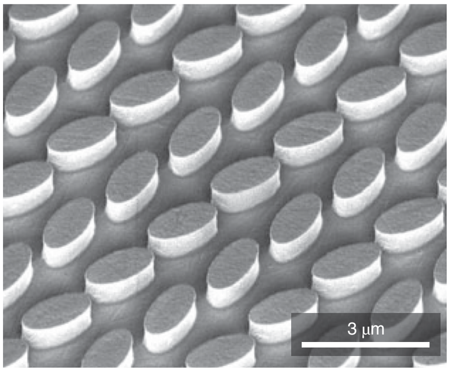
METASURFACES

Molecular sensing

Science **360**, 1105–1109 (2018)



Credit: AAAS

The development of pixelated dielectric metasurfaces, with individual pixels that are engineered to have distinct narrow-band reflectance resonances in the mid-infrared, is bringing new opportunities for low-cost spectrometry and molecule identification. Andreas Tittl and co-workers from the École Polytechnique Fédérale de Lausanne in Switzerland and the Australian National University in Canberra, fabricated up to 10 × 10 arrays of metasurface pixels. Each pixel was 100 × 100 μm^2 and composed of a series of tiny elliptical amorphous silicon resonators (pictured) . The entire array thus hosted a family of tightly packed narrowband reflections covering the 1,350 to 1,750 cm^{-1} spectral region. With a thin layer of protein deposited on the surface of pixels and illuminated with mid-infrared light, a molecular absorption signature or 'molecular barcode' of the sample can be imaged by a detector, allowing the constituents of the sample to be identified. The team successfully tested the approach with protein A/G and mixtures of polymer molecules and say that it may aid biosensing and environmental monitoring. *OG*

https://doi.org/10.1038/s41566-018-0211-7

LASERS

Encouraging instability

Phys. Rev. Lett. **120**, 213902 (2018)

Parametric instability can occur in dispersive and nonlinear systems when a parameter of the medium is periodically modulated along the axis of wave propagation. The effect is sometimes called Faraday instability due to the great scientist's observation of patterns formed in a fluid tank. Now, Auro Perego and colleagues in the UK, Russia, Spain and Italy propose that parametric instability can be self-induced in a fibre laser. The theoretical study uses the Ginzburg–Landau equation and coupled-mode analysis to predict the onset of self-induced parametric instability in a laser thanks to a periodic gain profile arising from pump injection into one side of a cavity. Due to the field structure in the cavity, the Stokes field resonating in the cavity 'sees' periodic gain and nonlinearity; if the gain passes a threshold, parametric instability occurs that leads to self-pulsing. The effect is theoretically analysed in a Raman fibre laser and the team hopes that it may ultimately yield pulsed fibre laser operating at high repetition rates. *DFPP*

https://doi.org/10.1038/s41566-018-0208-2

QUANTUM OPTICS

Twin-field QKD

Nature **557**, 400–403 (2018)

Quantum repeaters are likely to be needed in order to overcome existing bounds of quantum communications, but making practical devices remains challenging. For example, in quantum key distribution (QKD), there are fundamental rate–distance limits (related to the maximum secret key rate that is possible for a given transmission distance) and without quantum repeaters this issue remains a hurdle. Marco Lucamarini and a team at Toshiba Research Europe (Cambridge, UK) have now proposed a twin-field QKD approach that, without quantum repeaters, may enable 550 km QKD with acceptable noise using standard optical fibre; this would go beyond the typical ~200–340 km repeaterless bounds of QKD with standard optical fibre. Two light sources are required in twin-field QKD, creating the pulses for each user ('Alice' and 'Bob') that are phase-randomized and phase-encoded with secret bits. On interference of the pulses at a beam splitter, an eavesdropper 'Charlie' is able to infer whether the secrets bits of Alice and Bob are the same or different (that is, 00 or 11 versus 01 or 10), but is unable to determine the absolute values (0 or 1), making the scheme resistant to hacking. *DFPP*

https://doi.org/10.1038/s41566-018-0209-1

TERAHERTZ SOURCES

Tunable comb

Opt. Lett. **43**, 2507–2510 (2018)

Broadband optical frequency combs in the terahertz region with comb lines that are continuously tunable and exactly referenced would be highly beneficial as a source. Now, Lalitha Ponnampalam and co-workers stable, phase-coherent optical comb lines spanning over 3.8 THz using only a single phase modulator optical frequency comb generator (OFCG). The OFCG consists of a $LiNbO_3$ phase modulator with a 3-dB bandwidth of 22 GHz, a 980-nm pump laser and a 5-m-long erbium-doped fibre that gives a relatively flat gain spectrum over the entire C-band. An amplified loop incorporating a variable optical delay line allows the spacing between the comb lines to be continuously tuned from 17.5 to 20 GHz. By heterodyning two lines, the team obtained a continuously tunable electrical signal from 122.5 GHz to >2.7 THz. The team says that the scheme is potentially realizable in a monolithic platform. *RW*

https://doi.org/10.1038/s41566-018-0212-6

INTERFEROMETRY

Attosecond resolution

Sci. Adv. **4**, eaap9416 (2018)

A protocol to measure the relative arrival time between two photons with few-attosecond time resolution has been developed by researchers in the UK. Ashley Lyons and co-workers measure coincident event counts for photon pairs by Hong–Ou–Mandel (HOM) interferometry, but importantly, they use the estimated total Fisher information as a means to extract highly precise timing information. Photon pairs at the wavelength of 808 nm (generated by sending 130-fs pulses from a frequency-doubled Ti:sapphire laser to a nonlinear crystal) were sent to a dual-arm HOM interferometer. When the HOM co incidence dip was scanned as a function of the relative arrival time, two peaks asymptotically appeared in the estimated total Fisher information as the team theoretically predicted. By using a fitting calculation, the relative arrival time was obtained with accuracy of 0.5 as and precision of 4.7 as. With a small modification, HOM interferometry could be applied to quantum optical coherence tomography for biological specimens such as DNA. *NH*

https://doi.org/10.1038/s41566-018-0210-8

Oliver Graydon, Noriaki Horiuchi, David F. P. Pile and Rachel Won