IMAGING

Quantum time lens

J. Opt. **19,** 054001 (2017)

Optical temporal imaging is a technique that involves stretching or compressing an optical waveform in time, while fully preserving its temporal structure. Usually, the technique is used to manipulate classical light, but now Giuseppe Patera and co-workers from France, China and Belarus have theoretically investigated its application to a non-classical, squeezed optical temporal waveform. The development is important for temporal stretching and compressing of squeezed fields, which are used in quantum-enhanced metrology and quantum communications. The scientists made a temporal imaging system based on sum-frequency generation in a nonlinear β-barium borate crystal, where the squeezed state to be temporally magnified is the signal beam and a strong coherent beam serves as the pump. Pump, signal and idler beams were propagated nearly parallel to each other and fulfilled the type-I phase-matching condition at the central frequencies. The obtained field of view (FOV) in the quantum regime was different from that in the classical regime. The main limiting factor for the FOV was the group velocity in the crystal. The quantum FOV was much narrower than the classical FOV for the same temporal imaging system. *NH*

METAMATERIALS

Reverse Cherenkov

Nat. Commun. **8,** 14901 (2017)

Cherenkov radiation is emitted by charged particles when they propagate in a dielectric medium at a speed that exceeds the phase velocity of light and is a common sight in nuclear physics. In conventional materials, the emission is in the same direction as the particle motion. Now, making use of a specially designed left-handed metamaterial (a material engineered to simultaneously possess a negative permeability and a negative permittivity), a research team from China and the US has observed reverse Cherenkov radiation that counterintuitively propagates in the opposite direction to that of the particles. The experiment took place in the microwave part of the electromagnetic spectrum (2–4 GHz). It involved a single sheet-electron-beam travelling through a metamaterial made from a square waveguide loaded with split-ring resonators and engineered to have both a negative permittivity and a negative permeability in the range 2.83–3.05 GHz. *OG*

NANOSCOPY

Scrutinizing nanowires

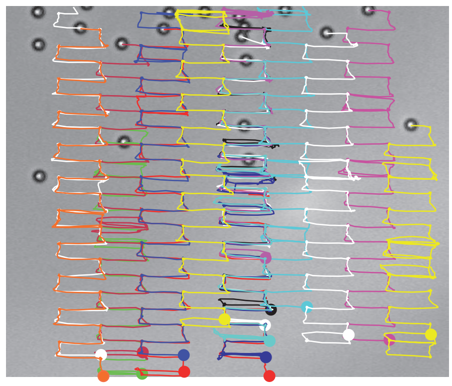
Nano Lett. http://doi.org/f9s7dk (2017)

Nanowires have emerged as promising probes in biological cells owing to their small size and optoelectronic properties. Now, Joanna Oracz and co-workers from Germany, Poland and Sweden have used ground state depletion (GSD) nanoscopy to resolve photoluminescent, heterostructure semiconductor nanowires at a resolution below the diffraction limit of light at room temperature. The nanowires consist of alternating non-luminescent gallium phosphide (GaP) and luminescent gallium indium phosphide (GaInP) segments, forming a barcode-like pattern, with an emission lifetime of 10–100 ps. The approach works by controlling the transfer of electrons out of the valence band ('off' state) into the conduction band of GaInP ('on' state), in a coordinate-targeted manner. The researchers show that the GSD nanoscopy technique can resolve nanowires with diameters down to 20 nm — a fivefold resolution enhancement over confocal imaging. The resolution of the GSD system is believed to be limited by the material properties of the nanowires and the residual intensity in the minimum of the doughnut-shaped beam. Because of the far-red excitation wavelength (~700 nm) and low excitation power (~3 mW), GSD nanoscopy is expected to be suitable for biological applications. *RW*

OPTICAL LATTICES

Reconfigurable ratchet

Phys. Rev. Lett. **118,** 138002 (2017)



APS

A scheme for realizing a reconfigurable, 2D lattice potential and that can perform directed transport of Brownian particles with a ratchet-like behaviour has been built by a Mexican–Czech collaboration. The set-up was shown to be able to control the propagation of 1.99-μm-diameter polystyrene microspheres immersed in water. Alejandro Arzola and co-workers from the Universidad Nacional Autonoma de Mexico and the Institute of Scientific Instruments of CAS used a spatial light modulator (SLM), programmed with a computer-generated hologram, to create a pattern of light spots in the form of a 2D lattice. Importantly, the beam leaving the SLM is split into two different polarizations that can have their relative intensities adjusted and their light spot pattern shifted with respect to one another to create an asymmetry in an arbitrary direction. As a result, an ensemble of particles can be made to move in a ratchet-type manner, as shown by the coloured paths in the image. Simulations with as many as 500 particles match well with the observed behaviour. *OG*

FREE-ELECTRON LASERS

Terahertz spectrometer

Appl. Phys. Lett. **110,** 094106 (2017)

Terahertz magneto-spectroscopy has been performed with light intensities far beyond that of conventional light sources by making use of the FLARE free-electron laser in The Netherlands and strong 33 T Bitter magnets. Mykhaylo Ozerov and co-workers from Radboud University tested the performance of the spectrometer by performing electron spin resonance (ESR) measurements of polycrystalline 2,2-diphenyl-1-picrylhydrazyl (DPPH), a well-known paramagnetic material. Terahertz pulses from FLARE with an average power of 100 mW were focused to a nearly diffraction limited Gaussian spot, resulting in THz electric and magnetic fields with strengths of 7–70 kV cm^{-1} and 2–20 mT, respectively. The photon energy of the THz pulse from FLARE was tunable from 0.3 to 3 THz in frequency. The ESR spectra of the DPPH sample were captured with sufficiently high resolution to reveal a 3 GHz fine structure. The spectral resolution $\Delta\nu/\nu$ is better than 0.1%, which is an order of magnitude higher than typical values for a RF-linac-based free-electron laser. *NH*

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