Cover story

Vol.2 No.12 December 2008

The development of a new branch of physics — spin optics — has taken a step forwards thanks to a direct observation of the influence of the spin Hall effect of light on photon trajectories. Konstantin Bliokh and co-workers report two important observations: first, a spin-dependent deflection of photons; and second, precession of the Stokes vector along a coiled ray trajectory. The measurements, which match theoretical predictions, verify the role that the topological monopole and Berry phase play in the evolution of light. The experiments were made by passing a circularly polarized beam of red light from a HeNe laser into a small glass cylinder at a grazing angle using a prism. Once inside the cylinder the beam travels in a helical trajectory along the glass–air interface and is collected and analysed at the far end using polarization optics and a CCD camera. **[Article p748; News & Views p716]**

NONLINEAR GLASS

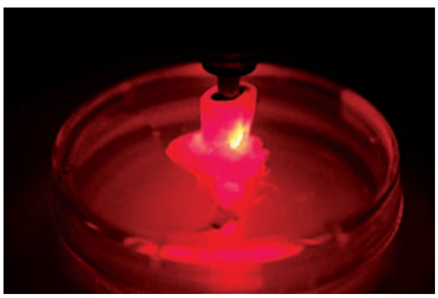
Low-power nonlinear optics is a potentially powerful tool for all-optical data processing, but on the chip scale it is typically limited to the realm of devices made from semiconductors (such as silicon and gallium arsenide) or exotic glasses such as chalcogenides. In this issue, Marcello Ferrara and his co-workers report four-wave mixing with low-power continuous-wave light in a doped silica glass waveguide. The device is a ring resonator made from a material called Hydex, which combines a large nonlinear parameter with low optical linear and nonlinear losses. The team perform their experiments in the so-called telecommunications window at a wavelength of 1,550 nm, and report that with a pump power of around 20 mW they were able to perform four-wave mixing with an efficiency of –49 dB. Although this conversion efficiency is small (about 0.0001%), the researchers show that it is sufficient for generating idler powers of tens of nanowatts when using a signal power of around 1 mW, and say that it could be improved by cascading devices.
[Letter p737]

FEMTOSECOND SYNCHRONIZATION

High precision and stable locking of lasers to microwave sources is important for applications that require careful femtosecond-scale synchronization of the delivery of optical and microwave radiation. This may be needed in modern large-scale facilities, such as particle accelerators, X-ray free-electron lasers and phased-array antennas for radio astronomy, for example. In this issue, Jungwon Kim and colleagues report that they have performed this synchronization feat with sub-10-fs precision over a period of more than 10 hours. Their scheme, involves the use of remotely located mode-locked lasers, optical-fibre links and balanced optical-microwave phase detectors, and boasts a stabilization at the level of 10^{-19}.
[Letter p733; News & Views p711]

A TRIP TO THE DENTIST

Dentistry is probably not the first application that springs to mind when discussing photonics, but laser and imaging technology is now helping to make a visit to the dentist more pleasant. In this month's Out of the Lab article, Duncan Graham-Rowe reports how laser ablation offers a compelling alternative to mechanical drills for treating tooth decay. Laser drills can be operated with greater precision so there is less damage to neighbouring tissue, and the bleeding, swelling and pain associated with traditional drilling are reduced. He describes how research in photodynamic therapy has revealed improved methods for disinfecting the biofilms in root canals. In addition, optical coherence tomography can capture real-time images of the interior of individual teeth allowing early detection of decay and disease.
[Out of the lab p705]



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Light-activated disinfection can help avoid the damage to healthy tissue that often results from current dental practices.

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COUPLED CAVITIES

Coupled photonic-crystal nanocavities show great promise for manipulating light and performing quantum information processing, but so far experiments have been confined to a small number of cavities. In this issue, Masaya Notomi, Eiichi Kuramochi and Takasumi Tanabe report experimental and theoretical results for a long chain of up to 200 wavelength-sized cavities. They show that such a chain is able to maintain a high *Q*-factor (around 10^6), low transmission losses and achieve slow-light pulse propagation with a group velocity below $c/100$. The researchers say that the low loss and highly compact size (a chain of 100 nanocavities is just 290 μm long) make it attractive for dense optoelectronic integration.
[Article p741; News & Views p715]

HARNESSING CHAOS

The ability to generate random bit sequences at very high bit rates is potentially important for applications such as data encryption and a wide variety of mathematical computations. Now Atsushi Uchida and his co-workers in Japan have generated streams of bits that pass statistical tests for randomness at rates of up to 1.7 Gbit s^{-1}, by sampling the optical outputs from two chaotic semiconductor lasers. The team say that the non-deterministic property of the bit sequences is assured by the amplification of microscopic laser noise by chaotic dynamics. Each chaotic laser is connected to a photodetector, and the resulting electronic signal is converted into a digital bit stream by a 1-bit analog-to-digital converter controlled by a clock. The binary bit streams from each laser are then combined by an XOR logical gate to create a single random bit sequence. No other digital processing is required.
[Letter p728; News & Views p714; Interview p760]

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