation laws governing the universe. For

example, electric charge, energy and mass conservation (coming from symmetries in physical laws governing electromagnetism, thermodynamics and chemistry) has allowed humans the ability to develop this technology (circuits, nuclear power stations, drugs...).

Exceptionally, supersymmetry was originally conceived in quantum physics as a hypothetical symmetry between particles that could explain all interactions in nature: nuclear forces, gravity and electromagnetism.

More information: Carlos García-Meca et al, Supersymmetry in the time domain and its applications in optics, *Nature Communications* (2020). DOI: 10.1038/s41467-020-14634-0

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