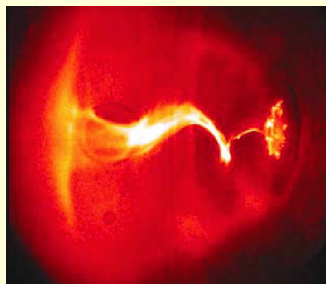


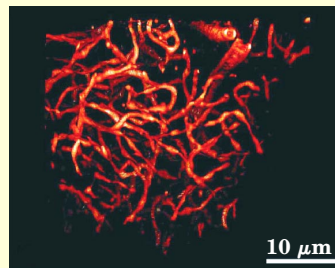
THE TWISTED ORIGIN OF SPHEROMAKS. Driving a sufficiently large current along a plasma-filled seed magnetic field can result in the formation of a spheromak—a self-organized, stable, vortexlike, isolated toroid of plasma. Typically, researchers use a coaxial “gun” (at right in this image) through which magnetic forces shoot current-carrying plasma into a vacuum chamber. The seed field extends out along the gun axis and then folds back; the current flows along the seed field and produces a path of bright light. Spheromak formation is believed to involve a dynamo process, whereby the seed magnetic field is amplified at the expense of the field associated with the current. Now, Caltech physicists Scott Hsu and Paul Bellan have captured images of the plasma in their 1.5-m-diameter $\times$ 2-m-long vacuum chamber, while measuring the magnetic fields. Their results demonstrated not only the dynamo amplification process but also its origin. At a critical current threshold, a so-called kink instability develops, and as



shown here, the initially straight current becomes helical. Acting as a solenoid, the helical current effectively amplifies the original seed field, and eventually the spheromak becomes detached from the gun and floats freely in its state of minimum magnetic energy. Spheromaks represent a possible plasma confinement configuration for nuclear fusion. Insight into their formation should help in the design of future magnetic confinement fusion experiments. Spheromak formation is also important for understanding plasma dynamics in the solar corona and in astrophysical jets. (S. C. Hsu, P. M. Bellan, *Phys. Rev. Lett.* **90**, 215002, 2003.) —JRR

ALL-OPTICAL HISTOLOGY with femtosecond lasers. To study the microscopic anatomy of tissue, histologists typically stain it, freeze it, slice it thinly, and sequentially look at the individual slices to get an overall picture. Now, a multidisciplinary and multi-institutional collaboration, led by neurophysicist David Kleinfeld (University of California, San Diego), has developed an automated, all-optical technique for cutting and imaging brain tissue. As described by Jeffrey Squier (Colorado School of Mines) at the June CLEO/QELS meeting in Baltimore, Maryland, the researchers first stained or otherwise labeled a tissue specimen and then imaged the desired structures in 1- μ m steps to a depth of about 150 μ m, using nJ pulses of their laser. Next, with μ J pulses, they ablated the previously imaged tissue layer. The newly exposed layer was then stained (if necessary), the laser intensity

was reduced to take another set of images, and the process continued until no tissue remained. Stacking up the successive images results in a diffraction-limited three-dimensional picture, such as that



of the vasculature of mouse brain tissue shown here. The laser ablation left a surface that was smooth to within 1 μ m and preserved protein viability. Because the femtosecond technique completely destroys its

tissue samples, it may be inappropriate for certain clinical applications like tumor biopsies, in which physicians wish to preserve the tissue for future reference. However, the automated technique may be well suited for many other applications in the burgeoning field of molecular medicine. (P. S. Tsai et al., *Neuron* **39**, 27, 2003.) —BPS

SUPER-TOUGH AND LONG COMPOSITE FIBERS made of carbon nanotubes. Scientists at the University of Texas at Dallas injected a dispersion of single-walled CNTs into a pipe filled with a flowing polyvinyl alcohol solution to spin 100-m-long gel fibers, which were then converted into solid fibers having a tensile strength of 1.8 gigapascals. Tougher than spider silk, Kevlar®, or graphite fibers, the 50- μ m-diameter composite fibers are 60% CNT by weight. The researchers also made their fiber into a “supercapacitor” and incorporated it into a woven fabric. (A. B. Dalton et al., *Nature* **423**, 703, 2003.) —PFS

AN ENERGY-FILTERED scanning tunneling microscope (EF-STM). A typical STM yields atomic-scale landscapes of electrically conducting surfaces by mapping the electronic states closest to the Fermi energy, ϵ_F . Now, physicists at the Colorado School of Mines have used a semiconductor tip (indium arsenide) on an STM to selectively image electronic states of various energies. Their EF-STM works by effectively suppressing tunneling in a range of energies within the “projected bandgap” along the tip’s axis. Changing the bias voltage on the tip shifts the gap relative to the sample’s states and allows electrons with different energies to tunnel. On a silicon surface, the researchers separately mapped dangling bonds from both the silicon adatoms, which have electron energy close to ϵ_F and are seen by conventional STMs, and the silicon atoms in the second layer, which have electron energies further below ϵ_F . The group foresees the ability to map the local composition of semiconductor alloys. (P. Sutter et al., *Phys. Rev. Lett.* **90**, 166101, 2003.) —BPS ■