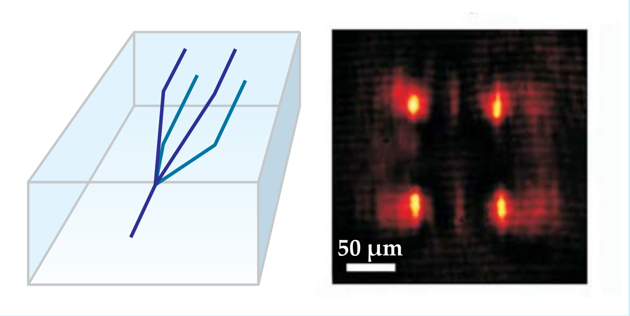
physics update These items, with supplementary material, first appeared at http://www.physicstoday.org.

How neurons reorganize in growing brains. Matthias Kaschube of Princeton University and his collaborators have applied concepts from pattern formation and continuum dynamics to address a key question in neuroscience: Do neurons retain their roles in a growing brain? Although an adult human's brain is four times as large as a baby human's, it has roughly the same number of neurons. The extra volume accommodates the developed brain's greater number of blood vessels, nonneuronal cells, and—crucially for memory and intelligence—interneuron connections. To understand the development of those connections, Kaschube and others study ocular dominance (the brain's preference for input from one eye over the other) in the primary visual cortex (the brain's principal image processor). Several factors make OD a convenient model system. Not only are OD signals readily induced and tracked; the neurons responsible for OD are grouped in recognizable rows of columns, like picket fences. Data gathered from kittens by Kaschube's collaborators—Karl-Friedrich Schmidt and Siegrid Löwel of Friedrich Schiller University in Jena, Germany—conflict with the simplest growth model in which OD columns and their separations both expand by the same factor as the visual cortex. Rather, the columns increase in number and keep their separations while the rows lose their original straight configuration and become wavier. Kaschube and his graduate student Wolfgang Keil account for the pattern change by invoking the zigzag instability, which arises when stripes in isotropic systems are stretched. In the simple growth model, individual OD neurons would continue to carry signals from the same part of the visual field of view to the same part of the visual cortex. In Kaschube and Keil's model, the reorganization of OD neurons implies that individual neurons continuously and flexibly change their signal-carrying roles. (W. Keil, K.-F. Schmidt, S. Löwel, M. Kaschube, *Proc. Natl. Acad. Sci. USA* **107**, 12293, 2010.) —CD

Carbon emissions sour ocean waters. It's not just the spilled oil: Since the Industrial Revolution, Earth's oceans have been soaking up unprecedented levels of atmospheric carbon dioxide as well as runoff from manufacturing processes. In a new review, Woods Hole Oceanographic Institution scientist Scott Doney describes the impact of human activities on the open ocean and coastal waters. Observations and models show that up to 30% of the carbon released by fossil-fuel combustion is absorbed by the ocean; with that rise in subsurface CO_2, a weak acid in seawater, the ocean's pH plummets. Measurements of CO_2 and pH collected over the past two decades off Hawaiian shores show that the ocean is becoming more acidic—30 to 100 times faster than what geological records report. The shift in the ocean's acid–base equilibrium due to excess CO_2 also hinders the precipitation of calcium carbonate, which makes up the shells and skeletons of many marine species. Yet another concern is hypoxia—dangerously low levels of subsurface oxygen caused by climate-warming-induced degradation of organic matter—which leads to anaerobic respiration conditions and produces even more CO_2. And yes, oil spills, even naturally occurring seeps from oil wells, release pernicious hydrocarbons into the marine environment. Most such industrial chemicals are "woefully undersampled," writes Doney, whose summary calls on the oceanographic community to better coordinate its monitoring of the ocean's biogeochemical cycle. (S. C. Doney, *Science* **328**, 1512, 2010.) —JNAM

Protecting the world's largest particle accelerator. When CERN's Large Hadron Collider is fully operational, it will accelerate countercirculating protons to energies of 7 TeV, the highest particle energy ever achieved by human ingenuity. By macroscopic standards, 7 TeV (10^{-6} J) is tiny. But each beam produced at the LHC will ultimately include some 3×10^{14} protons; should it go awry, it could seriously damage the LHC and the delicate particle detectors that the accelerator hosts. For that reason, as described in a new paper by Robert Appleby and colleagues at CERN, the LHC includes an elaborate safety system that regulates the beams, monitors them, and dumps them out of harm's way if they go off course. To give an idea of the system's complexity, the authors note that 17 distinct subsystems must continually give a virtual OK to a central processer, or else the beam will be dumped. In addition to describing the LHC's safety features, Appleby and colleagues calculate how the beams would respond to various possible accidents—improperly set magnetic fields, for example—and ask if the protection system would respond quickly and accurately enough to avert disaster. Although no system can protect against all failures, the researchers conclude that the accelerator and its associated detectors are as safe as could reasonably be expected. In addition to the simulated studies, scientists are testing the protection system with real 3.5-TeV beams whose intensity is gradually being ramped up. (R. B. Appleby et al., *Phys. Rev. ST Accel. Beams* **13**, 061002, 2010.) —SKB

Three-dimensional waveguide junctions inside glass. In photonic devices and networks, optical waveguides routinely need to be coupled, split, and switched; several methods are in use to fabricate those junctions. A promising technique for making three-dimensional junctions in transparent materials, such as silica glass, is to write them with femtosecond lasers. Under optimal laser-writing conditions, a focused spot photoexcites the glass through nonlinear absorption and locally changes the refractive index. Slowly moving the material stretches the spot into a line of altered index that acts as a waveguide. For creating junctions, however, it has proven difficult to precisely position the material for each branch. Now, researchers at Japan's Kyoto University have sidestepped that issue by introducing parallel laser writing of multiple branches in three dimensions. The key is computer-generated holograms. With a CGH and a single laser, multiple beam spots can be focused at precise locations in the glass. As the material is moved, CGHs are sequentially swapped



in and out to change the spots' locations. Using 256 CGHs, the researchers fabricated a 20-mm-long continuous waveguide that split and spread into four branches about 85 µm apart. A schematic is shown on the left, and the output from a single incident 635-nm laser beam is shown on the right. Optimization of the method is under way. (M. Sakakura et al., *Opt. Express* **18**, 12136, 2010.) —SGB ■