

Giant helium molecules have been created by researchers at the Ecole Normale Supérieure in Paris. With atomic separations ranging from 8 to 60 nanometers, the diatomic molecules are comparable to the size of small viruses. Normally, He is chemically inert. To create the new giant molecular states, the researchers first cooled a gas of He atoms to 10 μ K. Each atom was in a long-lived metastable state and carried nearly 20 eV of internal energy, more than 10^{10} times its average energy of motion. The physicists then used a laser to pair up He atoms through photoassociation, a process in which light-induced dipoles cause two atoms to bind to each other. To detect the molecules, the researchers recorded a temperature rise in the cloud; that increase resulted from the successful absorption of the laser light. In a typical experiment, 1% of the atoms absorb the light and form about 10^5 molecules. The atoms in each molecule are so far apart that they resist destructive auto-ionization effects in which an electron jumps from one atom to the other. To get theory to agree with the measured data, the researchers had to account for the finite speed of light through a retardation effect. The molecules lasted for a surprisingly long 50 nanoseconds. (J. Léonard et al., *Phys. Rev. Lett.* **91**, 073203, 2003.) —BPS

The attraction of like-charged biomolecules to each other is beginning to yield its secrets. The like-charge attraction occurs with polyelectrolytes, large molecules that have a net electric charge in an aqueous solution. (See the article by William Gelbart, Robijn Bruinsma, Philip Pincus, and Adrian Parsegian in PHYSICS TODAY, September 2000, page 38.) Researchers have long recognized the importance of multiply charged counterions—small dissolved ions having the opposite sign of charge as the biomolecule of interest. Now, a group of experimenters led by Gerard Wong (University of Illinois at Urbana-Champaign) has investigated the role of counterions in a series of experiments. They found that charged filamentary actin molecules could self-organize into an unexpected liquid-crystal phase—a stack of two-dimensional rafts—and that divalent (doubly charged) ions provided the crucial cross-linking between both the filaments and the rafts. Divalent ions of magnesium, calcium, strontium, and barium all worked. The ion-induced changes may play an important role in the restructuring and regulation of the cytoskeleton. Studying counterions fashioned from dumbbell-shaped divalent molecules with variable lengths, Wong's group found that the most effective ones were the smallest. Since the effective screening length can approach molecular dimensions, the smallest ions could fit within the "screening sheath" and create a localized charge inversion that promot-

ed attraction. The larger dumbbells could not, and behaved like two separate monovalent ions. Working again with filamentary actin, Wong and colleagues found that counterions organize themselves into columns and form frozen counterion-density waves between the protein rods. Remarkably, the tiny ions induce the large actin molecules to twist, which facilitates like-charge attractions. (G. C. L. Wong et al., *Phys. Rev. Lett.* **91**, 018103, 2003; J. C. Butler et al., *Phys. Rev. Lett.* **91**, 028301, 2003; T. E. Angelini et al., *Proc. Natl. Acad. Sci. USA* **100**, 8634, 2003.) —BPS

Detecting plastic explosives in air at the parts-per-trillion level has been achieved. Explosive compounds such as PETN and RDX are easy to mold, remain stable until detonated, and can inflict significant damage even in small amounts. Now, researchers at Oak Ridge National Laboratory and the University of Tennessee, Knoxville, have reported using commercially available atomic force microscope cantilevers for detecting PETN and RDX with great sensitivity. One surface of the cantilever was coated with a monolayer of 4-mercaptobenzoic acid, which can bind to both PETN and RDX. As the binding occurs, the cantilever bends significantly due to differential stress. The researchers estimate that a sensor based on their technique could detect the explosives at a level of 14 parts per trillion after only 20 seconds of operation. Such a sensor is also potentially cheap and easy to mass-produce. (L. A. Pinnaduwa et al., *Appl. Phys. Lett.* **83**, 1471, 2003.) —BPS

The big rip: A new cosmic doomsday scenario takes the present acceleration of the expansion of the universe to extremes. In the wake of observations of distant supernovae (see the article by Saul Perlmutter in PHYSICS TODAY, April 2003, page 53), cosmologists generally apportion 70% of the universe's energy inventory to an enigmatic dark energy. The new relevant parameter, which must be less than $-1/3$, is w , the ratio of the dark energy's average pressure to its energy density. The widely known cosmological-constant and quintessence models explore values of w between $-1/3$ and -1 . But what if w is less than -1 ? In that "phantom energy" case, Dartmouth College physicist Robert Caldwell with Marc Kamionkowski and Nevin Weinberg of Caltech have now determined that eventually all bound objects—galaxies, stars, planets, atoms, nuclei, and nucleons—will be torn apart. Caldwell suggests that deciding between their model and the others might be possible in coming years with much better measurements of the microwave background, supernovae, and galaxies. (R. R. Caldwell et al., *Phys. Rev. Lett.* **91**, 071301, 2003.) —PFS ■