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Physics news on the Internet (based on electronic preprints)

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1. Neutrino-nucleon interaction

At Fermilab (near Chicago), years-long analysis of data on the collisions of high-energy neutrinos with nucleons have revealed an unexpected departure from the Standard Model of elementary particles. The quantity measured in the experiments was the so-called mixing angle θ_W, a characteristic of the contribution which charged and neutral weak currents make to the cross section for the interaction involved. Charged currents are carried by $W^{\pm}$ bosons and cause the muon neutrino to become a muon. The exchange of Z bosons does not involve the creation of muons, thus enabling a distinction to be made between events with and without the participation of charged and neutral weak currents. The neutrino was one of the decay products of the pions and kaons produced by collisions of accelerated protons with the beryllium oxide target at the Tevatron accelerator. To record various types of events caused by the interaction of neutrinos with nuclei, a 700-ton detector complex was used. The measured value of $\sin^2\theta_W$ differs by about three standard deviations from its theoretical value. One reason for the departure from the Standard Model prediction might be the existence of new interactions or possibly new particles — leptoquarks, for example. Up to now, the Standard Model has served as a highly accurate description for all experimental data except for those on neutrino oscillations. Recent reports of an anomalously large magnetic moment of the muon (see *Usp. Fiz. Nauk* **171** 306 (2001) [*Phys. Usp.* **44** 306 (2001)]) proved to be due to an error in theoretical calculations, the elimination of which restored agreement between theory and experiment.

Source: http://xxx.lanl.gov/abs/hep-ph/0110059

2. New substances

Oxygen O_4. A team of researchers in Italy (F Cacace, G de Petris, and A Troiani) has succeeded for the first time in creating molecules of O_4 which were predicted to exist back in the 1920s. Positive O_4^+ ions formed in a mixture of neutral O_2 molecules with O_2^+ ions and were separated out by a mass spectrometer. The irradiation of O_4^+ with electrons produced neutral O_4 molecules. Upon repeated ionization the mass spectrograph again revealed O_4^+, indicative of the stability of the molecules.

Source: www.nature.com

A new form of fullerene. L Hultman and his colleagues have created a new form of fullerene, $C_{48}N_{12}$, in which, unlike the ordinary C_{60}, some of the carbon atoms are replaced by nitrogen atoms. Molecules in a C_{60} crystal are bound together by weak van der Waals forces. The presence of nitrogen atoms creates strong covalent bonds — the reason why a crystal of $C_{48}N_{12}$ possesses a unique combination of strength and elasticity.

Source: *Phys.Rev.Lett.* **87** 225503 (2001); http://prl.aps.org

A magnetic polymer. Recently, a polymerized form of fullerene was found to be ferromagnetic (see *Usp. Fiz. Nauk* **171** 1200 (2001) [*Phys. Usp.* **44** 1209 (2001)]). Now, a hundred times stronger ferromagnetic properties have been found by University of Nebraska researchers in a polymerized form of benzene they developed. The new polymer consists of 14-benzene blocks, in each of which 8 benzene molecules form a closed chain and the remaining 6 connect it to other chains.

Source: *Science* **294** 1503 (2001); www.science.com

Liquid crystals for radio wavelength applications. F Yang and J Sambles in Great Britain have developed liquid-crystal-based heterostructures acting as highly selective microwave filters. The structures consist of alternating thin layers of the liquid crystal and aluminium. The unusual properties of these structures are associated with standing electromagnetic waves appearing between the aluminium layers and with the difference in the way liquid crystals affect waves with different polarization. The range of wavelengths which can be transmitted can be changed by varying the electrical voltage applied to the structure.

Source: *Appl. Phys. Lett.* **79** 3717 (2001) http://physicsweb.org

3. Superfast insulator-metal transition

A Cavalleri and his colleagues in the US and Canada have been exploring the dynamics of vanadium oxide VO_2 making a transition to the conducting state. This phase transition is due to the reorganization of the crystal structure of the oxide. Previously, only slow transitions occurring on heating VO_2 to a temperature of 340 K have been observed. A Cavalleri and his colleagues irradiated the oxide with powerful, 50 fs laser pulses which caused a phase transition to occur in as short a time as 100 fs. The state of the crystal was monitored by an X-ray diffraction technique as well as optically. The team also established that the phase transition did not result from the growth of islands of the new phase, as is the case usually, but occurred over the entire sample volume at once.

Source: *Phys.Rev.Lett.* **87** 237401 (2001); http://prl.aps.org

4. Microlensing identification

Ten years of observations have revealed about 20 cases of stars in the Large Magellanic Cloud being gravitationally microlensed by compact dark objects in the halo of the Milky Way galaxy (see *Usp. Fiz. Nauk* **167** 913 (1997) [*Phys. Usp.* **40** 869 (1997)] for a review). Until recently, however, the nature of these objects was not understood. Now an international collaboration of astronomers has identified and studied one of these gravitational lenses for the first time. Using the Hubble Space Telescope, they found that the lens is a brown

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dwarf — a faint star of class M, 5 – 10% the mass of the Sun, located about 600 light years from Earth. The fact that the star belongs to class M is confirmed by the analysis of its spectrum using the Very Large Telescope (VLT) at the European Southern Observatory (ESO). The statistics of microlensing events reveal that 'microlenses' might constitute up to 50% of all dark matter in the Galaxy. It is still unclear whether brown dwarfs were also involved in the remaining 20 or so microlensing events observed.

Source: http://unisci.com/stories/20014/120611/htm;
Nature **414** 617 (2001)

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