# Topological transitions in metamaterials

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The ability to control the flow of electrons using engineered materials is fundamental to the information technology revolution, yet many properties of matter are still unclear. Now a University of Alberta researcher is closer to understanding some of the exotic electronic properties in matter using optical analogues.

U of A electrical engineering researcher Zubin Jacob is the co-lead author on a study of the behaviour of photons flowing through metamaterials designed to emulate exotic electronic processes. Metamaterials are man-made nano materials, which can be used in applications as varied as future information networks, imaging and energy harvesting.

Jacob says think of metamaterials as an artificial medium that can control light. In order to control and use light in future optical circuitry, researchers need something as basic as an on-off switch for light-matter interaction. This research shows abrupt changes in the properties of an artificial medium imprints itself on light.

Zubin says we are five to 10 years away from the commercial application of such metamaterial based light-matter interaction control. One area of science that metamaterials can change on a shorter term is microscope technology. The ability of metamaterials to compress the size of light will enhance the power of microscopes to nanoscopes that are able to reveal nanofeatures to the human eye.

The research was published April 13 in the journal *Science*.

The research team comes from the U of A, Purdue University as well as the Queens and City colleges of the City University of New York.

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**ABSTRACT**
Light-matter interactions can be controlled by manipulating the photonic environment. We uncovered an optical topological transition in strongly anisotropic metamaterials that results in a dramatic increase in the photon density of states—an effect that can be used to engineer this interaction. We describe a transition in the topology of the iso-frequency surface from a closed ellipsoid to an open hyperboloid by use of artificially nanostructured metamaterials. We show that this topological transition manifests itself in increased rates of spontaneous emission of emitters positioned near the metamaterial. Altering the topology of the iso-frequency surface by using metamaterials provides a fundamentally new route to manipulating light-matter interactions.

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