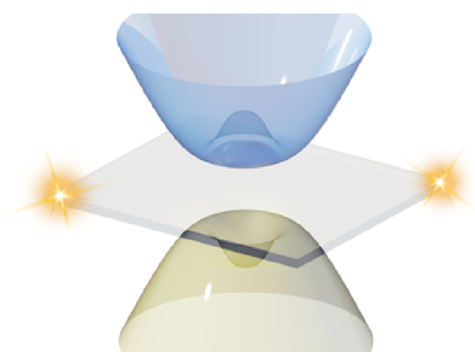
A Twist in Topological Wisdom

New theoretical predictions overthrow the assumption that a material's bulk topological properties are linked to the same properties at its surface.

By **Katherine Wright**

Common wisdom among researchers studying topological materials is that a material's bulk topological state determines that at its surface. This "bulk–boundary correspondence" means that they only need to know one state to know the other. New predictions from Kai Wang from Nanjing University in China and colleagues now bring that assumption into question [1]. The team has found two classes of material where the bulk topological properties fit with myriad possible surface states, rather than just one. They say that by revisiting predictions for other assumed "one-to-one" topological materials, researchers could uncover more systems with novel and exotic "one-to-many" topological properties.

The surface states of a topological material protect its properties from being ruined by defects in the material or by disorder in its structure. These protected properties can include its conductivity or optical polarization, for example, and arise from the material's band structure. In topological semimetals, the protection comes from the joining of the conduction and valence bands at specific points, known as Dirac points, which are connected by arc-sharped Fermi surfaces, called Fermi arcs.



Credit: K. Wang/Nanjing University

Wang and his colleagues show that if a 3D topological semimetal has "*PT* symmetry"—meaning that it preserves inversion and time-reversal symmetries—then that band structure changes. (For more information on these materials, see **Viewpoint: Non-Hermitian Topological Systems**). Instead of smooth Fermi arcs, they predict helical ones, which change how the bulk and surfaces link together and lead to a one-to-many correspondence. They also find the same behavior for *PT*-symmetric topological insulators. Wang says that their predictions should be testable using experimentally accessible *PT*-symmetric topological materials, such as certain carbon allotropes and cold-atom systems.

Katherine Wright is a Senior Editor for ***Physics***.

REFERENCES

1. K. Wang *et al.*, "Boundary criticality of PT-invariant topology and second-order nodal-line semimetals," **Phys. Rev. Lett. 125, 126403 (2020).**