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Physics news on the Internet (based on electronic preprints)

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1. A new meson discovered

A new subatomic particle named $D_s^+(2317)$ has been discovered in the BaBar experiment at the DOE's Stanford Linear Accelerator Center (SLAC). It was observed as a resonance in the system of $D_s^+\pi^0$ mesons. The new particle is probably a P-wave excitation of the D_s^+ meson (the $^1S_0$ ground state of the system of c and $\bar{s}$ quarks). Its existence has been predicted theoretically, but its measured mass, 2.317 GeV/c^2, turned out to be much lower than predicted. Nor is the particle's decay pattern consistent with the current theoretical model of the meson (no radiation transitions to the ground state occur). Alternative hypotheses are suggested, according to which the newly discovered particle is either a four-quark system or a hadron molecule. The particle $D_s^+(2317)$ was produced in electron – positron collisions at the PEP-II asymmetric-energy storage ring. The international BaBar Collaboration consists of more than 500 scientists and engineers from 75 institutions, including Russian scientists from the G I Budker Institute of Nuclear Physics in Novosibirsk.

Source: http://www-public.slac.stanford.edu/babar/

2. Atomic levels of fermium

The electronic energy levels of the isotope ^{255}Fe have been studied for the first time at Mainz University in Germany. This makes fermium the heaviest element whose optical spectrum has been investigated. Fermium-225 atoms, with a half-life of 20.1 h, were produced in the reactor at the Oak Ridge National Laboratory in the US and then air shipped to Germany. The absorption lines of the atomic transitions involved were detected using the two-step resonance ionization spectroscopy. The ionization of atoms was produced in two stages: the first excimer pump laser pulse promoted electrons to an excited level, and the second tunable dye laser pulse knocked electrons out of an atom. After that, the number of produced ions was counted using the mass analysis. In this way, two atomic energy levels were found whose characteristics were identical to those calculated by the relativistic multiconfiguration Dirac – Fock method. In calculating electronic states in heavy atoms it is necessary to include relativistic effects, which somewhat changes the usual classification rules for stationary orbitals.

Source: *Phys. Rev. Lett.* **90** 163002 (2003)
http://prl.aps.org

3. Long α-decay

P de Marcillac and his colleagues in France have measured the longest α-decay half-life known thus far. The only naturally occurring bismuth isotope ^{209}Bi, according to calculations, should decay to more stable ^{205}Tl with a half-life of 4.6×10^{19} yr. That long time is due to the small difference between the binding energies of the nuclei and the fact that ^{209}Bi is next to doubly 'magic' nucleus ^{208}Pb. The low energy ($\sim$ 3 keV) of the α particles emitted in the decay process has prevented their detection in previous experiments. In particular, attempts to detect them by using nuclear emulsions have been unsuccessful. The new experiment used a scintillating bolometer enclosed in a light-reflecting cavity and cooled to a temperature of 20 mK. The bolometer consisted of two detectors, one of which, a crystal of $Bi_4Ge_3O_{12}$, converted a temperature change into an electrical signal, and the other, a germanium photodiode, registered photons. As the α particles were absorbed by the germanium target, light was emitted and heat released. Over 5 days of experimentation, 128 reported events occurred, with a 3.14-keV α-decay energy of ^{209}Bi in the spectrum. The half-life of $(1.9 \pm 0.2) \times 10^{19}$ yr obtained based on detection rate measurements, is close to the theoretically evaluated value. The experimental facility employed is a prototype for the more massive scintillating bolometers for the dark matter search experiment ROSEBUD now planned.

Source: *Nature* **422** 876 (2003); www.nature.com

4. Two-band superconductivity in magnesium diboride

Evidence has been found in a number of experiments that the intermetallic superconductor MgB_2 has at least two gaps in the electronic energy spectrum (see *Usp. Fiz. Nauk* **171** 306 (2001) [*Phys. Usp.* **44** 330 (2001)] and *Usp. Fiz. Nauk* **172** 1110 (2002) [*Phys. Usp.* **45** 998 (2002)]). The experiments failed to unambiguously characterize the gaps, however, because only the averaged electron momentum distribution was measured. T Takahashi and his colleagues used high-resolution angle-resolved photoemission spectroscopy to obtain direct data on the two gaps. The energy gaps originate in the σ and π bands due to electron – phonon coupling within boron layers and have sizes of $(6-7) \times 10^{-3}$ eV and $(1-2) \times 10^{-3}$ eV, respectively. It is the former which is mainly responsible for the superconducting properties of MgB_2.

Source: *Nature* **423** 65 (2003); www.nature.com

5. Young stars in the Andromeda halo

Among the stars in the spherical halo of the galaxy M31 (Andromeda nebula), only bright giants have previously been observed. Now, using the Advanced Camera for Surveys on board the NASA's Hubble Space Telescope, it has proved possible to discern about 300,000 normal- and low-brightness stars. It turned out that about one-third of these stars have an unexpectedly short age of 6 to 8 billion years, much less than that of stars in the halo of our galaxy, about 11 – 13 billion years. In addition, the discovered young stars are richer in heavier elements compared to those in our Milky Way's halo. The astronomers believe that the composition difference between the halos of the two galaxies is due to their different formation histories. The Andromeda galaxy may have undergone a merger with another galaxy. Disk stars of one of the merged galaxies dispersed into the halo or, alternatively, the merger initiated the birth of new stars in the halo itself.

Source: http://hubblesite.org/news/2003/15

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