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1. The fourth spatial dimension

Theoretical physicists have long argued that our universe may have other spatial dimensions in addition to those three we know of, which for some reason neither experiment nor human senses can detect. In nine-space-dimensional string theory, for example, these additional dimensions are compactified — curled up to a microscopic size. A model proposed by L Randall and R Sundrum now assumes that our world is a three-space-dimensional subspace of a four-space-dimensional universe and while the electromagnetic, weak, and strong forces are limited to this subspace, the gravitational force — essentially a deformation of space-time — operates in all four dimensions. By solving Einstein's equations for this model, it is shown that the law of gravity operative in the three-dimensional subspace remains practically unaffected by the fourth spatial dimension. As regards the minor corrections predicted by the theory (assuming of course that the theory is correct and that such corrections do exist), it is not yet known whether they can be detected experimentally.

Source: *Phys. Rev. Lett.* **83** 4690 (1999)
http://publish.aps.org/FOCUS/

2. Atom amplifier

A new technique for increasing atomic beam intensity has been developed by an MIT team led by W Ketterle and D E Pritchard, which has the advantage of conserving information about the structure of the original beam. As compared to electromagnetic waves, atomic beams are much more difficult to amplify because, unlike photons, atoms do not disappear and their number is conserved. The development of the atom amplifier was preceded by the 1998 MIT discovery that an atomic beam can be generated by illuminating a Bose – Einstein condensate by laser light with a specific direction and specific polarization. In the new amplifier, a beam of sodium atoms is amplified when passed through a condensate simultaneously with laser light. The beam at the output is coherent with respect to and 30 times stronger than that at the input. The new technique has possible applications in ultrahigh precision measuring devices according to the researchers.

Source: *Nature* December 9 (1999)
http://web.mit.edu/news.html

3. Interaction cross section of ultracold neutrons

The largest nuclear cross section known, $\sigma = 5 \times 10^7$ barn (0.5 A^2), was observed by H Rauch of the Atom Institute in Vienna and his colleagues using a beam of ultracold neutrons to bombard the gadolinium nucleus. A giant absorption cross section of neutrons in Gd had been predicted theoretically as being due to a certain resonant energy-level configuration in the Gd nucleus which enables it to capture any neutron approaching within a distance 10,000 times its diameter. The team used a solution of Gd in heavy water (D_2O) as a target and took the neutron beam to be as slow as $v = 10$ m s^{-1}, which is equivalent to a temperature of about 1 mK (since slow neutrons spend more time near the target nucleus, they are more likely to interact, which increases the cross section for this reaction). A deviation from the theoretical law $\sigma \propto 1/v$ at velocities below 4 m s^{-1} is attributed to the fact that the solution used was dilute and a beam neutron therefore met less than one Gd nucleus on the average on its path.

Source: *Phys. Rev. Lett.* **83** 4955 (1999)
http://ojps.aip.org/prlo/top.html

4. The second law of thermodynamics

According to the second law of thermodynamics, heat cannot flow unassisted from a cold to a warm body; no Maxwell's 'demon' violates this law whatever the first impression. In fact it was this thought experiment which was conducted at the University of Essen in Germany using sand grains to imitate ideal gas molecules in a box divided into two equal chambers by a baffle with a hole in it. When the box is agitated and the sand is thus set in random motion, it turns out that slower grains start to congregate in the lower part of one chamber, implying an increase in the number of faster particles in the second chamber. The reason why the second law is not violated in this case is that sand grains cannot be viewed as ideal molecules since they dissipate the energy of their translational motion when colliding with each other. When grains start to congregate in one of the chambers as a result of their random motion, they lose more energy and become slower because of more frequent collisions — leading to more congregation.

Source: *Physics News Update*, Number 461;
Phys. Rev. Lett. December 20 (1999)
http://www.hep.net/documents/newsletters/pnu/pnu.html#RECENT

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