To be sure, the high-throughput technique isn't yet for every experiment. With a mixing time of about 10 s, it would have been poorly suited to the investigation of nonequilibrium α-synuclein folding. Still, Weiss envisions it as a useful tool for elucidating complex processes such as eukaryotic transcription, which can involve hundreds of proteins.

"Looking at many different conditions used to be tedious and imprecise work," says Weiss. "Now we just load everything, press enter, and when we come back the next morning we have all the answers."

Ashley G. Smart

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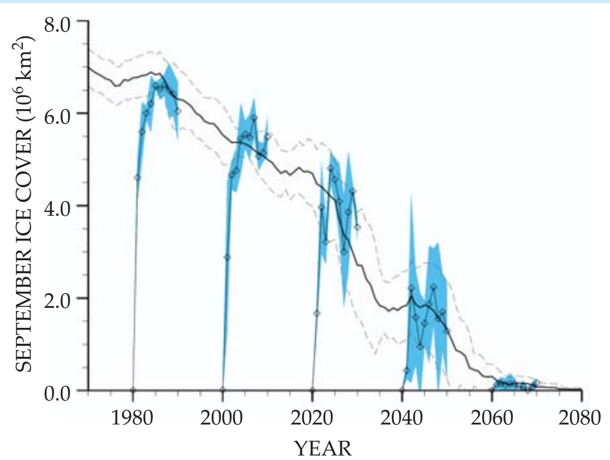
physics update

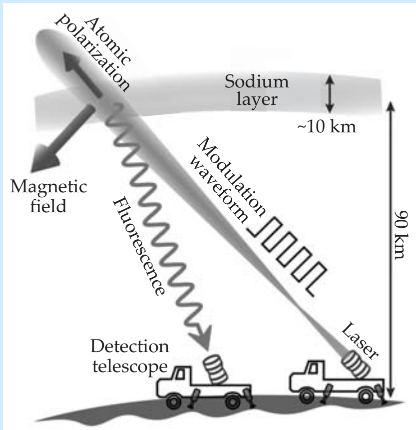
These items, with supplementary material, first appeared at http://www.physicstoday.org.

Recovery mechanism for Arctic ice. Global climate change is progressively reducing the Arctic Ocean's summer ice cover. That retreat harbors an obvious positive-feedback mechanism: Because ice is more reflective than open water, the shrinking cover means more absorption of solar radiation, leading, in turn, to more loss of ice. (See the article by Ron Kwok and Norbert Untersteiner on page 36.) That raises the prospect of a possible tipping point at which the thus-far relatively gradual retreat of summer ice "runs away," leaving

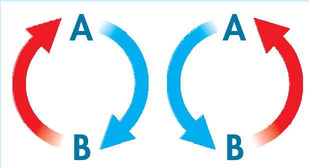


the Arctic Ocean perennially free of summer ice long before the date—sometime late in this century—generally deduced from climate models. But might not those models be made to reveal such threshold behavior by subjecting them to strong perturbations? Steffen Tietsche and coworkers at the Max Planck Institute for Meteorology in Hamburg, Germany, tried that with a widely used climate model. What would happen, they asked, if by a random fluctuation in some year, the Arctic Ocean became completely free of ice on 1 July? The figure, plotting ice cover in September, when it's typically least, shows the result (in blue) when that initial perturbation is imposed in a particular year. In every case, the September cover reverts to its gradually falling unperturbed level (black curve) within about two years. Tietsche and company attribute such prompt recovery primarily to a negative-feedback mechanism that damps the albedo reinforcement: During the long, dark winter, the lack of insulating ice produces an anomalously warm arctic atmosphere, whose top radiates heat away faster and whose sides receive less wind-driven heat from temperate latitudes. So, they conclude, a tipping point at which the loss of summer sea ice becomes sudden and irreversible is unlikely. (S. Tietsche et al., *Geophys. Res. Lett.* **38**, L02707, 2011, doi:10.1029/2010GL045698.) —BMS

Building an atomic geomagnetometer from the ground up. Measurements of the geomagnetic field at the smallest scales are used to locate sunken ships and mineral-rich geological formations. Large-scale measurements probe properties of Earth's core. At length scales of tens to hundreds of kilometers, geomagnetic maps yield clues about the chemical dynamics in Earth's outer mantle and the effects of ionic currents on ocean circulation. To avoid ground-based electromagnetic interference, geomagnetometers are typically placed aboard orbiting satellites, which are deployed sporadically and at a relatively high cost. Now, an international team of scientists led by James Higbie (Bucknell University), Domenico Bonaccini Calia (European Southern Observatory), and Dmitry Budker (University of California, Berkeley) has proposed a lower-cost ground-to-space system that exploits the interaction of beams from ground-based lasers with sodium atoms in the mesosphere, about 90 km above Earth's surface. The team's system would harness the existing and expanding infrastructure of high-powered lasers that generate artificial stars for optical telescopes by exciting mesospheric sodium. As shown in the image, an optically pumped laser would spin polarize the sodium atoms, and then a ground-based telescope would measure the fluorescence intensity, which is dependent on the atoms' precession frequency in the magnetic field. The researchers calculate that such a system would achieve subnanotesla sensitivity and could lead to the formation of a global network for continuous mapping and monitoring of mesospheric magnetic fields. (J. M. Higbie et al., *Proc. Natl. Acad. Sci. USA* **108**, 3522, 2011, doi:10.1073/pnas.1013641108.) —JNAM



Wavefunction's unconventional statistics manifested. In three dimensions, exchanging identical particles has a simple effect on a wavefunction: no change for bosons, multiplication by −1 for fermions. In two dimensions, things are more complicated. Consider the two ways to switch identical particles "A" and "B" shown in the figure. Because the clockwise and counterclockwise switches can't be continuously deformed into each other, 2D exchange doesn't just swap coordinates; it also involves a topological component. When many particles are involved, the topological issues are correspondingly more complex, and exchange operations might not commute. In that case the particles are said to have non-abelian (that is, noncommuting) anyon statistics. Non-abelian anyons are more than a mathematical curiosity: Condensed-matter physicists have plausibly argued that the quasiparticles that participate in the so-called $\nu = 5/2$ fractional quantum Hall state are objects of that type (see the article by Sankar Das Sarma, Michael Freedman, and Chetan Nayak in PHYSICS TODAY, July 2006, page 32). Now, Nayak (Microsoft Station Q and the University of California, Santa Barbara) and colleagues have, in the first calculation of its kind, explicitly demonstrated the compatibility of a specific popular candidate $\nu = 5/2$ wavefunction with non-abelian anyon statistics. The key step, says MIT's Frank Wilczek, was to map the wavefunction to a rather different physical system amenable to attack with a well-established battery of mathematical tools. Does the wavefunction studied by the Nayak team actually describe the $\nu = 5/2$ state? That ball is in the experimentalists' court. (P. Bonderson et al., *Phys. Rev. B* **83**, 075303, 2011.)

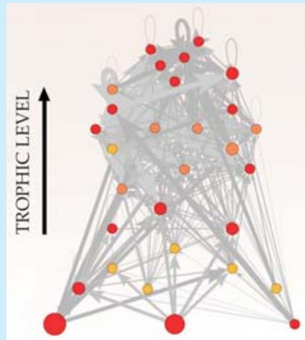


—SKB

Chemical pattern formation in three dimensions. Irving Epstein and his coworkers at Brandeis University in Waltham, Massachusetts, have shown that a chemical mechanism for producing patterns in two dimensions also works in three. Proposed in 1952 by Alan Turing, the mechanism relies on the competition between a slow-diffusing chemical that activates a reaction and a fast-diffusing chemical that inhibits the reaction. Nudging the reaction–diffusion system into a metastable state yields stable stripes, spots, and other periodic patterns. Turing's analysis and its subsequent experimental confirmation was for two-dimensional systems. Although computer simulations suggest the mechanism also operates in 3D, proving it in the lab is challenging: The extra spatial dimension makes it difficult to see patterns inside the medium. To meet that challenge, the Brandeis team used optical tomography to view a medium made up of aqueous droplets embedded in oil. Turing's model doesn't ordinarily apply to such an inhomogeneous medium. However, by coating the droplets with a surfactant, the team ensured that the slow-diffusing activator and fast-diffusing inhibitor leaked in and out at rates that sustained pattern formation on scales larger than the droplets themselves. To monitor the system, the team rotated the reaction vessel (a quartz cylinder) in front of a camera that took a sequence of 2D images. Tomographic reconstruction of the system under different initial conditions revealed a gallery of structures, including the labyrinthine worms shown here. Epstein anticipates that the 3D version of Turing's model may explain the formation of some biological patterns, such as the process by which *Hydra* regrows its tentacle-tipped head after decapitation. (T. Bánsági Jr, V. K. Vanag, I. R. Epstein, *Science* **331**, 1309, 2011.)

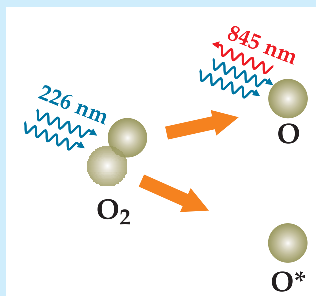
—CD

Saving food webs by subtraction. An ecosystem is a dynamic, complex tangle of predators and prey in which the depletion of one species can trigger a cascade that leads to the extinction of several others. Some cascades are structural—they propagate when an extinction leaves some predators with no prey. Others are dynamic—they occur when an initial extinction leaves the system in an unstable state that, in mathematical parlance, is drawn by an attractor toward multispecies extinction, even though more favorable steady states might exist. Now, simulations by Adilson Motter and Sagar Sahasrabudhe (both at Northwestern University) suggest that many dynamic cascades can be mitigated with the strategic removal or suppression of a second species. Some rescues are intuitive, such as removing a second species that's a predator or prey of the first. But the ideal rescue species need not share such a direct link with the cascade-instigating species; it can even be a species that would have gone extinct in the cascade anyway. Sometimes just partial suppression of a species can spare the entire food web. The team demonstrated how its approach might work in California's Coachella Valley ecosystem, depicted as a network in the figure. Arrows point from each prey to its predator. The larger circles indicate species that, if removed, would most likely instigate a cascade; the yellow circles, those most likely to mitigate one. The results suggest that smart, sometimes counterintuitive population-control measures could be instrumental in conserving ecosystems. (S. Sahasrabudhe, A. E. Motter, *Nat. Commun.* **2**, 170, 2011.)



—AGS

Backward lasing in air. A central challenge in detecting hazardous gases and vapors that indicate the presence of hidden explosives is obtaining a strong enough signal from a distant, safe location. Optical techniques commonly rely on the backscattering of incident laser light. At long distances, though, the backscattered signal can be prohibitively weak due to the omnidirectional nature of fluorescence. Arthur Dogariu and his Princeton University colleagues have now developed an approach that could produce much stronger signals. They demonstrate that a thin 1-mm-long patch of oxygen molecules can be optically pumped from afar to emit laser light in the forward and backward directions—the backward-going beam sampling the air as it returns. As outlined in the figure, a remote UV laser (blue) does double duty: It drives both the two-photon dissociation of molecular oxygen and the two-photon excitation of one of the atomic fragments, which then emits in the IR (red) back toward the pump laser. Stimulated IR emission from atomic O is itself not new; it was first observed in combustion experiments in the late 1980s. But the Princeton team realized, from their own combustion experiments a few years ago, that lasing in room-temperature, atmospheric-pressure air might be possible without the need for a local, molecule-dissociating flame. Thanks to the backward-going laser's high gain, its signal intensity is roughly a million times greater than the intensity of concomitant fluorescence collected in the same solid angle. (A. Dogariu et al., *Science* **331**, 442, 2011.)



—RMW