1995. The asymmetry in STM reflects the strong electron interactions, which make it easier to extract an electron from the superconductor than it is to inject one.[15] Taking the ratio of current at negative bias to that at positive bias can yield a measure of the hole density.

The Cornell collaboration measured that tunneling asymmetry in very underdoped samples[12] of Bi-2212 and of a particular compound of calcium, sodium, copper, oxygen, and chlorine atoms—called Na-CCOC. In both materials, the experimenters found regions where the holes appeared to be localized and ordered in a stripelike pattern. The orientation and location of such regions were random, as shown in figure 3b.

For the work reported at recent conferences, Davis and his coworkers exploited both the space- and momentum-tracking capabilities of STM. They presented evidence for nonlocal states at low-bias voltages and partially localized states at higher bias.

ARPES studies of underdoped cuprates have also uncovered interesting changes in behavior as a function of direction in *k* space. Below T_c, ARPES measurements confirm that the gap has a cosine variation in momentum space, as expected for electrons that pair in a *d*-wave state. Thus, the gap function has four nodal points on the Fermi surface where the gap is zero, and four antinodal points, where the gap is maximal.

Above T_c, ARPES and other techniques find that the simple *d*-wave structure is distorted. Many points along the Fermi surface have no superconducting gap. The locus of those gapless points along a section of the Fermi surface forms an arc centered on the nodal point, while the gap remains open in the antinodal regions. Some theorists have speculated that the nodal region is governed by superconductivity and the antinodal region by a different mechanism; other theorists disagree. (See PHYSICS TODAY, July 2007, page 26.)

In the STM measurements, Davis's group sees the long-lived (nonlocal) quasiparticles near the nodal region of *k* space and the partially localized states near the antinodal regions. The experimenters extrapolate an energy scale for the superconductor that increases with decreasing doping, as does the pseudogap measured by other experiments.

While the new STM experiments—and others—don't settle any questions, the rich new details they provide are confronting theory in a region where many investigators believe they may find the key to high-T_c superconductivity.

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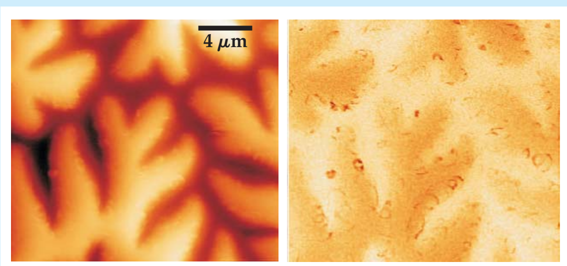

dissipation centers. The researchers anticipate that the BE method will be a fast and sensitive technique for understanding and mitigating energy losses in magnetic, electrical, and electromechanical processes and technologies. (S. Jesse et al., *Nanotechnology* **18**, 435503, 2007.) —JNAM

A new look at relativistic thermodynamics. The Lorentz transformations of special relativity (SR) convert time or distance intervals from a resting frame of reference to one that is moving, even at nearly the speed of light. But what temperature will a speeding observer register for a gas in a stationary bottle? A closely related question concerns the correct generalization of Maxwell's velocity distribution to SR, in which more energy means more mass and nothing can move faster than the speed of light. The first answer was put forth by Ferencz Jüttner in 1911, and many variations on his theme have appeared since the 1980s. It is very difficult to maintain a contained gas at relativistic speeds in a terrestrial laboratory, but Jörn Dunkel and his colleagues at the University of Augsburg (Germany) and the University of Seville (Spain) have now performed extensive simulations for a one-dimensional, fully relativistic, two-component gas. The results unequivocally favor the original Jüttner distribution. Furthermore, the simulations illustrate that the concepts of thermal equilibrium and temperature can extend to SR only for spatially confined systems. And, measured with a velocity-based statistical thermometer, moving bodies appear neither hotter nor colder than stationary ones. (D. Cubero et al., *Phys. Rev. Lett.* **99**, 170601, 2007.) —PFS

LHC limit glimpsed at RHIC. Modern physics has shown that the vacuum is seething with virtual particles springing in and out of existence. In high-energy heavy-ion collisions at accelerators, some of the original beam energy can be consumed by ripping particle–antiparticle pairs out of the vacuum. For example, in the Large Hadron Collider (LHC), soon to turn on at CERN in Geneva, Switzerland, a major source of beam losses for lead-ion collisions is expected to be so-called bound–free pair production (BFPP) in which the countermoving ions don't interact except to spawn an electron–positron pair; the positron goes off to oblivion while the electron latches onto one of the ions, reducing that ion's charge. The modified ion's trajectory will be bent less in the accelerator's magnets and eventually it will smash into the pipe carrying the beams. A shower of particles will result, and the deposited energy will heat up the pipe and the surrounding magnets. Using 6.3-TeV copper ions (about 100 GeV per nucleon), accelerator physicists have now seen the BFPP effect at an existing machine, the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory in New York. They spotted a tiny splash of energy amounting to about 200 mW at the predicted location in the pipe. According to CERN scientist John Jowett, BFPP will produce thousands of times more heat at the LHC than it did at RHIC, possibly quenching a few of the LHC's superconducting magnets and thus limiting the LHC's peak luminosity for heavy-ion physics. (R. Bruce et al., *Phys. Rev. Lett.* **99**, 144801, 2007.) —PFS ■