Intermittent Chaos for Ergodic Light Trapping in a Photonic Fiber Plate

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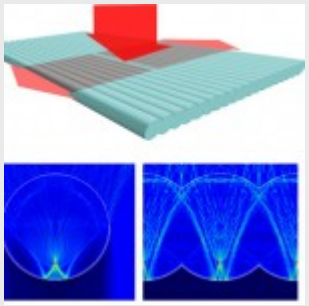

Light trapping and guiding in thin films combined with efficient light extraction or insertion in the direction orthogonal to the guiding one is essential to obtain energy-efficient light harvesting or emission. In this context, one is faced with two seemingly incompatible constraints -namely, to let as much light in or out as possible at any point on the guiding film surface while maintaining the light effectively trapped across the film. For several decades, in an attempt to maximize sunlight energy harvesting, researchers of thin film solar cells have been searching for the optimal system architecture to achieve the most effective light path 'bending' into the cell absorber layer. In a collaboration between the Departamento de Física Teórica de la Materia Condensada and the Condensed Matter Physics Center (IFIMAC) at the Universidad Autónoma de Madrid, the Institute of Photonic Sciences (ICFO) and the Université Libre de Bruxelles (ULB) , it has now been demonstrated that the paradoxical goal of letting as much light in or out while maintaining the wave effectively trapped can be achieved with a periodic array of interpenetrated fibers forming a photonic fiber plate. Photons entering perpendicular to that plate may be trapped in an intermittent chaotic trajectory, leading to an optically ergodic system. The researchers simulated and fabricated such a photonic fiber plate and showed that for a solar cell incorporated on one of the plate surfaces, light absorption is greatly enhanced. The interest in the novel light-guiding mechanism proposed in this work well exceeds photovoltaics and may contribute to many relevant applications in future illumination systems, displays or wearable devices. [Full article]