Physics news on the Internet (based on electronic preprints)

1. Interaction of electrons and protons

Experiments were carried out on the TRISTAN particle accelerator (Japan) to get insight into the close encounters of electrons and positrons. As quantum electrodynamics tells us, electrons (as well as positrons and other charged particles) are surrounded each by a cloud of virtual particles which rather strongly shield the core of the cloud, that is, the electron proper, from the surroundings. Therefore, the observed properties of the electron are determined in many respects not only by the electron itself, but by the cloud around it as well. In particular, the cloud reduces the strength of electromagnetic interaction between the electron and other particles. In the TRISTAN experiments, electrons and positrons were brought to within 2×10^{-16} cm of one another. In such a close approach, the virtual clouds around the colliding particles penetrate into one another. This weakened the influence of the clouds and made it possible to study the interaction of electrons and positrons themselves. As should be expected theoretically, the constant of electromagnetic interaction increased as the particles moved closer together. In contrast to the experiments at the E Fermi laboratory, where collisions of protons and antiprotons made quarks and antiquarks approach to within 10^{-17} cm, the interactions observed in the TRISTAN experiments were of purely electromagnetic nature and were not mixed with strong nuclear interactions, thus permitting the quantum electromagnetic phenomena to be investigated very accurately. The experimental findings were analyzed by D Koltick and his coworkers.

Source: *Phys. Rev. Lett.* (January 20)
http://aps.org/Journals/PRL-online/

2. Cooling of atoms

Scientists at NIST and the University of Colorado have developed a new method to cool neutral atoms. Using a combination of lasers and suitably configured magnetic fields, the investigators were able to trap a group of rubidium-87 atoms. Atoms with one of two possible values for spin and, accordingly, for magnetic moment are less tightly bound in the magnetic trap than atoms with the other spin value. On escaping from the trap, such atoms carry away some of the energy given up by the second species upon collisions, and this serves to cool the atoms remaining in the trap. As a result of cooling, the rubidium atoms form Bose – Einstein condensates. Actually, atoms differing in spin direction form two distinct repelling but partly overlapping subsystems of the Bose – Einstein condensate. The new technique can be useful in producing Bose – Einstein condensation for rare isotopes.

Source: *Physics News Update*, No. 302
http://www.hep.net/documents/newsletters/newsletters.html

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3. A superconducting magnet

Researchers at the Texas Center for Superconductivity at the University of Houston have built a superconducting magnet with a magnetic field strength of 10.1 T at a temperature of 42 K. A magnet developed previously had a field strength of as low as 2.3 T at a temperature of 4 K. In the developing the new magnet, the researchers had to overcome a number of engineering difficulties. First, field strength in high-temperature superconductors is limited by inability to achieve high current density. In the new magnet, the high current is produced by high-energy proton bombardment. Second, cracking of the superconducting magnetic material under the action of high magnetic fields has been eliminated by keeping the applied field as low as possible during cooling. The problem of preserving the induced field when the applied field is removed has also been overcome. Still another problem of maintaining magnetic strength over time has been resolved.

Source: *Energy Research News*
http://w3.pnl.gov:2080/er_news/toc.html

4. New Hubble Space Telescope observations

Intergalactic stars. For the first time ever, the Hubble Space Telescope has found isolated stars in intergalactic space in the Virgo cluster of galaxies. These stars are adrift in the common gravitational field of the cluster and are not related to any of the 2,500 galaxies that make up the cluster. Some 600 stars, predominantly red giants, have been observed in a small region of space. This region is more than 300,000 light-years from the nearest M87 galaxy, far beyond the limits of the stellar halo of M87. According to one hypothesis, these stars were tossed out of their home galaxy during a collision of galaxies at the early stage of evolution of the Virgo cluster. Presumably, intergalactic space should also contain a significant number of fainter stars not visible in the telescope. All of these stars may account for 10% of the Virgo cluster's mass. Intergalactic stars, whose existence has been predicted theoretically, can help astronomers to study the distribution of dark matter (hidden mass) in clusters of galaxies and to construct a cosmic scale of distances. Quite likely, these stars are the source of diffuse radiation from the Virgo cluster observed earlier by ground-based telescopes.

Evolution of a supernova after an explosion. Ten years after the blast of a supernova designated SN1987A occurred, the expanding cloud of gas produced by the explosion has become large enough for its spatial structure to be resolved. The cloud is the shape of a dumbbell about 0.1 light-year long, which is expanding apart at nearly 10^7 km/h. It is not unlikely that the cloud is actually spherical in shape, but the middle part of the cloud is shadowed by the gas-dust ring around the exploded star. These observations are extremely important for the theory of stellar evolution and for the theory of supernova explosion.

Black holes at centres of galaxies. A census of 27 nearby galaxies carried out jointly by the Hubble Space Telescope and a ground-based telescope in Hawaii has yielded reliable evidence that three of them may contain supermassive black holes. This conclusion is based on the observation of the peculiar velocities of the stars near the centres of the galaxies [see *Uspekhi Fizicheskikh Nauk* **166** 1230 (1006)]. The masses of the black holes thus discovered range from 5×10^7 to 5×10^8 Sun's masses and are almost proportional to the masses of their host galaxies. That is, more massive galaxies contain more massive black holes. The observation technique is sensitive in respect of only massive black holes. Therefore, it is possible that small galaxies also contain black holes with smaller masses.

Source: http://www.stsci.edu/

5. Black holes in binary systems

From an analysis of data from Japan's ASCA satellite, researchers at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, have reported the discovery of black holes in binary stellar systems known as X-ray novae. An X-ray nova is presumed to consist of a normal star and a compact object — a neutron star or a black hole. Matter from the normal star flows to the compact object and gives rise to a flare of X-ray radiation upon its impact. When matter strikes a neutron star, a sizable proportion of the energy is converted to radiation. When it strikes a black hole, the greater proportion of the energy goes under the 'event horizon' of the black hole. As a result, an X-ray nova with a neutron star must look significantly brighter than an X-ray nova with a black hole. Basing themselves on this theory, the researchers have examined 9 X-ray novae and concluded that four of them should contain black holes. An additional argument in favour of the presence of black holes is the relatively large masses of the superdense objects compared to those of the compact objects (which are neutron stars, according to the study in question) in the five remaining binary systems.

Source: *Science*
http://www.sciencemag.org/

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