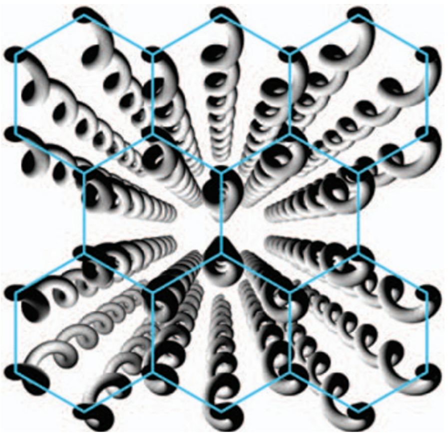
TOPOLOGICAL INSULATORS

Visible demonstration

Nature **496,** 196–200 (2013)



The topological insulator, a new phase of matter whose surface conducts electricity but whose interior is an insulator, has attracted intense interest in recent years. Now, researchers from Technion in Israel and Friedrich-Schiller Universität in Germany have fabricated a photonic analogue that transports visible light along its edges. The optical structure of this device consists of a hexagonal array of helical waveguides, each of which has an elliptical cross-section (major axis of 11 µm, minor axis of 4 µm). The waveguides were written into silica by femtosecond laser writing. When red light with a wavelength of 633 nm was sent into the upper edge of the array, it remained on the outermost edge of the array but propagated clockwise around the edge of the structure. The researchers report that the velocity at which the light travels around the structure's perimeter depends on the radius of the waveguide helix, reaching a maximum at a radius of 10.3 µm. *OG*

WAVELENGTH CONVERSION

Phase transparency

IEEE Photon. Tech. Lett. **25,** 791–794 (2013)

Wavelength conversion, whereby data is transferred from one carrier wavelength to another, is a potentially useful functionality in optical networks. In the optical domain, conversion can be performed by nonlinear optical processes such as four-wave mixing and it is routinely applied to intensity-modulated data. Now, Giampiero Contestabile and co-workers from Scuola Superiore Sant'Anna in Italy and Osaka University in Japan have demonstrated that the technique can also be applied to various coherent, phase-modulated data formats such as QPSK, 8-PSK and 16-QAM. The team used an InAs/InGaAsP/InP quantum-dot semiconductor optical amplifier to perform four-wave mixing. They report a conversion efficiency of more than −10 dB and an output optical signal-to-noise ratio in excess of 20 dB over a wavelength band of about 30 nm. An optical signal-to-noise ratio penalty of around 1 dB — which varies according to the data format used — is reported for the conversion process. *OG*

ADAPTIVE OPTICS

Elastomer–liquid lens

Opt. Express **21,** 8669–8676 (2013)

Compact, adaptive lenses with adjustable focal lengths are particularly attractive for space-constrained applications such as endoscopes, cellular phone cameras, web cams and machine vision systems. Now, Samuel Shian and colleagues from Harvard University in the USA report a simple, self-contained adaptive lens whose focal length can be varied through an integrated electrical actuator lying in the optical path of the lens. The lens consists of a stiff frame and a clear liquid housed between two membranes, one passive and the other electroactive. The latter is made from a transparent dielectric elastomer coated on both sides with transparent flexible electrodes. The focal length of the lens is varied by altering the relative curvatures of the two membranes. This is done by applying a voltage to the active membrane, causing it to deform and hence changing the liquid pressure, which, in turn, alters the curvature of the passive membrane. The researchers report a change in focal length of over 100% with a response time of less than 1 s. Numerical analysis indicates that appropriate selection of the lens geometry should give even better performance. *SP*

OPTOMECHANICS

Quantum collective motion

Phys. Rev. Lett. **110,** 153001 (2013)

Cavity-enhanced interactions between light and a moving mechanical structure provide a new framework for quantum-sensitive displacement measurements. Thierry Botter and co-workers from the University of California and Lawrence Berkeley National Laboratory, USA, have now demonstrated that the near-ground-state collective motion of as many as six atomic ensembles can be simultaneously measured with quantum-limited sensitivity. ^{87}Rb atoms were inserted into a Fabry–Pérot optical cavity and trapped in the potential minima of the superlattice formed by spatial beats generated by two laser beams with wavelengths of 843 nm and 862 nm. The spectrum of motional sidebands modified by the atomic motion was then extracted through optomechanical interactions with a weak probe beam whose intensity corresponded to an average intracavity photon number of 2.9. The quantum nature of six collective motional modes was confirmed by the asymmetry between the rates of red- and blue-detuned scattered photons near the frequency of each collective motional mode. The researchers also demonstrated that one particular collective motional mode can be coherently driven by modulating the intensity of the 843 nm laser beam while preserving the

PHOTODETECTORS

Highly responsive detectors

Nano Lett. **13**, 1649–1654 (2013)

Ultrathin, two-dimensional nanomaterials are highly promising for fabricating miniature electronic and optoelectronic devices. For example, graphene is potentially attractive for creating wideband, high-speed photodetectors, but it suffers from low responsivity, a very low external quantum efficiency and no spectral selectivity. This has led researchers to investigate two-dimensional nanostructures made from other materials. Now, PingAn Hu and co-workers from China, the USA and Japan have fabricated highly responsive photodetectors consisting of GaS nanosheets on both rigid (SiO_2/Si) and flexible (polyethylene terephthalate) substrates. They report a photoresponsivity of 4.2 A W^{-1} and an external quantum efficiency of 9,370% at 254 nm for GaS nanosheets on flexible substrates, which are several orders of magnitude higher than those of pristine graphene. Furthermore, these devices have high linear dynamic ranges of 97.7 dB and 78.73 dB on rigid and flexible substrates, respectively, which are higher than those of currently used InGaAs photodetectors. Theoretical analysis of the electronic band structures suggests that the photoresponse of GaS nanosheets is enhanced relative to that of bulk GaS by the existence of a double peak in the valence band and a reduction in the effective electron mass with decreasing layer thickness. The findings indicate that two-dimensional GaS nanostructures are highly suitable for realizing high-performance photodetectors on a variety of substrates. *SP*