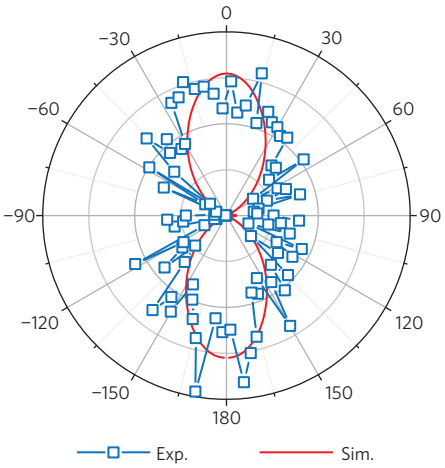
SPECTROSCOPY

Imaginary echoes

Phys. Rev. X **6,** 041056 (2016)



Echoes are observed in many nonlinear physical situations, such as spin echoes and optical echoes. Now, Kang Lin and co-workers from China, France and Israel have experimentally observed new types of molecular alignment echoes in CO_2 and N_2O. The team detected two types of echo — alignment echoes whose angular orientation is controlled by the polarization of two ultrashort pulses, and imaginary alignment echoes that appear at negative time delays. To probe the spatiotemporal molecular dynamics, the cold-target recoil-ion-momentum spectroscopy technique was employed. A supersonic gas jet of CO_2 or N_2O molecules was subject to a pair of polarized-skewed and time-delayed femtosecond laser pulses. By scanning the delay of the circularly polarized probe pulse, snapshots of the angular distribution of the molecular axis at various times were taken via Coulomb explosion. *NH*

NANOPHOTONICS

Plasmonic photoemission

Nat. Phys. http://doi.org/bw2k (2016)

Field-controlled light–matter interactions, such as those between laser pulses and metallic nanotips, are important for attosecond science. William Putnam and co-workers have now investigated strong-field photoemission from metallic nanoparticles supporting localized surface plasmon resonances. The device operates under ambient conditions and is similar to a microscale phototube, the photocathode — a layer of indium tin oxide (ITO) topped by an array of gold nanoparticles — is separated from the ITO anode by a micrometre-wide gap. The team illuminates the nanoparticle emitters with femtosecond pulses of tunable pulse energy at a central wavelength of 1,177 nm (with the plasmon resonances ranging from 895 nm to 1,256 nm). Tight focusing of the laser pulses at an incident peak field of 1.2 V nm^{-1} drives photoemission currents up to ~30 nA from the nanoparticles. In the strong-field regime, the emission process is expected to resemble tunnelling and experimental estimates indicate a field enhancement of ~32. *GD*

OPTICAL MATERIALS

Tuning 2D

Appl. Phys. Lett. **110,** 012103 (2017)

Recent experimental progress on the synthesis of 2D sheets of group-III nitrides is encouraging. Maria Stella Prete and colleagues from Italy and Germany have used density functional theory and Green's function many-body perturbation theory to customize and tune the electronic and optical properties of 2D group-III nitrides, suggesting that they are useful for realizing efficient light-harvesting devices. From their analysis of B-, Al-, Ga-, In- and Tl-based nitrides the authors showed it is possible to select an electronic gap from 0 eV to 6.7 eV (smaller group-III atomic number yields larger gap), which spans the ultraviolet to longer wavelengths. Cation composition tunes 2D heterostructures from type I to type II, which the authors proposed may be exploited in efficient light harvesting in III–V solar cells, with 2D InGaN and InTlN heterostructures as main candidates. Interestingly, by combining GaN and TlN with InN it may be possible to push the tuning out to the THz region, with InTlN sheets being a candidate for THz emitters and detectors. *DP*

PHOTOCHEMISTRY

Solar-driven reactor

Angew. Chem. Int. Ed. http://doi.org/f3tnwf (2016)

Taking inspiration from plant leaves, researchers in the Netherlands have created a photomicroreactor that collects sunlight, converts it to a desired, narrow-wavelength region and then uses it to convert chemical reactants flowing in nearby microchannels. The approach may ultimately prove useful for the manufacture of solar fuels, pharmaceuticals and agrochemicals. The design is realized by implementing a luminescent solar concentrator from fluorescent dye-doped polydimethysiloxane (PDMS), which acts as a light guide with high transparency and good thermal stability. A PDMS platform 50 × 50 × 3 mm^3 was fabricated that featured an embedded 150 µl flow microreactor consisting of a serpentine-shaped microchannel (500 µm wide and 1 mm high). The PDMS was doped with the fluorescent lumiphore LR305 (doping concentration of 10–250 ppm) that strongly absorbs light in the 400–600 nm window and re-emits it at around 650 nm. As a benchmark reaction to test the effectiveness of the system, the [4+2] cycloaddition of singlet oxygen to 9,10-diphenylanthracene was monitored using methylene blue as a photocatalyst that has an absorption that overlaps with the LR305 emission. Tests with blue LED illumination, solar simulator and outdoor experiments on a sunny summer day all indicated that the reactor featuring the LR305 dopant exhibited a significant increase in the conversion rates of the reaction when compared with a non-doped reactor. *OG*

QUANTUM OPTICS

Single-atom-operated circulator

Science **354,** 1577–1580 (2016)

Non-reciprocal optical components such as isolators and circulators are useful in photonic circuits for signal routing and processing tasks. Quantum optical applications also require such elements, but with the additional constraints that they need to work with low light levels and exhibit low loss. Now, Michael Scheucher and collaborators report the realization of a fibre-integrated optical circulator based on a single rubidium atom resonantly coupled to the evanescent field of a whispering-gallery-mode microresonator. Two coupling fibres interfaced with the microresonator identify the four-port circulator. Owing to strong transverse confinement, the evanescent fields of the clockwise and anticlockwise propagating resonator modes are almost fully circularly polarized (albeit in opposite directions). The internal state of the atom determines whether circularly polarized light in the clockwise or anticlockwise resonator mode interacts strongly with the single atom, thus determining whether the incident light couples to the microresonator and switches fibre on its exit (as opposed to staying in its initial fibre). Therefore, the internal state of the rubidium atom effectively controls the operation direction of the circulator. The average operation fidelity of the device is above 0.7, and the average insertion loss is 1.4 dB. *GD*

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