More moons promised

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JEAN PAUL ROUX

Without the Moon, life on Earth would, most likely, have developed rather differently. Mere luck? Maybe not: computer simulations by Sebastian Elser and colleagues suggest that 2–25% of Earth-like extrasolar planets may have a Moon-like moon.

The Moon stabilizes the Earth's otherwise chaotic spin and endows it with a relatively stable obliquity relative to the normal of its orbit around the Sun. As a result, insolation patterns and thus the climate are quite stable. The tilt of our planet is estimated to fluctuate by just ±1.3° every 41,000 years — an order of magnitude less than the obliquity fluctuation of Mars, which has no massive satellite. In fact, none of the terrestrial planets in our Solar System has.

But the simulations of Elser *et al.* indicate that the Earth–Moon system is not necessarily a "cosmic rarity". Their simulations re-enact the formation of our Solar System, and in 64 runs they have observed 88 moon-forming events through giant impacts; 10% of the virtual Earth-like planets sport a massive, obliquity-stabilizing moon. Extrapolated to extrasolar planets, this could mean that the prospects of finding other habitable places are a bit more promising. *AT*

Label free

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Optical detection often requires that viruses are labelled to make them react more strongly to light. Lina He and colleagues have now come up with a real-time technique for detecting nanometre-scale virions that does away with such marking.

Tiny optical cavities enhance the interaction between light and matter by concentrating radiation into a very small volume. He *et al.* used a toroidal laser-cavity, 20–40 μm in diameter, made of erbium-doped silica. The frequencies at which this laser produced light changed whenever a nanoparticle bound to its surface, a variation that could be easily measured. In this way, the researchers detected gold particles, polystyrene spheres and influenza A virions.

The team has previously applied the same idea but using a passive structure in which the probe laser light comes from an external source. The advantage of an integrated microlaser is that the device is sensitive to much smaller objects, and also allows for a more compact and portable instrument. *DG*

Free estimate guaranteed

Phys. Rev. Lett. (in the press)

Estimating the free-energy change associated with a non-equilibrium transformation between equilibrium states is a notoriously difficult task — and one for which biological systems offer fertile testing ground. The work required to change a biomolecule from one functional conformation to another provides an upper bound to the free-energy difference, but the two are equal only in the limit of infinitesimally slow processes.

In practice, the Jarzynski equality is widely used for free-energy estimates, irrespective of how quickly a process occurs. The trick lies in taking a weighted average of the work, including rare processes populating the low-energy end of the work distribution. The downside of this approach is that experimental verification is left wanting: an unfeasibly large ensemble would be required to sample those rare events.

By mapping Jarzynski's estimator onto the random energy model, Matteo Palassini and Felix Ritort circumvent this challenge, calculating corrections to the many-trial limit explicitly. The resulting expressions improve free-energy estimation for a realistically sized ensemble of DNA unfolding–refolding experiments, and hold promise for a large class of non-equilibrium systems. *AK*

Better with two

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If CPT symmetry is exact, an antiparticle has the same mass and the same charge (although of opposite sign) as its corresponding particle. Masaki Hori and colleagues have conducted a stringent test of such symmetry using antiprotonic helium.

When a beam of antiprotons is decelerated and fed into a chamber of helium-3 or helium-4 gas, an atomic electron may be spontaneously replaced by an antiproton, caught in a high-angular-momentum Rydberg state. The microsecond lifetime of the resulting three-body atom (nucleus, electron and antiproton) is long enough to allow spectroscopic studies to be made.

However, the precision achievable using single-photon spectroscopy is limited by Doppler broadening. But, as Hori *et al.* show, two-photon spectroscopy — using counter-propagating beams at specially chosen frequencies — initiates nonlinear transitions of the antiproton that can be measured with a narrower Doppler width.

By extracting the antiproton-to-electron mass ratio, and comparing that to the proton-to-electron mass ratio, the authors conclude that any difference between the charges and masses of proton and antiproton is less than 7×10^{-10}, at 90% confidence level. *AW*

Workplace antiferromagnetism

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They say that a problem shared is a problem halved. In fact, studies suggest that if one member of a friendship group suffers from stress, their friends suffer too. Moreover, their closest friends are likely to suffer most. And so, Jun-ichiro Watanabe and co-workers were surprised to find that, amongst a group of work colleagues, almost the opposite was true. Or to use a physical analogy, whereas stress among friends is diffusive — decaying monotonically as it spreads from a source — stress among co-workers is antiferromagnetic.

This unexpected finding emerged in the researchers' study of an occupational-health stress survey conducted in a software development company, on networks of workers in 11 different divisions (each containing between 15 and 120 people). The employees were asked to wear personal sensors that measured the extent of their interactions with each other, and thereby their proximity to others in each network.

What emerged was an anticorrelation between high stress scores and nearest-neighbour proximity within the network. So the stress experienced by employees that interact most closely with colleagues who are highly stressed is likely to be low, and vice versa: much like the alignment of spins in an antiferromagnet. *EG*

Written by Ed Gerstner, David Gevaux, Abigail Klopper, Andreas Trabesinger and Alison Wright