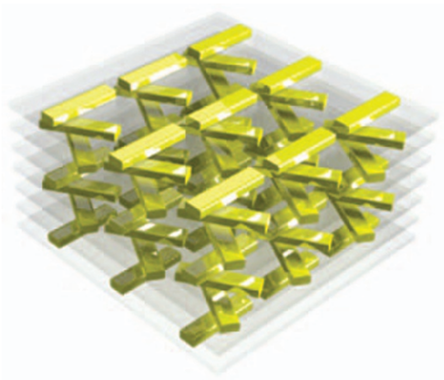
METAMATERIALS

Twisted layers

Nature Commun. **3,** 870 (2012)



Optical metamaterials are artificially engineered structures that can be used to realize optical properties not normally found in nature, and are usually made from an array of complex-shaped metal–dielectric nanostructures. Three-dimensional metamaterial geometries, which can provide additional functionalities such as broadband chirality for manipulating the circular polarization of light, become increasingly difficult to fabricate at smaller dimensions. Y. Zhao and co-workers from the University of Texas at Austin in the USA have now shown that such three-dimensional effects can be achieved by tailoring the relative orientation of each layer within a stacked lattice. Their approach involves using conventional lithographic techniques to produce an array of stacked planar metasurfaces whose constituent layers differ by a predetermined twist in the lattice orientation. The resulting planarized, broadband bianisotropic metamaterial acts as an ultrathin, broadband circular polarizer that can be directly integrated into a nanophotonic system. The approach may help to realize a wide variety of novel metamaterial devices for controlling optical behaviour, such as modal propagation and spatial dispersion. *JB*

QUANTUM INFORMATION

Teleporting robust cats

Phys. Rev. A **85,** 053824 (2012)

Quantum computing with light will likely require the use of exotic states such as 'optical Schrödinger's cats'. Unfortunately, such states are extreme fragile; they are highly susceptible to noise and rarely survive quantum teleportation, which is an important scheme for transferring quantum information. Shuntaro Takeda and co-workers from the University of Tokyo in Japan have now shown that an optical high-pass filter can remove the problematic low-frequency noise generated in most lasers, which usually destroys Schrödinger's cat states. A filter cavity in the trigger-photon channel removes unwanted noise from the spectrum where the quantum states are encoded. Unlike an electrical filter, which removes information from the measurement results, this optical high-pass filter preserves the original state. The researchers used this method to create high-quality Schrödinger's cat states of light and then tested their increased robustness in teleportation experiments. The teleported states had a central minimum of −0.033 in their Wigner functions, which indicates that these are the highest-quality cat states teleported to date. *SA*

QUANTUM OPTICS

Phase imprinting in an atomic gas

Opt. Lett. **37,** 2853–2855 (2012)

Electrically induced transparency is a promising optical scheme for a variety of applications in parallel optical computing and quantum information processing. Now, Lu Zhao and co-workers from Tsinghua University and Beijing Normal University in China have investigated two-dimensional quadratic phase shift and image reconstruction in an ultracold atomic gas in the microkelvin temperature regime. The researchers considered enhanced cross-phase modulation in a four-level N-type electrically induced transparency system. They tuned a pattern-bearing weak probe field and a strong coupling field to the two different transition wavelengths in the atomic gas. By adiabatically switching off the coupling field, they coherently mapped the probe carrying the diffraction pattern to the atomic spin coherence, which was determined by the Rabi frequency of the strong coupling field. They then retrieved the intensity profile, which is proportional to the square of the Rabi frequency, by sending a signal field to the atomic gas. Because the signal field was red-detuned from the transition frequency of the atomic gas, the cross-phase modulation dominated the nonlinear absorption, which allowed the researchers to reconstruct the stored image in the far-field. *NH*

LIGHT AND MATTER

Tunable Entanglement

Nature **485,** 482–486 (2012)

The realization of quantum networks will require precise control over light–matter interactions at the quantum scale. Andreas Stute and co-workers from Austria and Germany have now brought us one step closer to this goal by demonstrating a tunable entanglement interaction between a single calcium ion and the polarization state of a single photon. The researchers confined the ion in a Paul trap within an optical cavity and engineered entangled states between the ion and photons emitted from the ion. Varying the strengths and phases of two Raman pulses fired simultaneously at the ion allowed both the amplitude and phase of the resulting entangled states to be tuned freely. Previous light–matter systems, in contrast, were not able to tune the entanglement interaction strength. The researchers found the entangled states had a 97.4% overlap with theoretically ideal states, which is reported to be the highest fidelity ever achieved for a system of this kind. *SA*

NONLINEAR OPTICS

Bessel beams in water

Appl. Phys. B **107,** 649–652 (2012)

Pulsed Bessel beams are of particular interest for performing frequency mixing and conversion using stimulated Raman scattering (SRS). Until now, studies have considered only first-order Stokes and anti-Stokes scattering in water over femtosecond time periods. Now, Ivan Blonskyi and colleagues from the Institute of Physics of National Academy of Sciences of Ukraine have investigated SRS-seeded four-wave mixing in water under femtosecond excitation by a Bessel beam containing up to four orders of anti-Stokes bands. They used a glass axicon to focus 802 nm horizontally polarized 12-mm-diameter femtosecond laser pulses into a water-filled cell, and found that four-wave mixing caused the formation of four concentric anti-Stokes rings of different wavelengths surrounding the pump ring beam. From their analysis and experiments, the researchers concluded that the angles of the anti-Stokes cones are determined only by the longitudinal phase-matching relations between the wave vectors. Contrary to previous work, the researchers also showed that if the axial phase velocity of the pump Bessel beam is chosen to be equal to the phase velocity of the Stokes axial wave, anti-Stokes emissions of any order will satisfy the same condition of pure Cherenkov synchronism; that is, their axial phase velocities will be equal to that of the Bessel pump beam. *RW*