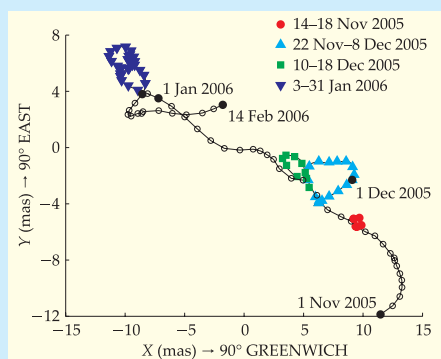


Warm dense gold. At the crossroads between condensed matter and plasmas lies warm dense matter, for which the thermal energy is comparable to the electrons' Fermi energy and the ionic cores are strongly correlated. Difficult to study either theoretically or experimentally, warm dense matter is a largely uncharted frontier. Now, physicists at Lawrence Livermore National Laboratory have used intense femtosecond laser pulses to turn a thin film of gold into a warm dense state and have measured a key parameter of the sample: the frequency-dependent dielectric function, which contains information about the density of states and band structure. After an initial femtosecond laser pulse heated the gold to energy densities as high as 10^7 J/kg, the team sent in a second pulse, spanning the energy range from 1.5 to 2.8 eV, to probe the gold's dielectric response. The results show an initial transient response that settles after about a picosecond into a quasi-steady-state response. Contributions from both interband and intraband transitions are evident in the dielectric function. By varying the energy of the initial pulse and the delay between the initial and probe pulses, the researchers could follow the evolution of the density of states. Furthermore, they could use the AC response to derive the DC conductivity and other material parameters. Such studies of nonequilibrium, transient states in warm dense matter will provide insights into other areas of physics, including shock physics, inertial confinement fusion, and astrophysics. (Y. Ping et al., *Phys. Rev. Lett.* **96**, 255003, 2006.) —PFS

Tracking Earth's wobbles. Like a spinning top, Earth wobbles as it rotates on its axis. Several oscillations, whose periods range from a few minutes to billions of years, contribute to the motion. The two largest oscillations, the so-called Chandler wobble of 433 days and the annual wobble, are well studied, and together they can tilt Earth's axis 300 milliarcseconds (10 meters



at the poles) or more. Earth's irregular, shorter-term wobbles have been more difficult to study, partly because their smaller motions are usually masked by those of more prominent wobbles. Taking advantage of a period of destructive interference between the annual and Chandler oscillations, scientists in Belgium and France have used data from November 2005 to February 2006—computed with centimeter precision at the Earth Orientation Centre, part of the International Earth Rotation and Reference Systems Service, and based primarily on global positioning system measurements—to study the short-term wobbles that occurred during that period. As plotted in the figure, the pole position traced small loops that ranged from the size of a compact disc down to that of a postage stamp. The scientists found that the pole

displacements were almost fully attributable to oceanic and atmospheric pressure variations. Although such effects had been previously credited with maintaining the large Chandler wobble, this is the first time scientists have been able to demonstrate that day-to-day changes in atmospheric pressure produce a measurable effect on Earth's rotation. (S. B. Lambert et al., *Geophys. Res. Lett.* **13**, L13303, 2006.) —HL

Phonon amplification by stimulated emission of radiation. The concept of the saser, the acoustic analogue of the laser, has been around for years. New work by scientists from the University of Nottingham in the UK and the Lashkarev Institute of Semiconductor Physics in Ukraine has brought the realization of a saser one step closer. In the new experiments, the amplification medium consists of a semiconductor superlattice—stacks of thin layers of alternating semiconductors that confine electrons in so-called quantum wells. When a voltage is applied across the superlattice, electrons can hop from one well to the next and emit a phonon along the way. Because the superlattice also forms an acoustic cavity, phonons at certain frequencies will be resonant and remain in the superlattice for long periods of time. Measurements indicate that such resonant phonons stimulate the emission of additional phonons of the same frequency: When the applied voltage is tuned so that the hopping electrons emit resonant phonons, both the number of emitted phonons and the electric current through the superlattice increase. The researchers estimate that the generated phonon power is on the order of milliwatts per square centimeter of cross section. With improved efficiency, a semiconductor superlattice may form the basis of a saser that would emit terahertz coherent acoustic phonons. Sasers have potential applications in phonon optics, spectroscopy, and acoustical imaging of nanostructures. (A. J. Kent et al., *Phys. Rev. Lett.* **96**, 215504, 2006.) —PFS

A hint of negative electrical resistance. At a planar interface between two different semiconductors, electrons can form a two-dimensional electron gas. When placed in a magnetic field and illuminated with microwaves, such a 2DEG can show oscillations in its resistance as the magnetic field is varied. In some cases, the oscillations get so large that the resistance minima reach zero; for still larger oscillations, though, the resistance does not go negative but instead stays at zero over an extended region (see *PHYSICS TODAY*, April 2003, page 24). Of the many theories that have been proposed to explain the zero-resistance state, new experiments support the most popular: Microwaves do induce negative resistance, but because a negative-resistance state is unstable, the current flow breaks up into different domains in such a way that the total voltage across the sample vanishes. In the new work, the researchers simultaneously illuminate the 2DEG with microwaves at two different frequencies and compare the bichromatic photoresistance with the two monochromatic photoresistances. At fields for which the two monochromatic responses are either both positive or both zero, the bichromatic response is the average of the two. But at fields for which only one of the microwave frequencies induces a zero-resistance state, the averaging no longer holds—the bichromatic response is always lower than the average. Such behavior, claim the researchers, can be viewed as qualitative evidence of absolute negative resistance in the monochromatic behavior. (M. A. Zudov et al., *Phys. Rev. Lett.* **96**, 236804, 2006.) —PFS ■