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1. Parameters of the unitarity triangle

The most accurate measurement to date of the angle ϕ_3 in the unitarity triangle, a graphical representation of the Cabbibo – Kobayashi – Maskawa matrix, has been carried out by the Belle Collaboration at the KEK laboratory in Japan. The role of the CKM matrix in the Standard Model of elementary particles comes to describing *CP* violation which is responsible for the difference between matter and antimatter. In the course of the experiment, the Belle team obtained 275×10^6 $B\bar{B}$-meson pairs and studied their decay into neutral D-mesons and charged kaons, which in 56 observed events was followed by a D-meson decay into a pion pair and a kaon. From the difference in the decay characteristics between B-mesons and anti-B-mesons, the team calculated that the angle $\phi_3 = 112^\circ \pm 35 \pm 9 \pm 11 \pm 8$, where the respective errors are statistical, systematic, model-related, and due to the possible presence of the nonresonant decay $B^\pm \to DK_S\pi^\pm$. The data processing technique used in the experiment was the Dalitz plot analysis of the three-body decay of the neutral D-meson from the $B^\pm \to DK^{*\pm}$ process. Measuring the unitarity triangle parameters is important in the search for new effects and as a tool for checking the Standard Model for self-consistency. Participating in the international experiment were Russian scientists from the G I Budker Institute of Nuclear Physics (Novosibirsk) and the Institute for Theoretical and Experimental Physics (Moscow).

Source: http://arXiv.org/abs/hep-ex/0504013

2. The decay half-lives of ^{78}Ni nuclei

A team of German and American researchers has for the first time measured the decay half-lives of ^{78}Ni nuclei. These nuclei are 'doubly magic' (with completely filled proton and neutron shells) and are crucially important for the formation of heavy elements in the Universe: the rapid capture of neutrons by ^{78}Ni nuclei (the so-called r-process occurring in supernova explosions) produces more than half of all chemical elements beyond iron. Although ^{78}Ni nuclei had been synthesized previously at the GSI Laboratory in Darmstadt, Germany, their decay half-life proved impossible to measure. In the new experiment, conducted at the Coupled Cyclotron Facility of the National Superconducting Cyclotron Laboratory at Michigan State University, USA, the German – American team collided a beam of krypton with a beryllium target and measured the decay half-life of ^{78}Ni nuclei separated from the atomic reaction products. The result, 110^{+100}_{-60} ms, is four times shorter than the theoretical prediction. The experimental data are best fitted with the nuclear shell model and suggest that models of element synthesis in supernova explosions should be revised. The same experiment yielded the decay half-lives of the ^{75}Ni, ^{76}Ni, and ^{77}Ni nuclei.

Source: *Phys. Rev. Lett.* **94** 112501 (2005);
http://prl.aps.org

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3. Measuring extremely small masses

In a technique developed by M Roukes and his colleagues at the California Institute of Technology, Pasadena, USA, extremely small masses can be measured based on the amount by which a nanoscopic oscillator changes its resonant frequency as its mass is increased. The oscillator, a flattened balance beam made from silicon carbide, was loaded at both ends, put in an ultra high vacuum, and exposed to a beam of xenon atoms, part of which is absorbed on its surface. The oscillator was placed in a radio frequency cavity, whose electric oscillations were measured in the Caltech experiment. The frequency shift is discernible when 30 xenon atoms (i.e., 7×10^{-21} g in mass) are absorbed by the oscillator. The new technique may be useful in biomedical research for mass sensing of large organic molecules.

Source: *Physics News Update*, Number 725;
http://www.aip.org/pnu/2005/split/725-1.html

4. Electromechanics at the nanoscale

A Zettl and his colleagues at the University of California at Berkeley and the Lawrence Berkeley National Laboratory, USA have developed an electromechanical device only a few dozen nanometers in size, which relies on the phenomenon of surface tension for its mechanical motions. The device, called a relaxation oscillator, consists of two liquid indium droplets placed on a carbon nanotube substrate. Applying an external electric field through the substrate causes the indium molecules to leave the larger droplet for the smaller one — ultimately making the latter big enough to touch the former. After that the backflow of indium due to surface tension starts to occur — thus leading to oscillations. It is found that the oscillation frequency depends on the electric field strength and that during each oscillation (about 200 ps in duration) a mechanical work of 5 fJ is performed.

Source: *Appl. Phys. Lett.* **86** 123119 (2005);
http://physicsweb.org/articles/news/9/3/14/1

5. A new class of cosmic gamma-ray sources

The High Energy Stereoscopic System (HESS) telescope in Namibia in Africa has discovered eight new point sources of hard gamma-ray emission near the center of the Milky Way. HESS is a set of four Cherenkov detectors, each 107 m^2 in area, which operate jointly in a stereoscopic mode, thus providing a resolution of better than 0.1°. The emission observed has an energy of more than 100 GeV. Gamma photons or cosmic rays entering the atmosphere trigger a cascade of charged particles, resulting in Cherenkov radiation which is detected by the four telescopes. The eight previously unknown gamma-ray sources are located in the plane of the Galaxy disk close to its center. While six of them were identified as either supernova explosions or neutron stars or neutron star nebulas, based on their observations at other wavelengths, the two remaining sources do not spatially coincide with known astrophysical objects and are not seen in other wavelengths — suggesting they may form a new population of gamma-ray sources. The hard gamma radiation is likely due to the interaction between high-energy accelerated charged particles, and the fact that no long-wave radiation comes along points to protons as the most likely to be accelerated. This is another peculiarity where these two sources differ from known objects where mainly electrons are accelerated.

Source: http://arXiv.org/abs/astro-ph/0504380

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