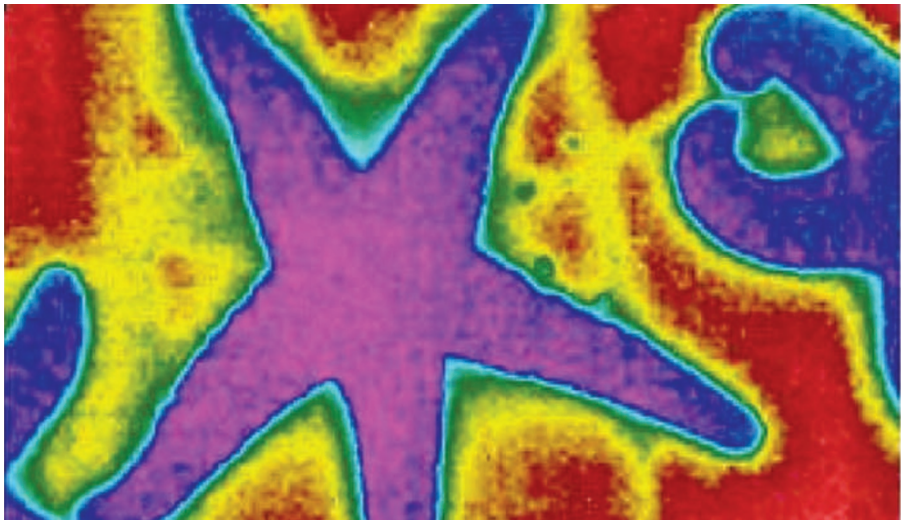
RESEARCH HIGHLIGHTS

Chill out

Am. Nat. doi:10.1086/648065 (2009)

Sea stars know how to keep their cool when the weather heats up. By sucking up cold water while submerged at high tide, they can avoid overheating after the waves roll out. Sylvain Pincebourde, now at the University of François Rabelais in Tours, France, and his colleagues exposed ochre sea stars (*Pisaster ochraceus*) to simulated tidal cycles and various water and ambient temperatures in laboratory aquaria. They found that the intertidal predators increase the amount of colder-than-air fluid in their internal cavity after exposure to elevated aerial temperatures during low tide. This substantially reduces the sea stars' body temperatures, as shown in the infrared image, during subsequent low tides.



B. HELMUTH/S. PINCEBOURDE

PHYSICS

Quantum speed limit

Phys. Rev. Lett. **103,** 160502 (2009)

The processing speed of computer chips has doubled almost every two years for the past 40, as engineers have crammed ever more transistors into smaller circuits. But according to Lev Levitin and Tommaso Toffoli of Boston University in Massachusetts, chips will ultimately hit a roadblock, limited by the minimum time it takes for a particle to flip from one quantum state to another — a fundamental step in any information system.

There are two independent bounds on this minimum time — one based on the average energy of the quantum system, the other based on the uncertainty in the system's energy. In their calculations, Levitin and Toffoli unify the bounds and show there is an absolute limit to the number of operations that can be achieved per second by a computer system of a given energy. Levitin says that, at the current doubling pace, computing speed will reach this limit in about 80 years.

BIOLOGY

How cockroaches steer

J. Exp. Biol. **212,** 3473–3477 (2009)

Many animals can sense Earth's magnetic field, but for some species, it remains uncertain whether this ability depends on embedded magnetic particles or magnetically sensitive 'radical pair' chemical reactions of light-sensitive molecules.

Martin Vácha and his colleagues at Masaryk University in the Czech Republic exposed American cockroaches to a magnetic field in which the position of magnetic north changed by 60° every 5 minutes. This normally makes cockroaches restless. The team also applied a radio-frequency field at only a fraction of Earth's field intensity to jam the creature's magnetic sensing system. At a certain frequency, the cockroaches stayed calm. Other radio frequencies had the same effect, but at higher field strengths.

Because the radio-frequency field should not affect a magnetic-particle-based sensor, the result suggests that insects use a radical-pair-based method of sensing magnetic fields.

NANOTOXICOLOGY

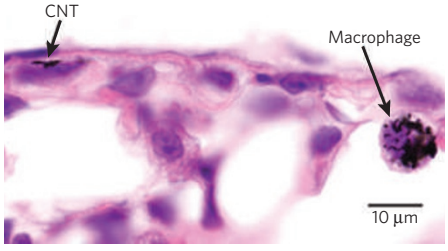
Lung penetration

Nature Nanotechnol. doi:10.1038/nnano.2009.305 (2009)

When inhaled by mice, multiwalled carbon nanotubes (CNTs) can embed themselves in the lining of the lung (pictured below).

James Bonner at North Carolina State University in Raleigh and his colleagues exposed mice to nanoparticle aerosols of either 30 milligrams per cubic metre or 1 milligram per cubic metre for six hours. In the mice exposed to the higher level, immune cells called macrophages (pictured) engulfed the nanotubes and carried them to the lung lining.

Within weeks of exposure, those mice also developed a condition called subpleural fibrosis, which causes localized fibrous lesions. This work does not confirm the suggestion made by other studies that nanotubes may cause lung tumours, but the authors say they urge caution be taken when people are exposed to nanotubes in the air.



CLIMATE CHANGE

Stormy warming weather

Geophys. Res. Lett. doi:10.1029/2009GL039810 (2009)

Arctic residents have complained that their weather is changing, and a study by researchers in Australia backs this up.

Ian Simmonds and Kevin Keay of the University of Melbourne examined the relationship between the number and strength of cyclones each year in the Arctic basin and the extent of Arctic sea ice during the month of September for the past 30 years. They found that years with the least amount of ice had significantly stronger storms, although there was no correlation with the number of storms.

The findings support previous forecasts that the decline in sea ice, and particularly the record lows of recent years, is raising the risk of stronger storms in the Arctic.

CANCER BIOLOGY

Double protection

Sci. Trans. Med. **1,** 3ra7 (2009)

Blocking a key cell-signalling pathway increases certain tumours' sensitivity to high doses of ionizing radiation while protecting healthy tissue from the harmful rays.

David Roberts of the National Cancer Institute in Bethesda, Maryland, and his colleagues inhibited the cell-surface receptor

CD47 or the protein that binds it, TSP1, which regulates cell growth and survival in response to stress, such as that caused by radiation. They found that suppressing the CD47–TSP1 pathway in normal human cells improved their survival after irradiation and, in mice, led to reduced radiation injury.

In addition, the tumours of mice treated with a CD47-blocking molecule prior to radiation exposure were up to 89% smaller 30 days after irradiation than those of mice receiving radiation alone.

BIOPHYSICS

All seeing eye

Nature Photon. doi:10.1038/nphoton.2009.189 (2009)

Polarized light is used in optical devices, including some microscopes. Being able to control polarized light is key. Materials such as crystals can do the job, but only within a limited range of wavelengths.

Nicholas Roberts of the University of Bristol, UK, and his colleagues have worked out how a species of mantis shrimp can switch polarized light from one form to another over a range of colours. A thin band of specialized receptor cells in the eyes of *Odontodactylus scyllarus* have just the right structure, dimensions and composition to enable them to control polarization over most of the visible spectrum. The team believes that further study of this mantis shrimp's eyes could lead to better optical devices.

NEUROSCIENCE

Brain signal source

Proc. Natl Acad. Sci. USA doi:10.1073/pnas.0905509106 (2009)

Functional magnetic resonance imaging (fMRI), used to map brain activity, gives a signal when the levels of oxygenated blood increase. The signal is often preceded by a darkening, thought to indicate early oxygen absorption by the brain owing to local neural activity.

But a study by Aniruddha Das and his colleagues at Columbia University in New York casts doubt on this. They used intrinsic signal optical imaging, a technique similar to fMRI, to measure changes in blood volume and blood oxygenation in the brains of two macaques while they performed a visual task.

The researchers found that during the initial darkening, blood-oxygen levels changed little, but blood volume increased markedly. The team suggests that blood-volume change is a better signal to use in brain imaging because it seems to be more closely linked to neural activity, occurring even before changes in blood oxygenation.

SEXUAL SELECTION

Intruder alert!

Proc. R. Soc. B doi:10.1098/rspb.2009.1554 (2009)

Male redback spiders can sneak in and quickly copulate with a female after a rival male has already spent hours wooing her, yet avoid the usual penalty of short courtship — being eaten prematurely by his lover.

The female Australian redback spider (*Latrodectus hasselti*, pictured below) eats the male after mating, but sometimes consumes him prematurely — after he's copulated only once. Jeffrey Stoltz and Maydianne Andrade of the University of Toronto in Canada measured the spiders' courtship durations and found that females tend to eat their partners prematurely if courtship is less than 100 minutes long. However, intruder males can mate after a shorter courtship and avoid premature death if an earlier male had already exceeded this 100-minute threshold.

This could lead to lower quality males seeking out, rather than avoiding, competition with rival spider studs, the authors say.

For a longer story on this research, see http://go.nature.com/U6DPEG

K. JONES

ASTRONOMY

Galaxy size matters

Astrophys. J. **705,** 255–260 (2009)

A survey of distant galaxies shows that more loosely packed ones tend to form more stars.

The survey looked at 225 galaxies at distances of between about 2.8 and 3.4 parsecs from Earth. It found that compact galaxies tend to have fewer new stars than do their larger counterparts of comparative mass.

Sune Toft of the University of Copenhagen and his colleagues conclude that compact galaxies formed many stars quickly in one intense burst, early in the history of the Universe. Conversely, larger, more diffuse galaxies form stars gradually over a longer period of time. The results may explain why very distant galaxies are often more compact than the younger ones nearby.

JOURNAL CLUB

Jonathan Weissman
University of California, San Francisco

A biochemist looks at how DNA sequencing can reveal more than just sequences.

Huge advances in DNA sequencing have allowed us to readily determine the sequence of almost any living (and a few extinct) species. Yet arguably, most biological insight comes from work on five model organisms: *Escherichia coli*, baker's yeast, roundworms, fruitflies and mice. Unfortunately, many important biological processes are not captured in these creatures.

Papers from two groups, one led by Andrew Camilli of Tufts University in Boston, Massachusetts, the other by Brian Akerley at the University of Massachusetts in Worcester, describe new genetic tools that allow the quantitative dissection of gene function in a wide range of microorganisms (T. van Opijnen *et al. Nature Methods* **6,** 767–772; 2009; and J. D. Gawronski *et al. Proc. Natl Acad. Sci. USA* **106,** 16422–16427; 2009). These studies combine exhaustive transposon mutagenesis — whereby thousands of small DNA segments, or transposons, are introduced into the genome to mutate many genes — with massively parallel, or 'deep' sequencing of transposon/chromosome junctions to monitor the consequences of the loss of single or pairs of genes on the organisms' traits.

The real power of the approaches comes from the deep sequencing, which tracks the abundance of individual transposon mutants after they have been subjected to a stress. Knowing by how much each mutant has grown or suffered under the stress provides a measure of the relative roles that the mutated genes have.

I find it particularly gratifying that the advances in deep sequencing that have allowed us to catalogue so many genes from so many organisms can now be harnessed to help us figure out what these genes actually do.

Discuss this paper at **http://blogs.nature.com/nature/journalclub**