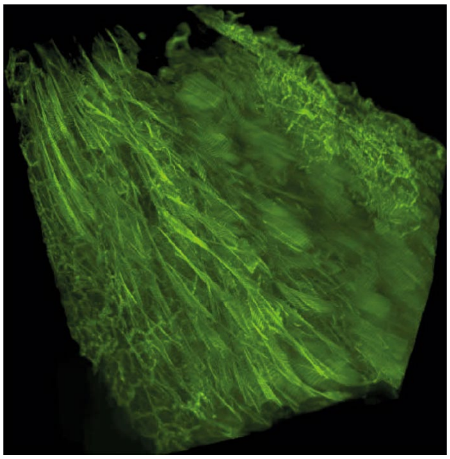
IMAGING
## Intracellular movies
*Science* **360**, eaaq1392 (2018)



Credit: AAAS

The ability to observe subcellular dynamics in vivo has now been achieved with some breath-taking images as a result. An international team of scientists, including the Nobel Prize winner Eric Betzig, has combined lattice light sheet microscopy with adaptive optics technology in a 3D imaging system called AO-LLSM to create movies of subcellular processes. The approach rapidly and repeatedly scans an ultrathin sheet of light through the volume of interest, building up a 3D movie of the fluorescence that it captures. The adaptive optics is a two-channel approach, being applied to both the excitation and detection beams, and makes use of a deformable mirror for wavefront correction and two Shack–Hartmann wavefront sensors. The use of a fluorescent guidestar within the region of interest is used to calibrate the system. The AO-LLSM system was employed to a variety of cell types taken from zebrafish embryos, allowing the study of neural cells from its brain, its spinal cord neural circuit development, organelles in eye cells, and immune and cancer cell migration. The team says that the biggest challenge is dealing with the immense amount of data generated by an experiment, which is on the terabyte scale. *OG*

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QUANTUM INFORMATION
## Ion string qubits
*Phys. Rev. X* **8**, 021012 (2018)

It is a widely held view that a large number of qubits will be required for quantum computers to prove beneficial and offer supremacy over existing solutions. However, the generation and detection of complex multi-qubit entangled states remains an open challenge. Now, Nicolai Friis and co-workers from Austria and Germany have succeeded in generating and characterizing complex entangled states of 20 trapped-ion qubits. The 20 qubits were created from a one-dimensional string of $^{40}Ca^{+}$ ions confined in a linear Paul trap. The string length was 108 μm. The qubit was encoded into two long-lived states of the outer valence electron in each ion. Laser beams were used to rotate the basis of individual qubits. The team succeeded in detecting genuine multipartite entanglement in groups of up to 5 qubits within the 20-qubit system. They found that every qubit simultaneously became genuine multipartite entangled with at least two of its neighbours and, in most cases, three and four of its neighbours. Each qubit could be individually controlled and qubit–qubit interactions could be tuned on and off as desired, opening the way for universal quantum simulation and quantum computation. *NH*

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SILICON PHOTONICS
## Synthesizer on a chip
*Nature* **557**, 81–85 (2018)

Optical-frequency synthesizers using table-top mode-locked-laser frequency combs are useful for ultrafast photonics and metrology. However, their wide use is constrained by their bulky size, and high power requirement and cost. Now, exploiting dissipative Kerr-soliton combs and silicon photonics, Daryl Spencer and colleagues have realized a compact, low-power, on-chip synthesizer. Their synthesizer consists of a heterogeneously integrated III–V/silicon ring-resonator tunable laser and a fully stabilized dual comb composed of an octave-bandwidth comb with 1 THz mode spacing and a C-band-spanning comb with 22 GHz mode spacing. The former comb is generated in a silicon nitride planar waveguide-coupled resonator while the latter in a silicon oxide wedge-based whispering-gallery-mode resonator with a quality factor of 180 million, which facilitates low-power operation. By phase-stabilizing the comb spacing and offset frequency, the team managed to achieve highly precise phase-coherent multiplication from an electronic clock at 10 MHz to the optical domain with a multiplication factor of 19,403,904. Frequency synthesis across a 4 THz band near 1,550 nm with 1 Hz resolution and an uncertainty of better than $7.7 \times 10^{-15}$ was obtained. The researchers are optimistic that their high-precision, high-accuracy, compact synthesizer will be of great use to any applications that need an optical-frequency source. *RW*

https://doi.org/10.1038/s41566-018-0186-4

NANOPHOTONICS
## Energy-efficient detector
*APL Photon.* **3**, 046101 (2018)

By harnessing photonic crystal waveguide technology, scientists in Japan have fabricated a miniature photodetector that is fast and highly responsive. The micrometre-scale device consists of an InP lateral p–n junction that features a waveguide and a buried InGaAsP absorbing region at the interface between the p and n regions. Experiments with 1.3 μm light indicate photodetection with a responsivity of 0.88 A $W^{-1}$ while tests at 1.53 μm suggest a speed of operation of 40 Gbit $s^{-1}$ at a forward bias of 0.2 V. In principle, the approach should make it feasible in the future to construct photoreceivers with a $\mu m^2$ footprint that consume just 1 fJ per bit and do not need electrical amplifiers. Such devices could prove to be useful building blocks for densely integrated nanophotonics chips for applications in energy-efficient information processors and communications. *OG*

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