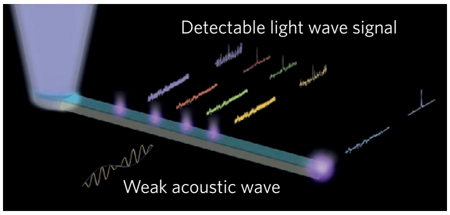
SENSORS

Plasmonic microphone

ACS Photon. http://doi.org/brmn (2016)



AMERICAN CHEMICAL SOCIETY

Reducing the size of acoustic detectors is important for applications such as high-resolution ultrasound imaging. Although optic-fibre-based sound sensors are being explored it is not clear if they can be made any smaller than the micrometre scale since light confinement in such structures is limited by diffraction. Now, Yaoguang Ma and colleagues from the USA and China have created a nanoscale microphone with an optical readout. The key to the idea is detecting changes in scattered light from small metal nanoparticles in the optical near-field of a nanofibre while sound waves modulate the position of the particles and thus their scattering intensity. SnO_2 fibres with a refractive index of 2.1 were used to enable good optical confinement in a low-index liquid environment. A compressible polyelectrolyte layer was applied to the fibres and gold nanoparticles chemically attached. The fibres were excited by 325 nm light from a continuous-wave He–Cd laser to create broadband emission that propagates along the fibre and excites the plasmonic metal particles. Initial tests were conducted in water using an external speaker oscillating the nanoparticles, while later experiments, probing the limits of the system, used an electromagnet approach to mechanically drive the system. By monitoring the modulated scattered light from the particles, either in the far-field, or via transmission along the fibre, acoustic intensities of $<10^{-8}$ W m^{-2} were detected by the devices with an interaction area of <4 μm^2. *DP*

FREQUENCY COMBS

Ultrawide span

Opt. Lett. **41,** 3980–3983 (2016)

An ultrabroadband frequency comb spanning the ultraviolet to the mid-infrared, 350 nm to 4.4 μm, has been generated in a waveguide of periodically poled lithium niobate (PPLN). The scientists from Japan behind the achievement claim that the 3.6 octave optical frequency comb is the broadest ever reported. The long- and short-wavelength measurements of the comb were limited by the spectral coverage of the team's spectral analysers. Significantly, the comb covers the absorption lines of CO_2 at 2.7 and 4.3 μm and water's absorption band at 2.6–3.1 μm, making it a potentially valuable tool for sensing or spectroscopy. The team pumped the PPLN waveguide with a train of amplified light pulses from a mode-locked erbium-fibre laser (wavelength 1.56 μm, 48 MHz repetition rate) that was passed through a 15-cm-long highly nonlinear fibre (HNLF) for spectral broadening before entering the waveguide. The apparatus has been running for more than six months without the need to replace either the PPLN waveguide or HNLF and the team says that its repeatability and reproducibility are good. *OG*

TERAHERTZ SCIENCE

Ultrafast wireless link

APL Photon. **1,** 081301 (2016)

An ultrafast wireless communications link operating at a total data capacity rate 160 Gbit s^{-1} in the terahertz (THz) frequency band has been demonstrated by researchers from Denmark and China. The team used a coherent frequency comb and an optical local oscillator to create 8 carrier channels in the 300–500 GHz band, each channel was modulated at 20 Gbit s^{-1} and separated by 25 GHz. The THz beam was generated by a uni-travelling photodiode (UTC-PD) photomixing emitter and sent over free space for a distance of 50 cm, prior to being down-converted by a THz Schottky mixer receiver and the data channels demodulated. Analysis indicates that all 8 data channels operated with a bit-error-rate performance within the capabilities of forward-error correction, indicating the potential for free-space communication in the THz window at data rates beyond 100 Gbit s^{-1}. According to the team, the reduction of THz phase noise by compensating the optical path difference for different channels was important to the success of the experiment. *OG*

ATOM OPTICS

Self-stabilizing light

Nature Phys. http://doi.org/brmp (2016)

Although the exact role that different quantum systems — photonic, solid-state and others — will play in large-scale quantum information processing is currently unclear, controlling atom–light interactions is likely to be crucial in devices such as quantum repeaters. Now, Jesse Everett and colleagues report the observation of self-stabilizing stationary light with a technique that might prove advantageous for applications in quantum information processing. The team uses the gradient echo memory method to create a spin wave (that is, a collective excitation) between two atomic levels in a cloud of cold rubidium atoms. Subsequently, two counter-propagating bright control fields illuminate the atomic ensemble in the presence of two weak probe beams so that the dynamics of the resulting atom–light interaction can be studied. Two photodetectors collect the output probe light, and the evolution of the spin wave is also captured through absorption imaging of an additional resonant field on a charge-coupled device (CCD) camera. Large signals at the detectors indicate that the atom–light system evolves to a stable configuration where a stationary optical field is trapped in the atomic cloud. The ability to precisely engineer the spatial profile of the spin wave lends flexibility to the scheme. *GD*

BRAGG SCATTERING

Atomic mirror

Phys. Rev. Lett. **117,** 133603 (2016)

Measuring the interaction of light with small ensembles of atoms is important for investigating quantum electrodynamic effects. However, millions of atoms are typically required to obtain strong atom–photon interactions. Now, Neil Corzo and co-workers report how just 2,000 caesium atoms, carefully arranged in two lines either side of a nanoscale waveguide, can reflect 75% of light guided in the waveguide. The atoms were optically trapped near the surface of the fibre so that they could interact with the fibre's evanescent field. An optical lattice formed by counter-propagating laser beams (with a frequency slightly detuned to the atomic resonance) was used to perform the trapping and create the 1D periodic arrays of atoms. The atom chains effectively act like a Bragg amplitude grating and reflect light travelling in the waveguide. Due to the periodic arrangement of the atoms the small reflections from each atom constructively interfere with reflections from every other atom, resulting in a strong overall effect. The transmission and reflection of a probe laser beam sent through the waveguide was detected using avalanche photodiodes. *DP*

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