METAMATERIALS

## Quantum eraser

*ACS Photon.* http://doi.org/ccs7 (2017)

A 'quantum eraser' that can prevent or allow absorption of an entangled remotely located photon has been demonstrated by a Singapore–European collaboration of scientists. Charles Altuzarra and co-workers use the phenomenon of coherent perfect absorption in a thin plasmonic metamaterial that is placed inside an interferometer to perform the experiment. A pair of polarization-entangled photons is first produced by spontaneous parametric down-conversion in a 2-mm-thick nonlinear crystal of beta-barium borate (BBO) that is illuminated with 405 nm light from a 200 mW laser diode. One of the entangled photons (named the idler) passes through a polarizer to a photodectector, while the other (the signal) enters the interferometer that has a beamsplitter and photodetector either side of the metamaterial. Controlling the polarization of the idler photon can switch the metamaterial between regimes of travelling-wave absorption and coherent absorption. *OG*

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OPTICAL FIELDS

## Coherence converter

*Optica* **4**, 1052–1058 (2017)

Scientists from the US have now experimentally demonstrated that it is possible to reversibly convert coherence between the polarization and spatial domains. Chukwuemeka Okoro and co-workers from the University of Illinois at Urbana-Champaign and the University of Central Florida have built a coherency converter that transforms two linearly polarized, spatially incoherent fields into two randomly polarized, mutually coherent fields in space. According to the team, the scheme works because the degrees of freedom associated with coherence are effectively classically entangled, akin to entangled multipartite states in quantum mechanics. As a result, coherence can be treated as a resource that can be reversibly converted from one degree of freedom associated with the beam to another. The converter consists of two pairs of slits (for the input and output fields), with a half-wave plate, a polarizing beam splitter and a non-polarizing beam splitter placed between them. Measurement of the output fields' coherency matrix and spatial interference patterns confirm that the scheme operates as expected. *OG*

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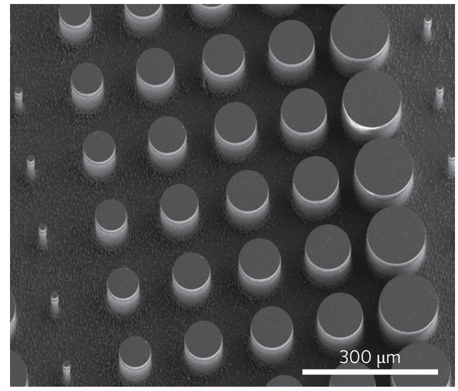
TERAHERTZ SCIENCE

## Variable beam splitters

*Appl. Phys. Lett.* **111**, 071101 (2017)

A broadband non-polarizing beam splitter for terahertz (THz) waves that features a controllable splitting ratio has been developed by researchers from China, Saudi Arabia and the USA. The device is based on an all-dielectric metasurface made of an array of miniature silicon cylinders on a silicon substrate. The cylinders were arranged into an array with a period of 150 μm. The thickness of the substrate was 1.8 mm, and the height of the cylinders was 200 μm. The radius of the cylinders increased from 33 μm at the centre of the metasurface to 74 μm at the edge. A THz beam at normal incidence to the metasurface is split into two diffracted beams. The ratio of the power in the split beams can be controlled by shifting the lateral position of the metasurface relative to the incident beam. When the beam struck the centre line of the metasurface, a split ratio of 1:1 was obtained, whereas it was 1:300 for an offset position of $x = 12$ mm. The splitter works over a frequency range from 0.65 to 0.95 THz. *NH*




Credit: AIP Publishing LLC

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FUNDAMENTAL OPTICS

## Light-by-light

*Nat. Phys.* **13**, 852–858 (2017)

Scattering of photons by other photons, without the assistance of nonlinear processes in a material, is prohibited in the classical realm. However, in extreme conditions where large field strengths dictate that a quantum electrodynamical description of interactions is required, light-by-light scattering is possible, although it remains difficult to observe using even the most powerful lasers. Now the ATLAS Collaboration, which includes some 3,000 researchers and 182 institutions from around the world, has used the Large Hadron Collider (LHC) and the ATLAS detector to provide evidence for light-by-light scattering from collisions of lead ions with one another. The ATLAS detector is a cylindrical particle detector at the LHC facility in Geneva. Extreme electromagnetic field strengths can result from the collisions of relativistic lead ions and the team determined 13 potential light-by-light scattering events in a dataset recorded using the ATLAS detector in 2015. The team reports the steps taken to eliminate false positives due to various background events such as electron and quark pair production, or cosmic-ray muons. Events with 4.4 standard deviations of statistical significance over background were determined and the interaction cross-section was found to be in good agreement with the standard model predictions. *DFPP*

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BIOPHOTONICS

## Nonlinear bacteria

*Phys. Rev. Lett.* **119**, 058101 (2017)

Much recent study has focused on the propagation of light through complex scattering media, in part due to applications in biosensing. Now, Anna Bezryadina and colleagues have investigated the nonlinear transmission of light through biological suspensions of *Synechococcus* cyanobacteria. The team showed nonlinear self-trapping of a light beam propagating through seawater containing the bacteria. The team sent a beam of collimated green light (full-width at half-maximum size of 50 μm) into water samples with and without bacteria. After propagating a distance of 4 cm through water without bacteria, the beam had diverged to 650 μm, with no dependence on incident power. When $1.3 \times 10^7$ cells $ml^{-1}$ were added to the water, the beam expanded to 1.25 mm due to scattering in the case of low incident optical powers (0.1 W), but for a higher power of 3 W the team observed self-trapping and a similar output beam size compared to the input beam size. The researchers hope that the results may lead to new approaches to tackle the problem of scattering losses in biophotonics, but further studies are required. *DFPP*

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