Mathematicians develop new method for describing extremely complicated shapes

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Mathematicians at the Institute for Advanced Study in New Jersey "bridged" topology and fractals and made a discovery that could lead to a new way of describing extremely complicated shapes such as the configuration of the tiniest defects in a metal or even the froth of a breaking wave.

Topology is a powerful branch of mathematics that looks at qualitative geometric properties such as the number of holes a geometric shape contains, while fractals are extremely complicated geometric shapes that appear similarly complicated even when viewed under a microscope of high magnification.

Bridging the topology and fractals, as described in the American Institute of Physics' *Journal of Mathematical Physics* (JMP), relies upon a recently developed mathematical theory, known as "persistent homology," which takes into account the sizes and number of holes in a geometric shape. The work described in JMP is a proof of concept based on fractals that have already been studied by other methods – such as the shapes assumed by large polymer molecules as they twist or bend under random thermal fluctuation.

Many geometric structures with fractal-like complexity arise in nature, such as the configuration of defects in a metal or the froth of a breaking wave. Their geometry has important physical effects too, but until now we haven't had a vocabulary rich enough to adequately describe these and other complicated shapes. The mathematicians plan to use the

vocabulary provided by persistent homology methods to investigate and describe complicated shapes in a whole new way.

More information: "Measuring shape with topology," is published in *Journal of Mathematical Physics*.
jmp.aip.org/resource/1/jmapaq/v53/i7/p073516_s1

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