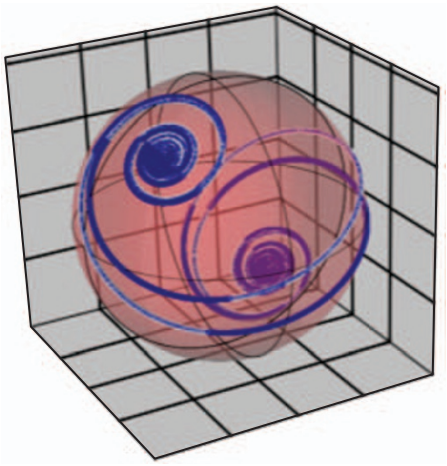
VECTOR SOLITONS

Chaotic polarization attractor

Light: Sci. Applications **3,** e131 (2014)



Dissipative solitons generated by mode-locked fibre lasers are attractive for metrology, high-resolution spectroscopy, optical fibre communications and nanophotonics applications. Now, Sergey Sergeyev and co-workers from Aston University in the UK have experimentally and theoretically investigated slowly evolving vector solitons measured over 25–25,000 round trips in an erbium-doped fibre laser that is mode locked with carbon nanotubes. Such solitons are characterized by a chaotic polarization attractor, which takes the form of a double scroll on the Poincaré sphere and has a correlation dimensionality of about 1.6. The team developed a model that, unlike previous models based on either coupled nonlinear Schrödinger or Ginzburg–Landau equations, can account for the dipole mechanism of light absorption and emission in erbium and carbon nanotubes, the slow relaxation dynamics of erbium ions and the absorption of erbium at the lasing wavelength. The researchers theoretically reproduced a new chaotic attractor for parameters close to the experimental ones. As well as being of fundamental interest, the findings are technologically significant as they permit the development of new types of lasers with controlled dynamic states of polarization. *RW*

DIAMOND OPTICS

Implantation innovation

Nano Lett. **14,** 1982–1986 (2014)

The development of diamond-based quantum optical devices has advanced significantly with the report of implanted nitrogen–vacancy centres in diamond possessing excellent optical coherence properties. Y. Chu and co-workers from the USA, Switzerland and the UK describe how, by employing a combination of ion implantation, high-temperature annealing and surface treatment, they could realize nitrogen–vacancy centres with lifetime-limited optical linewidths. The researchers comment that they managed to suppress spectral diffusion by using annealing and surface treatment to create a diamond environment that is nearly free from defects, which contribute to charge fluctuations. Linewidths as narrow as a few hundred megahertz were measured in a diamond sample with a nitrogen dose of 10^{11} cm^{-2} and an estimated doping depth of 10 nm. The ability to place nitrogen–vacancy centres with high-quality optical properties in a well-defined layer bodes well for the development of devices based on this approach. *OG*

ATTOSECOND PHOTONICS

Probing molecular hydrogen

Phys. Rev. A **89,** 023420 (2014)

Extreme ultraviolet (XUV) pump–probe measurements have made it possible to investigate the electronic and nuclear dynamics of molecular hydrogen on a subfemtosecond scale. A European collaboration of scientists from Greece and Spain has generated ultrashort (~600 as) pulses in the XUV part of the electromagnetic spectrum via a nonlinear interaction between xenon atoms and femtosecond (33 fs) laser pulses (wavelength, 800 nm; pulse energy, ~170 mJ) from a Ti:sapphire laser. The XUV pulses were then focused by a split spherical mirror onto a pulsed jet of H_2 that was synchronized with the arrival of the XUV pulses. The waist diameter of the focused XUV beam was measured to be 2 ± 1 μm with an intensity in the range 10^{13}–10^{14} W cm^{-2}. The intense XUV pulses ionized the H_2 molecules, producing charged H_2^+ and H^+ products that were detected by a time-of-flight mass spectrometer. *OG*

NANO-OPTICS

Exciting channels

Nano Lett. **14,** 1659–1664 (2014)

Channel plasmons guided by sharp V-shaped grooves in metal surfaces are known to have relatively low propagation losses. Recent work has revealed promising applications for such plasmons, including nano-optical coupling and nanofocusing; however, efficient excitation of the modes remains a challenge. Previously, this had usually been achieved by end-fire excitation (light incident on a waveguide termination) with either a focused laser beam or butt-coupling an optical fibre. However, the efficiency is typically low (~10% or less), because of the poor spatial overlap between optical modes, impedance mismatch, and polarization and positioning issues. Now, Cameron Smith and colleagues in Denmark have fabricated high-quality V-grooves having tilted 'mirrors' at their ends, which can couple bulk waves that are approximately normally incident on their surfaces. Although the idea of employing normally incident coupling and using mirrors to scatter or couple light into V-grooves is not entirely new, the

QUANTUM CRYPTOGRAPHY

Damaging laser illumination

Phys. Rev. Lett. **112,** 070503 (2014)

In recent years, the security of cryptography schemes based on quantum key distribution (QKD) has come under scrutiny due to the presence of experimental loopholes and innovative hacking approaches. The latest threat to such systems has now been outlined by Audun Bugge and co-workers based in Norway, Sweden, Malaysia and Canada. The team propose a different type of quantum hacking attack on QKD systems in which an eavesdropper actively engineers new loopholes by using damaging laser illumination to permanently change the properties of the system components. The scientists investigated widely used silicon avalanche photodiodes (APDs), which are employed as single-photon detectors in several QKD experiments. A high-power continuous-wave 807-nm laser beam was focused to a 50-μm-diameter spot on an APD. The detector dark count rate and photon detection efficiency were measured as a function of the illumination power. After laser irradiation at a power of about 1.5 W, the APDs developed a large dark current. This blinds the passively quenched detector, reducing the photon detection efficiency and the dark count rate to zero. The laser damage is permanent and renders APDs completely insecure for QKD applications. *NH*