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1. Another baryon found

Among the baryons composed of quarks of the first two generations (ud and cs), all baryon types with no more than one c-quark have already been discovered experimentally. Theory predicts the existence of six baryons with two c-quarks in their makeup (doubly charmed baryons). One such baryon, Ξ_{cc}^{+}, has now been seen for the first time in the SELEX experiment at Fermilab. The particle was produced in a collision between a beam of charged 600-GeV hyperons with copper or diamond targets and identified by the products of its decay, $\Xi_{cc}^{+} \to \Lambda_c^{+} K^{-} \pi^{+}$. The baryon mass was found to be about 3.5 GeV, and its lifetime less than 33 fs.

Source: *Phys. Rev. Lett.* **89** 112001 (2002)
http://prl.aps.org

2. Two-proton radioactivity of ^{45}Fe

A new form of radioactivity, with a nucleus emitting two protons simultaneously, has been discovered independently at the GANIL laboratory in France and the GSI laboratory in Germany. The possibility of the two-proton decay of *Z*-odd nuclei with an excess of protons was predicted by V I Gol'danskiĭ in 1960. Earlier work provided only weak signs of two-proton decays, and only for excited nuclei. The GANIL and GSI experiments have given the first credible evidence of two-proton decays in ground state nuclei. The collisions of the beam of ^{58}Ni ions with a target led to the decay of ^{58}Ni into a large number of smaller nuclei, including ^{45}Fe nuclei with 26 protons and 19 neutrons. These iron nuclei were then separated from other collision products, slowed down and captured by silicon detectors, where they decayed with a half-life of about 5 ms. The French and German experiments registered twelve and four two-proton decays, respectively. In both experiments, the measured proton energy of 1.14 MeV agrees well with the theoretical models of decay.

Source: *Phys. Rev. Lett.* **89** 102501 (2002)
http://prl.aps.org
European Physical Journal A **14** 279 (2002)

3. Antihydrogen

A small quantity of antihydrogen atoms, consisting of antiprotons and positrons, had been obtained earlier at CERN and Fermilab. Now significant progress has been made in this area by an international collaboration at CERN, where about 50,000 atoms have already been produced in the ATHENA experiment. The atoms formed during three-particle and radiation recombination processes when a beam of antiprotons was sent through a cloud of positrons confined in a Penning trap. The positron source was the radioactive decay of sodium-22 atoms; positrons were captured in the trap and cooled to a temperature of 15 K. The antihydrogen was registered by the products of its annihilation in the material of the trap. In this way, about 130 atoms were registered directly which, given the experiment's registration probability, corresponds to approximately 50,000 created atoms. The ability to produce large amounts of antihydrogen is important, in particular, for testing the CPT theorem. The violation of this theorem would lead to a difference between the energy levels of the hydrogen and anti-hydrogen atoms, which can in principle be detected by comparing the emission spectra. In a paper submitted for an upcoming issue of *Usp. Fiz. Nauk* **173** (2003) [*Physics – Uspekhi* **46** (2003)], two members of the ATHENA collaboration (L I Men'shikov and G Landua) review work on the creation of antihydrogen.

Source: http://physicsweb.org

Uspekhi Fizicheskikh Nauk **172** (10) 1224 (2002)
Translated by E G Strel'chenko

4. Acoustic memory in a crystal

M A Breazeale and his colleagues at the University of Mississippi observed that 70 μs after a short ultrasonic pulse has been passed through a crystal of ferroelectric lithiumniobate $LiNbO_3$, a similar but smaller-amplitude pulse is re-emitted by the crystal. It is established that this effect has nothing to do with reflection from the crystal's surfaces. The new acoustic effect was observed at several frequencies. The amplitude of the re-emitted signal is proportional to that of the original signal and has a maximum value for sound propagation along a piezoelectrically active direction of the crystal. The effect disappeared when the crystal was heated above 75 °C. The acoustic memory effect is, both in its characteristics and in the conditions for its existence, fundamentally different from the hysteretic effect of ferroelectric memory and from the effect of electro-optic memory recently discovered in crystals of $LiNbO_3$. In the authors' opinion, the effect is due to the redistribution of charge within the domains and to the deformation of domain walls under the action of sound vibrations. The relaxation of charges to their initial positions gives rise to a reversed deformation and generates sound.

Source: *Phys. Rev. Lett.* **89** 115506 (2002)
http://prl.aps.org

5. Black holes in globular clusters

Hubble observations reveal the presence of massive black holes in two globular star clusters, M15 in our galaxy and G1 in the Andromeda Nebula. For M15, astronomers have measured the ray velocities of individual stars and determined the velocity dispersion in the central region ($\sigma \simeq 25$ km s^{-1}). From these data, a dynamic model was constructed, according to which a sufficiently compact object with a mass $M_{\mathrm{BH}} = (3.9 \pm 2.2) \times 10^3$ solar masses, most likely a black hole, is located at the centre of the cluster. In the distant cluster G1, individual stars are invisible, and the only quantities that astronomers have been able to measure are the velocity dispersion, $\sigma \simeq 14$ km s^{-1}, and the mass of the central object, $M_{\mathrm{BH}} = 2.0(+1.4; -0.8) \times 10^4$ solar masses. It turned out that M_{BH} and σ correspond to the M_{BH} (σ)

dependence found earlier for supermassive galaxy-core black holes and extrapolated to the region of small masses. This may suggest a similarity between black hole formation processes in galaxy cores and globular clusters. However, the existence of black holes in globular clusters is still awaiting confirmation. In stead, dense clusters of neutron stars may be located in the centres of globular clusters, or, alternatively, double stars, whose orbital motions create the illusion of a large velocity dispersion.)

Source: http://arXiv.org/abs/astro-ph/0209313
http://arXiv.org/abs/astro-ph/0209315

Compiled by *Yu N Eroshenko*