OPTOMECHANICS

Cool levitation

Phys. Rev. Lett. **114,** 123602 (2015)

Cooling schemes that employ levitation are potentially useful for applications where isolation from the environment is important. James Millen and co-workers at University College London in the UK have now demonstrated the cooling of a single, charged 400 nm silica nanosphere that is levitated inside a specially designed trap. Their set-up combines a Paul trap — which typically use radio frequency fields for trapping ions — and an optical cavity field. A key advantage of the system is that levitation is achieved not by the optical field alone, so the light intensities required are not sufficiently strong to risk melting or damaging the sample. A particle in the Paul trap, which is inside the optical cavity, can be captured by one of the potential wells of the optical field. This capture occurs when the particle motion is optomechanically damped by red-detuned light during its oscillation in the trap. By monitoring scattered light the nanosphere was observed to be cooled to ~10 K. The particles are trapped for ~200 ms but it only takes about 10 ms to cool them. And a nanosphere lost from the optical well is caught in the Paul trap and the cooling cycle commences again. *DP*

TWO-DIMENSIONAL MATERIALS

Enhanced nonlinearity

Phys. Rev. Lett. **114,** 097403 (2015)

Monolayers of transition metal dichalcogenides, such as WSe_2 and MoS_2, are potentially ideal materials for nonlinear optics because of their broken inversion symmetry and strong light–matter interaction. Gang Wang and colleagues from Université de Toulouse in France have now demonstrated an enhancement by up to three orders of magnitude of the efficiency of second harmonic generation (SHG) when a monolayer of WSe_2 is excited by an electromagnetic wave. The wave needs to be in resonance with the energy of the exciton states of strongly Coulomb-bound electron–hole pairs below the electronic band gap. Wang *et al.* achieved this by tuning the optical excitation on and off resonance with respect to the ground (1s) and excited (2s, 2p and so on) exciton states. When the excitation laser is tuned in resonance with the 1s exciton states, for which two-photon absorption is parity-forbidden, strong SHG is observed. They attribute this to the unusual combination of electric dipole and magnetic dipole transitions. When the 2s or 2p exciton states are excited resonantly, *k*-valley coherence and valley polarization in two- and one-photon absorption can be maximized. *RW*

LIGHT–MATTER COUPLING

Domain motion by light

Nature Commun. **6**, 6594 (2015)

Controlling the spontaneous polarization of ferroelectric materials is essential for nonvolatile ferroelectric random memory (FeRAM). However, the need for physical contact between electrodes and ferroelectric materials makes it difficult to integrate FeRAM into devices. Now, Fernando Rubio-Marcos and co-workers from Spain and France report how polarized light with a wavelength of 532 nm can induce the motion of ferroelectric domain walls of a $BaTiO_3$ single crystal without any physical contact. With the aid of optical microscopy and confocal Raman microscopy, mappings of the domain structure were obtained at the surface and deeper within the sample. Two well-known types of domains were identified by their characteristic Raman peak and the team also found a new type of domain, which appears at the surface like a domain boundary. Surprisingly, the new domain was sensitive to the polarized light and pushed away other domains. The authors say that the findings could ultimately yield a non-contact read-out method in FeRAM devices or remote control of piezoelectric actuators. *NH*

EXCITONICS

Weak lasing

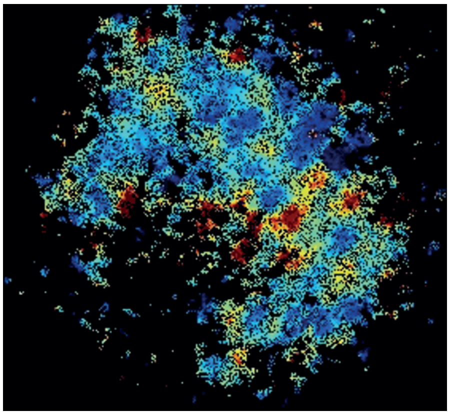
Proc. Natl Acad. Sci. USA **112,** E1516–E1519 (2015)

Polaritons in periodic potentials are useful for understanding the physics of many-body systems and exploring applications in optoelectronics. Recent experiments by Long Zhang, Wei Xie and an international collaboration from China, Russia, Mexico, the USA and the UK suggest that an effect known as weak lasing in one-dimensional polaritons in superlattices has now been observed at room-temperature. A structure with one-dimensional periodicity was made by laying a ZnO microrod of hexagonal cross-section onto silicon corrugated with 1-μm-wide channels, with a period of 2 μm. The ZnO rod forms a whispering-gallery mode resonator for the exciton–polaritons, subject to a periodic potential along the length of the wire due to the adjacent structured silicon. Photoluminescence was used to investigate the structure when optically pumped at room temperature. Long-range phase coherence was observed and for strong pumping the spatial period of the condensate is twice that of the superlattice period. The authors state that previous work using GaAs did not confirm the period-doubling feature of weak lasing and they suggest that ZnO may yield more robust weak lasing. *DP*

PHOTON COUNTING MICROSCOPY

Improved time resolution

New J. Phys. **17,** 023032 (2015)



IOP

The 'afterglow' from the phosphor found in an image intensifier can be usefully employed to dramatically improve the temporal resolution of time-correlated single photon counting microscopy, say scientists from Kings College London in the UK. Usually the temporal resolution of such an imaging system is limited by the camera's exposure time, which hinders the ability to measure photon arrival times precisely. However, Liisa Hirvonen and co-workers report how taking ratios of the intensity of photon events in two subsequent frames allows photon arrival times to be determined with a precision of just 300 ns — far faster than the camera's exposure time of 18 μs. Tests with samples, including living cells, containing ruthenium and iridium fluorescent complexes demonstrated the viability of the approach. Images can be acquired in a few seconds and require an excitation power far smaller than time-gating schemes. The team says that in the future using an image intensifier with a faster phosphor decay time than the P20 phosphor used in their initial tests could potentially make the measurement of photon arrival times on the nanosecond scale possible. Applications that may benefit from the approach include biological imaging, LIDAR and ion velocity mapping. *OG*

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