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1. Neutrinoless double-β decay

The experiment being performed at the underground Gran Sasso Laboratory in Italy by the Heidelberg – Moscow collaboration is leading the international effort to study the double-β decay and to search for dark matter particles. The experiment is studying the nuclei of enriched super-pure ^{76}Ge and in particular is seeking neutrinoless double-β decay. In this reaction two neutrons of the ^{76}Ge nuclei should simultaneously convert into two protons, emitting a pair of electrons in doing so. Unlike the usual β-decay, the neutrinoless decay would not produce a neutrino, thus violating the conservation law for lepton number. Until recently, no evidence for the neutrinoless decay channel has been found, and its lower decay half-life limit has been found to be $T_{1/2} > 5.7 \times 10^{25}$ years. However, H Klapdor-Kleingrothaus and colleagues, of the Max Planck Institute for Nuclear Physics in Heidelberg, Germany, have reanalyzed the experimental data and observed a peak in the electron energy spectrum which corresponds to the neutrinoless double-β decay. The neutrino involved in the decay should be of Majorana type (i. e., should be identical to its antiparticle), and its mass should be 0.39 eV, much more than obtained from neutrino oscillation experiments. If confirmed, this discovery will be a breakthrough in elementary particle physics beyond the Standard Model. Many researchers, however, have doubts about the procedure by which the peak in the electron spectrum was identified and background events were counted. Thus, it is too early to speak of a new discovery, and more careful analysis of experimental data is needed.

Source: *Mod. Phys. Lett.* **16** 2409 (2001);
http://xxx.lanl.gov/abs/hep-ex/0202018

2. Solar neutrino flux

One possible explanation for the shortfall of solar neutrinos is neutrino oscillations, the transformation of electron neutrinos to the muon and tau species (see *Usp. Fiz. Nauk* **169** 1299 (1999) [*Phys. Usp.* **42** 1193 (1999)]). The primary source of high-energy neutrinos in the Sun are the β^+-decays of the isotope ^{8}B, a product of the ^{7}Be(p, γ)^{8}B reaction. While a reliable calculation of the neutrino flux requires that the cross section of this reaction be known to an accuracy of 5% or better, thus far the uncertainty of the experimental data exceeded 9%. Now a US – Canada collaboration at the University of Washington has performed an experiment in which, for the first time, the accuracy of 5% was achieved. The experiment studied collisions of a proton beam with a beryllium target. The technique developed by the researchers overcame the factors that had limited the accuracy of the previous experiments, such as the beam non-homogeneity and the backscattering of ^{8}B nuclei. Calculations using new data showed that the solar neutrino flux was 17% greater — and hence neutrino oscillations must be faster — than previously thought.

Source: *Phys. Rev. Lett.* **88** 041101 (2002);
http://prl.aps.org

Uspekhi Fizicheskikh Nauk **172** (3) 334 (2002)
Translated by E G Strel'chenko

3. Photomagnetic effect

A J Epstein and D A Pejakovic, of Ohio State University, and their colleagues from the University of Utah have for the first time observed that the magnetization of an organic material varies with illumination. It was known previously that some organic materials are magnetic and that some metallic compounds exhibit the photomagnetic effect. Now it turns out that the compound tetracyanoethylene (TCNE) combines both these properties. The team placed a polycrystalline (plastic) sample, a solution of $Mn(TCNE)_2$ in CH_2Cl_2, in a magnetic field and illuminated it with light in the blue portion of the spectrum. After 6 hours, the sample's magnetization increased by 50% and saturated. On turning the light off, the magnetization continued to increase for some time due to the cooling of the sample and then remained almost unchanged (decreased by as little as 0.5%) for the next 60 hours. It then dropped significantly when the sample was exposed to green light and was destroyed completely as the sample was heated to 75 K. Based on spectroscopy data, the photomagnetic effect is explained by the presence of a metastable electronic state in the material and by the fact that the material's molecules change their chemical bond configuration when exposed to light.

Source: *Phys. Rev. Lett.* **88** 057202 (2002);
http://prl.aps.org

4. Nanotube thermometer

Y Gao and Y Bando, both in Japan, have designed a microscopic thermometer consisting of a carbon nanotube 75 nm in diameter, partially filled with liquid gallium. Like the column of mercury in a normal thermometer, the column of liquid gallium increases in height almost linearly with temperature. The position of the end of the column was determined using a scanning tunneling microscope. The thermometer allows measurements in the temperature range from 323 to 823 K. The nanotube size itself remains practically unchanged over this range. Gallium filled nanotubes were produced by mixing gallium oxide and carbon monoxide in a flow of nitrogen in an electromagnetic field at high temperature.

Source: *Nature* **415** 599 (2002); www.nature.com

5. Chemical composition of a distant galaxy

J Bechtold of the University of Arizona and A Siemiginowska (Cambridge, Massachusetts) have determined the oxygen content of a galaxy 4×10^9 light years from Earth. The galaxy is seen in projection on a yet more distant object, quasar PKS 1127-145, which emits X-rays. The X-ray radiation is due to the photons of the background radiation being scattered by ultra-relativistic particle jets spewn out from the core of the galaxy. Using the space-based Chandra X-ray Observatory, the researchers detected an absorption line of oxygen in the galaxy's spectrum. (This observation has only become possible thanks to the launch of the Chandra observatory; before that, X-ray hydrogen lines had not been seen in galactic spectra). It turned out that the percentage oxygen content of the distant galaxy is five times lower than in the Sun, even though the galaxy formed in the same epoch as our Milky Way. Galactic enrichment by heavy elements occurs as a result of supernova explosions. The observation results make it possible to determine the average formation rate of heavy elements over the last 4×10^9 years.

Source: http://unisci.com

Compiled by *Yu N Eroshenko*