Jam-packed spheres

Nature **453,** 629–632 (2008)

Packing problems seem to hold a never-ending fascination for scientists of all shades — from mathematicians interested in geometric aspects, to physicists studying crystal structures, to engineers concerned with more practical issues. But general insight into how densely solid bodies can be bunched together is scarce. Chaoming Song and colleagues now report progress in understanding the configurations that spheres can adopt when they are randomly added to a container.

Experiment suggests that the highest volume fraction such irregularly packed spheres can occupy is around 64%, whereas in the loosest stable configuration some 55% of the available space is filled. Song *et al.* now offer an explanation of where these numbers come from.

Providing a full phase diagram for jammed matter, they argue that the 'random close packing' state is the ground state of hard spheres with a given interparticle friction coefficient; in this configuration, the volume faction is 63.4% at most, independent of the amount of friction between spheres. The 'random loose packing' state, however, does depend on friction, but Song *et al.* find that even for the limiting case of infinite friction the density cannot be less than 53.6%.

High-speed exit

Astrophys. J. **678,** L81–L84 (2008)

When two galaxies merge, their respective central black holes also merge. Sometimes, though, the gravitational waves emitted (carrying linear momentum) during the black-hole merger are so strong that the newly formed black hole is ejected in the opposite direction. Such has been the theoretical picture for decades. Now Stefanie Komossa and co-workers have evidence for a recoiling supermassive black hole.

The recoiling black hole generates two sets of characteristic X-ray emission spectra: broad lines associated with the gas moving with the black hole (and feeding the black hole by accretion); and narrow lines from the gas remaining in the galaxy. The velocity offset between the two sets of lines is ~2,650 km s^{-1}, which is consistent with calculations for a catapulted black hole of a mass of several hundred millions of solar masses.

These results, plus future studies — such as Hubble Space Telescope imaging of the host galaxy, quasar SDSS J092712.65+294344.0, to search for any signs of distortion — will improve our understanding of galaxy formation and evolution.

Therapy enhancement

Phys. Rev. Lett. **100,** 198101 (2008)

A number of studies have shown that cancer treatment is more efficient for patients receiving a combination of chemotherapy and radiation, rather than only one of the two modalities. Why is that so? At least for one particular drug, known as cisplatinum, secondary species created by the primary radiation are believed to be involved. Cisplatinum is known to bind to DNA, and in one of the mechanisms put forward the assumption is that secondary electrons in the few-eV range might cause more damage to the DNA–cisplatinum complex than to DNA alone.

Yi Zheng and colleagues take a closer look at this possibility. They bombard solid DNA films with low-energy electrons and find that for electrons of 10 and 100 eV the presence of cisplatinum increases single- and double-strand breaks by a factor of up to four. They conclude that this additional damage results from an enhanced capture of secondary low-energy electrons at the site of cisplatinum, together with a higher ionization cross section due to the presence of platinum atoms.

Soft grip

Phys. Rev. E **77,** 051107 (2008)

Common sense suggests that the more force you use to control an object, be it a bicycle or a beagle, the more effectively you can bend it to your will. But common sense isn't always correct. And indeed, Giovanni Volpe and colleagues show that when the object is jostled in a noisy environment, the opposite may be true.

Using optical tweezers to trap a single polystyrene bead, the authors investigate the effect of increasing the trapping power as the bead is dragged back and forth through an aqueous solution. In the absence of noise, a higher trapping power holds the particle more tightly, as expected. But when noise is added, they find the trapping efficiency initially increases and then decreases again as the power is increased.

The effect is reminiscent of stochastic resonance, in which the addition of noise to a system being measured by a nonlinear sensor can actually improve its ability to detect a signal, up to some optimum noise level.

Random images in 3D

AQUARIUS

Opt. Express **16,** 6368–6377 (2008)

'Bullet-time photography' is the term coined by the Wachowkski brothers for the computer-assisted cinematic technique that enabled them to slow-down and pan around Keanu Reeves as he dodged a hail of bullets in *The Matrix*. The ability to view a scene from almost any perspective could be useful in many other situations besides cinematography — from surveying battlegrounds to biomedical imaging. But such techniques generally require that the images used to reconstruct a scene be collected by an array of cameras situated on a single, geometrically simple, surface; a requirement that cannot always be met.

Mehdi DaneshPanah and colleagues have developed a 3D image reconstruction algorithm that is free from such restrictions. First, they collected a series of images with a single camera moved to various random (but known) positions above a static arrangement of toy models. Then using a generalized algorithm similar to that used in so-called synthetic aperture integral imaging, they demonstrated it is possible to generate a series of 2D slices at a variety of heights through the scene.