Anti-atom in free fall

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An apple falls from a tree — but would an antimatter apple fall in exactly the same way? The gravitational interaction between matter and antimatter is still insufficiently understood, but so far evidence suggests that the gravitational mass of matter is the same as that of antimatter. To test this further, the ALPHA collaboration at CERN has developed a way of measuring anti-hydrogen atoms in free fall.

Anti-hydrogen atoms are produced by mixing antiprotons (supplied by CERN's Antiproton Decelerator) and positrons in a Penning trap. The anti-atoms are trapped in the three-dimensional potential minimum created by additional magnetic fields. When these fields are switched off, the anti-atoms are released, but their escape is short-lived as they are immediately annihilated on the trap walls. However, the decaying magnetic fields prevent the anti-atoms from just dropping straight down — in fact, most of them drift radially.

By combining the measured annihilation times with numerical simulations that reconstruct the anti-hydrogen trajectories, the ALPHA team has set an upper limit on the ratio of the gravitational mass of anti-hydrogen to the inertial mass of hydrogen. As yet, this limit sits far from the point at which deviations from the theory might be expected, but planned improvements to the experiment should take the limit down into the region of interest. *IG*

Just plain loopy?

Phys. Rev. Lett. **110,** 151601 (2013)

With the discovery of a Higgs boson cementing our understanding of the Higgs mechanism for electroweak symmetry breaking (ESB), T. G. Steele and Zhi-Wei Wang are now wondering what more it might tell us about the kind of ESB that occurred in the Universe.

In the 1970s, Sidney Coleman and Erick Weinberg suggested that spontaneous ESB could occur through radiative corrections (or 'loop' corrections, after the loops that appear in the progressively more complicated Feynman diagrams that can be drawn for radiative processes). Steele and Wang have applied calculational tricks to work up to the order of nine loops, and find a convergence suggestive of a Higgs mass around 124 GeV — remarkably consistent with the value of 125 GeV measured at CERN.

But this Higgs from radiative ESB would have a much higher self-coupling than the conventional one — something that might, in time, be measurable in the experiments at CERN. *AW*

Gravitational spectacles

Astrophys. J. **767,** 111 (2013)

A massive foreground object can bend light from a background source. Such gravitational lenses are usually stars, black holes, galaxy clusters or even dark matter. Now Philip Muirhead and co-workers report that a small dead star, a white dwarf, within a binary system is warping the light from its companion red dwarf.

The Kepler space mission is looking for Earth-sized planets in the Milky Way by measuring the dip in a star's brightness when a planet passes in front of it. So when Muirhead *et al.* saw huge dips in 'Kepler Object of Interest 256', they assumed that it was due to a transiting Jupiter-size planet. But data taken at the Palomar Observatory in California, USA, showed that the precessions of the red dwarf could only come from the passage of a small, but dense, white dwarf behind the red dwarf.

Sifting through more Kepler data, the authors found that when the white dwarf transited the red dwarf, the light from the background red dwarf was not only bent, but appreciably brightened. *MC*

Spiralling under control

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The spin Hall effect — a change in a particle's trajectory associated with its spin — is now seen with photons, by using a metamaterial to overcome the weak interaction of light with matter.

To an observer in a relativistic rest frame, an electrical current looks like an electron moving in an electric field. From its own perspective however, the electron is sitting stationary in a magnetic field. The spin-carrying electron can precess under the influence of this field. This can lead to spin-dependent scattering from impurities, which diverts electrons of opposing spin in opposite directions. An analogous spin Hall effect has been predicted in optics: a beam of light splits according to circular polarization. But the necessary spin–orbit interaction between a photon and matter is small.

Xiaobo Yin and colleagues used a thin metamaterial to induce a much stronger interaction, creating an array of V-shaped gold nanoantennae on a silicon substrate. The shape and orientation of the antennae varied across the surface, inducing a space-dependent phase discontinuity for a normal-incidence beam of infrared light. This separated the refracted beam into right and left circularly polarized light. *DG*

Droplet conveyor

Nature Nanotech. **8,** 277–281 (2013)

When liquids are transported, the fluid is typically on the inside of whatever vessel is used. On the nanoscale, however, it seems that controlled fluid flow can also be achieved along the surface of solid wires.

Jian Yu Huang and colleagues devised a set-up to bring together a silicon nanowire and a drop of an ionic liquid, both of which are connected to gold electrodes. With the whole assembly placed inside a transmission electron microscope to enable *in situ* observation, a bias voltage applied between the two electrodes results in the formation and subsequent motion of tiny droplets along the nanowire. The height profile of the liquid reveals the presence of a thin fluid film, about 10 nm thick, between the 'beads' — their coexistence consistent with the physics of solid–liquid interactions.

Huang *et al.* have also obtained similar results using tin dioxide and zinc oxide nanowires, and have demonstrated the pumping of droplets onto a graphene substrate. *BV*

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