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1. Evidence for the Higgs boson?

Higgs bosons H are quanta of a scalar field which was introduced by P Higgs in 1964 to secure the renormalization property of the weak interaction in elementary particle physics. The experimental proof of the existence of H is one of the challenges facing high-energy physics. Now the ALEPH experiment conducted at the LEP accelerator at CERN in Geneva, Italy, has provided indirect evidence for the presence of H in reaction products. The search for H was done by studying four-jet events resulting from simultaneous decays of H and Z bosons, with two jets of particles being produced in each. For three such events, the observed signal was found to be above the background by an amount which indicated H with a mass of 114 GeV to be involved. However, because this result is neither statistically significant enough nor can alternative explanations be excluded, a definitive conclusion about the detection of H is not possible, and a decision was therefore made to continue with the ALEPH experiment.

Source: http://press.web.cern.ch/

2. Lamb shift

According to quantum theory, vacuum is a polarizable medium: an electric charge in vacuum is surrounded by a cloud of virtual e^+e^- pairs which partially screen the charge. An electron approaching the atomic nucleus penetrates this cloud, which increases the effective nucleus-electron interaction — an experimentally observable effect underlying the so-called Lamb shift of the atomic energy levels. For the hydrogen atom, the Lamb shift has been measured to 0.01% and is found to agree well with theory. An electromagnetic interaction even stronger than that seen in the hydrogen atom takes place between the electrons and nuclei of heavy atoms. Researchers at the GSI Laboratory in Darmstadt, Germany, passed a beam of uranium-92 atoms through a foil with the result that the atoms were stripped of all but one of their electrons and thus turned into U^{91+} ions. In such ions, an electric field as high as 10^{16} V cm^{-1} operates between the nucleus and the remaining electron. The Lamb shift in such ions was measured to be 468 ± 13 eV, in agreement with quantum electrodynamic predictions. The team hopes an accuracy of 1 eV will soon be achieved.

Source: http://prl.aps.org

3. Bremsstrahlung photons

When high-energy, heavy atomic nuclei collide head-on, in addition to their fission products such as neutrons and lighter nuclei, many other particles are produced. Some of these decay by emitting gamma photons, and these photons have been detected in many experiments. The cloud of particles that forms around the location of a collision has properties very similar to those of hot plasma, and this latter is known to emit bremsstrahlung radiation. The first detection of this additional radiation has now been accomplished at CERN in collisions between lead nuclei, and based on the characteristics of this radiation, some theorists believe quark gluon plasma might have been produced in such collisions.

Source: *Physics News Update*, Number 505
http://www.hep.net./documents/newsletters/pnu/pnu.html#RECENT

4. Melting of atomic clusters

The traditional view is that a small solid particle has a lower melting point than a large one: in the former, relatively more atoms are close to the surface and so have fewer neighbour atoms to interact with — hence a lower binding energy per unit mass of the particle. However, A A Shvartsburg and M F Jarrold found the reverse to occur in their experiments on the melting of Si and Ge clusters as small as 15 – 30 atoms. They studied the motion of cigar-shaped clusters through a drift chamber filled with gaseous helium, and their idea was that when assuming a spherical shape upon melting, such clusters would experience more elastic resistance to their motion, and this would affect the amount of time they take to traverse the chamber. As it was, however, the clusters did not melt up to temperatures 50 K above the melting point of the bulk material. A theoretical explanation for this effect is still lacking.

Source: http://publish.aps.org/FOCUS/
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5. Optical interferometer

Cepheids are a special class of variable star which, due to the stable nature of their period – luminosity relation, form convenient 'standard candles' for distance determination purposes. Knowing distances to and the redshifts of Cepheid-containing galaxies makes it possible to determine the expansion rate and age of the Universe. To do this it is necessary first to calibrate the period – luminosity relation of the Cepheids, for which purpose distances to the closest of them must be very accurately measured. Because the physical diameter of the Cepheids is known from other data, the measurements of the distance reduce to measuring the Cepheid's angular diameter, which is about of milliarcseconds (mas; 1 mas $= 4.85 \times 10^{-9}$ radians) for even the closest Cepheids. However, even the resolving power of the Hubble telescope does not exceed 100 mas, let alone ground-based telescopes subject to the degrading effect of the atmosphere. This problem can be overcome by pooling observations from several ground-based telescopes united into one optical interferometer. Attempts at such a system date back to the 1920s, but only recently, with advances in computer and

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optical technologies, has real progress been made in this area. The optical interferometer constructed at the Palomar Observatory in California, US, has a resolution of $\sim 10^{-6}$, equivalent to a single telescope with a mirror 110 m in diameter. The distance to one Cepheid has already been found with high accuracy using the new interferometer, and this will enable the cosmic distance scale and the age of the Universe to be determined.

Source: http://www.nature.com; *Nature* **407** 485 (2000)

Compiled by *Yu N Eroshenko*