They seek it here…

Phys. Rev. Lett. **100,** 211801 (2008)

Few particles have proved as elusive as the Higgs boson, which remains undiscovered, despite ever broader searches undertaken at increasingly powerful accelerators. The latest results from Fermilab's Tevatron have also drawn a blank, even though the standard-model variety of the Higgs should be within kinematic reach, its mass constrained by detailed measurements of the *W* boson and top quark.

This latest search — by the CDF collaboration using data collected in Tevatron proton–antiproton collisions — relies on detecting energy lost in an interaction that produces a Higgs boson in association with a *W* or *Z* boson. The Higgs decays to a pair of bottom quarks; neutrinos created in the *W* or *Z* decay, however, escape direct detection, leading to an imbalance in transverse energy.

The CDF data rule against a standard-model Higgs boson of mass 115 GeV c^{-1} — the hint of a signal at such a mass having emerged at CERN's Large Electron Positron collider in 2000. CERN is once more set to join the hunt for the Higgs, when its Large Hadron Collider comes into operation this month.

Demon exercised

Phys. Rev. Lett. in the press (2008); http://arxiv.org/abs/0802.1585

ISTOCKPHOTO

Maxwell's demon is a hypothetical device to seemingly circumvent the second law of thermodynamics. It imagines two gas-filled containers separated by an aperture, which can be opened or closed to allow only slow-moving atoms to pass in one direction and only fast-moving atoms in the other — enabling heat to flow in the opposite direction to an increasing thermal gradient.

Jeremy Thorn and colleagues have realized a variation on Maxwell's demon using light. It consists of an asymmetric optical barrier generated by two parallel laser beams in the centre of a trapped cloud of neutral ^{87}Rb atoms. One of the beams allows only atoms in the lower of two hyperfine ground states to pass, reflecting those in the upper state. The other excites atoms from the lower to the upper state. Consequently, atoms initially in the lower state can pass only in one direction, and they accumulate on one side of the trap. As energy is required to generate the barrier, this is no violation of thermodynamics, but could offer a new approach to cooling a trapped gas.

Non-identical twins

NASA, ESA, M.ROBBERTO (STSCI/ESA) AND THE HST ORION TREASURY PROJECT

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Two stars of equal mass, formed from the same gaseous soup and at the same time, should be identical. However, Keivan Stassun and colleagues report that the youngest known twins, in the binary system Par 1802 of the Orion nebula cluster, are not identical after all. The masses do agree to within 2%, but the surface temperatures differ by 10% and the luminosities by 50%. Quite possibly the radii differ as well.

Binary stars that periodically eclipse one another are invaluable for testing models of star formation and evolution. However, most models of the earliest stages of evolution assume identical twins. For those models that predict rapid stellar evolution at around 1 Myr — about the estimated age for Par 1802 — the differences may be accounted for by a time-lag of a few hundred thousand years. Another possibility could be different magnetic strength or geometry between the companions. In any case, the (lack of) precision in age synchronization of stellar evolution clocks may stimulate new models for young, short-period binaries.

Breathing bubbles

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According to inflationary models, our Universe may have begun as a bubble of false vacuum, sitting in a Schwarzschild spacetime, that blew up through a period of inflation to become a 'child' universe, causally disconnected from the original. It's a tantalizing picture, but one with a singularity problem: the false-vacuum bubble can only be large enough to expand if there is an initial singularity.

Several attempts have been made to overcome this problem, which has become known as the Farhi–Guth obstacle. Eduardo Guendelman and Nobuyuki Sakai now delve deeper into the dynamics of the bubble itself, in search of the solution. They consider the surface-energy density of the thin wall of the bubble and arrive at the possibility of 'breathing bubbles', in a state of stable oscillation. If a breathing bubble decays to a lower mass state that then undergoes inflation, the result is a child universe — one that could, say the authors, avoid the Farhi–Guth obstacle. But, depending on the nature of the surface energy, it's also possible that the expanding bubble 'eats up' the original universe.

Unequal pairs

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According to the nuclear shell model, the neutrons and protons that make up atomic nuclei move in well-defined orbits, although they don't always do so independently of each other. At any one time, around 20% of the nucleons engage in pair-wise correlations, held together by the short-range components of the nucleon–nucleon interaction. But it seems the individual nucleons are quite picky when it comes to choosing their partner, as Ramesh Subedi and co-workers report.

In experiments using an intense high-energy electron beam to knock protons out of carbon-12 nuclei, Subedi *et al.* found that 90% of the short-range pairs consist of a neutron and a proton, whereas only 5% are proton–proton pairs (and 5% neutron–neutron pairs, as they infer by isospin symmetry). The experiment is the first to measure the constituents of the pairs simultaneously, and confirms recent theoretical predictions of large differences between neutron–proton and proton–proton distributions as a consequence of the so-called tensor force between nucleons.