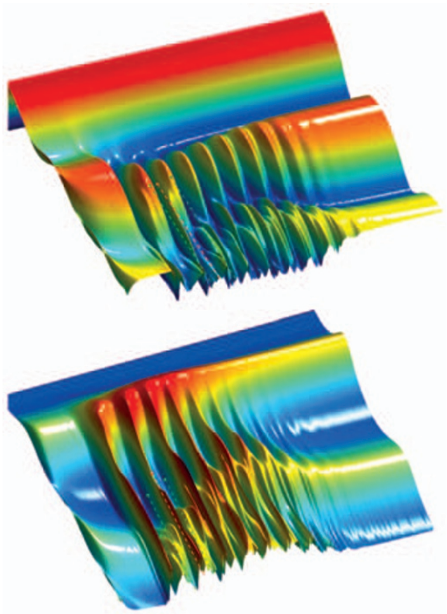
NONLINEAR OPTICS

Reversing loss

Phys. Rev. X **4,** 011054 (2014)



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The Fermi–Pasta–Ulam (FPU) problem is a paradox that was first analysed in the 1950s. Contrary to what one might intuitively expect, thermalization of coupled oscillators does not necessarily cause the initial modes to fade gradually. Instead it can yield quasi-periodic behaviour, known as FPU recurrence, which 'revives' the modes. The effect is highly relevant in the field of nonlinear optics. Arnaud Mussot and colleagues from Université de Lille in France and the Australian National University have now shown that under the influence of third-order dispersion, the FPU phenomenon can undergo multiple appearances and disappearances within an optical fibre. According to the authors, this behaviour is related to Čerenkov radiation. The team used two tunable diodes to generate the pump and signal beams. These beams were coupled using a 50/50 fibre coupler, amplified by an erbium-doped fibre amplifier and then injected into a dispersion-shifted fibre. A pseudo-random encoding was applied to prevent stimulated Brillouin scattering. In experiments showing FPU recurrence in an optical fibre, multiple recurrences can occur when the optical frequency varies near the zero-dispersion wavelength of the fibre. The team found that by varying the pump wavelength between 1,561.6 nm and the zero-dispersion wavelength of 1,550.2 nm, the radiation loss could be made reversible or irreversible, resulting in reappearance and disappearance of the FPU phenomenon, respectively. *DP*

UV LASERS

Narrow VUV pulses

IEEE Photon. Tech. Lett. **26,** 980–982 (2014)

Chinese scientists have developed a high-performance laser operating in the vacuum-ultraviolet (VUV) region. The narrow linewidth (estimated to be 0.71 pm) and high average power (146 mW) of this diode-pumped VUV laser make it attractive for applications in high-precision spectroscopy and semiconductor photolithography. Zhi Xu and co-workers used a three-stage system to generate 177 nm light. The first stage consists of a narrow-band Nd:YAG master oscillator power amplifier that produces 1,064 nm light. In the second stage, this light is frequency tripled to produce 355 nm nanosecond pulses by cascaded frequency conversion in two lithium triborate crystals. Finally, this light undergoes second-harmonic generation (SHG) in a $KBe_2BO_3F_2$ crystal. The researchers realized a high SHG conversion efficiency of 2.8% by reducing the wave-vector mismatch between the fundamental and second-harmonic light through using a pump source with a narrow linewidth (2 pm). The scientists claim that this represents the highest power at 177.3 nm and the highest SHG conversion efficiency for 355 nm to 17.3 nm reported to date for the nanosecond regime. *SP*

TWO-DIMENSIONAL MATERIALS

Laser *Q*-switching

Adv. Mater. http://dx.doi.org/10.1002/adma.201306322 (2014)

Monolayers of molybdenum disulphide (MoS_2), a transition-metal dichalcogenide, are interesting for electronic and optoelectronic applications, because they possess a direct bandgap in the visible range. Now, by introducing suitable defects through varying the ratio of Mo ions to S ions, Shuxian Wang and co-workers from Shandong University in China have demonstrated that a stack of MoS_2 sheets can act as a saturable absorber. The introduction of defects reduces the bandgap of MoS_2 atomic layers, causing the material to exhibit broadband saturable absorption that can be used to passively *Q*-switch a laser. Using over 30 stacked monolayers of MoS_2 prepared by pulsed laser deposition, the team succeeded in making passively *Q*-switched lasers that operate at wavelengths of 1.06 μm, 1.42 μm and 2.1 μm and have Nd:$GdVO_4$, Nd:$Y_5Ga_5O_{12}$ and Tm:Ho:$Y_5Ga_5O_{12}$ crystals as gain materials. Pulses were generated with sub-microsecond temporal widths and microjoule energies at repetition rates of hundreds of kilohertz, giving maximum output powers of up to a few hundred milliwatts. The team envisages that the findings will aid the design of variable bandgaps in two-dimensional optoelectronic crystals. *RW*

QUANTUM DOTS

Monitoring charge jumps

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Highly sensitive coherent reflectivity measurements have enabled a French team to monitor in real-time single-charge 'jumps' in a semiconductor quantum dot in a cavity. Loic Lanco and co-workers from the Laboratoire de Photonique et Nanostructures in Marcoussis and the Université Paris Diderot say that the strongly enhanced light–matter coupling in the cavity and the use of an almost shot-noise-limited detection arrangement has allowed them to perform measurements on the microsecond timescale — five orders of magnitude faster than previous efforts. The researchers say that the charge transitions in a cryogenically cooled InGaAs quantum-dot micropillar can be monitored with a temporal error of less than 0.2% and that the transitions correspond to the capture and subsequent release of a charge carrier. Light from a continuous-wave single-mode laser with a tunable photon energy was intensity modulated at a rate of 2 MHz and focused onto the micropillar, where it was reflected. The incident and reflected powers were detected by a pair of silicon avalanche photodiodes connected to lock-in amplifiers. The high speed of the technique may make it useful for monitoring other rapid single-quantum events, such as spin flips of a single electron or hole. *OG*

SINGLE-PHOTON SOURCES

Spontaneous answer

New J. Phys. **16,** 033042 (2014)

'Rephased' amplified spontaneous emission (RASE) from an atomic ensemble could in principle lead to on-demand production of single photons with a high efficiency and fidelity, according to an international team of researchers. Robin Stevenson and co-workers from Australia, the UK and Germany investigated the RASE approach and how its performance could be optimized. They concluded that to avoid unwanted multiple photon events one should operate with a low optical depth; however, the rephasing efficiency rises with increasing optical depth.