One man's trash

Astrophys. J. **766,** 24 (2013)

An outer halo of old stars surrounds the Milky Way. These ancient bodies should encode details of the formation of our Galaxy, but being rather diffuse, the clues they hold are difficult to decipher. Fortunately for Alis Deason and co-workers, the Hubble Space Telescope has taken plenty of data on this halo — although, until now, the stars in question had been thought of only as foreground noise in observations of the more distant Andromeda constellation. The 100,000 stars of Andromeda recorded in each Hubble image have now become background clutter.

Using a combination of colour, brightness, sideways motion and velocity, Deason's team have identified 13 stars as belonging to the Milky Way halo. Surprisingly, these stars have high sideways motion, as opposed to the mostly radial motion of inner halo stars.

Roughly 80,000 light years from the Galactic Centre, these stars bunch together in a shell-like structure. Could they be remnants from the accretion of smaller galaxies? To account for their unexpected sideways motion, the authors suggest that the stars have reached their outermost orbit and are turning back towards the galaxy. *MC*

Four's a crowd

Phys. Rev. Lett. **110,** 091801 (2013)

The standard model of particle physics comprises three 'generations': the known leptons and quarks fall naturally into groups of three particles of increasing mass. But might there be a fourth generation, another tier in the hierarchy at higher mass?

Eric Kuflik and colleagues have explored data from the ATLAS and CMS experiments at CERN, and from the former CDF experiment at Fermilab. They've checked the rates at which the Higgs — with a mass of 125 GeV — is produced in various channels: if there were a fourth generation, the rate of production of this Higgs particle by the fusion of gluons could be enhanced almost ten-fold, and, at the same time, the rate of its decay into photon pairs could be suppressed by as much as a factor of 100, compared with the basic standard-model prediction. Neither effect is seen, and Kuflik *et al.* strongly exclude the existence of a fourth generation, at 99.95% confidence level for a 125-GeV Higgs. *AW*

Free ride for quantum theory

Phys. Rev. Lett. **110,** 093602 (2013)

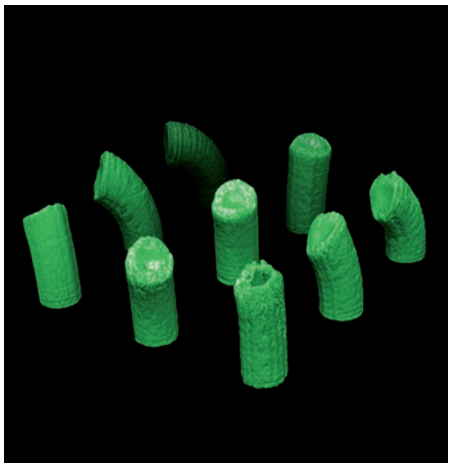
Quantum mechanics and general relativity represent opposite length-scale limits of the laws of physics as we know them — and linking the two theories together has proved extremely difficult. But Hauke Müntinga and colleagues now demonstrate a free-falling matter-wave interferometer that could soon provide some clues.

Müntinga *et al.* packed all of the equipment required to trap and cool a Bose–Einstein condensate (BEC) of rubidium atoms into a capsule at the top of a 120-m tower — then they let it go. It took 2.7 seconds to create the BEC. A laser then separated the condensate into two wave packets that drifted slowly apart. Further laser pulses later reversed and then partially recombined the two. The team verified that the spacing of the interference fringes scales linearly with the time the BEC spent in the interferometer.

This proof-of-principle experiment demonstrates the potential of this approach for exploring atom interferometry with novel states of matter in extended free fall. The technique could verify Einstein's principle of equivalence with quantum objects, or even help in the search for gravitational waves. *DG*

Actin up

Nature Mater. http://doi.org/ksw (2013)



Stacking two-dimensional circuits to form three-dimensional arrays of interconnected chips may seem like the ultimate solution to our ever-increasing demands for high-performance microelectronic devices. But engineering the electrical connections between wafers is no mean feat, and at present prototypical devices face severe limitations associated with the precision of assembly. It seems now, however, that using naturally self-organizing materials might be a way forward. Rémi Galland and colleagues have succeeded in controlling the growth of actin filament networks — the building blocks of the cellular cytoskeleton — to form conductive connections between chips.

By micropatterning chips with an actin-promoting factor, and then flooding them with an actin polymerization mix, the authors were able to induce the localized growth of actin networks on the surface, but failed to control their three-dimensional architecture. This problem was solved with the introduction of capping proteins, which promote the branching of actin filaments by blocking elongation. The force generated by actin filament assembly effectively displaced the assembled network upwards, replicating the micropatterned network in a series of layers that made contact with a second surface. Once formed, these organic connections were coated with gold, and proved capable of conducting electricity between chips. *AK*

Cool me down

Nature **495,** 490–494 (2013)

Unlike atoms, when it comes to cooling, molecules can be very stubborn. Because of their complicated internal vibrational motion, even the simplest molecules are unaccommodating of laser cooling. Other ways of removing energy from molecules — such as sympathetic cooling, which relies on collisions with a partner more amenable to laser cooling — prove equally challenging because the molecules usually react with the cohabitating atomic species. But Wade Rellergert and colleagues have now demonstrated that ultracold atoms can efficiently quench molecular vibrational motion.

Rellergert *et al.* trapped barium monochloride ions and brought them into contact with a cloud of ultracold calcium atoms, that are held in a magneto-optical trap.

Surprisingly, the elastic collisions between the neutral atoms and the molecular ions do not result in a chemical reaction, but in the damping of the molecular vibrational motion. To check the outcome of the cooling, the authors used a new thermometric technique based on molecular photodissociation — the laser-induced dissociation of molecules in a certain vibrational state.

The degree of cooling demonstrated is modest, but further technical improvements promise highly efficient vibrational, and even rotational, cooling. *IG*

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