

Physics news on the Internet (based on electronic preprints)

1. Quantum communications

Austrian researches from the University of Innsbruck have carried out experiments on conveying information at a quantum level. A UV photon is converted into a pair of correlated photons with the help of special equipment. One of them is then submitted to a certain action leading to alteration of its spin or phase. After that they interfere in the signal receiver. As a result, having a pair of photons, one is able to encode three states: 0, 1, and 2. By analogy with a bit of information (states 0 and 1) that element of information was termed as 'trit'. The standard ASCII code usually transmitted in 8-bit representation could be transmitted with 5 trits. The quantum communication together with recent construction of quantum logical cells may create a basis for future information technologies.

In the experiments described information was transmitted at the speed of light. There is a long discussion on whether it can be transmitted superluminally, at collapse of correlated wave functions (see *Uspekhi Fizicheskikh Nauk* **166** 651 (1996) [Physics Uspekhi **39** 609 (1996)] for more details). This question is still not solved unequivocally. If such quantum communication is possible, then seemingly only over small distances and in complex irreversible systems.

Source: http://www.uibk.ac.at/c/c704/qo/photon/_qdc

2. LEP2 accelerator

At CERN's (Switzerland) Large Electron Positron (LEP) collider, after series of upgrades, first pairs of $W^{\pm}$ were detected. LEP was put into operation in 1989 to explore processes governed by electroweak interaction. In 1990, the energy of $e^{\pm}$ particles in each of beams of the collider amounted to 45 GeV. The circumference of the accelerator is about 27 km. The modernisation was accomplished by adding new superconducting accelerating elements. Such elements accelerate particles more efficiently than the copper ones. At present, 144 superconducting elements are already installed. This resulted in a beam energy of 81 GeV which is sufficient to make pairs of $W^{\pm}$ bosons. These were in fact successfully detected in July 1996. For the first time these particles were experimentally discovered at CERN in 1983, with the help of proton–antiproton collider. As the modernisation goes on, LEP in essence transforms into a new accelerator, called LEP2. By 1998, the number of superconducting elements should reach 272 and the energy should increase up to 96 GeV in each of beams. The increase in energy is expected to bring new discoveries and surprises. One of the main tasks in high-energy physics is searching for Higgs bosons. At least one such particle is needed in gauge theories predicting $W^{\pm}$ bosons, already discovered. Theory poses no constraints on the Higgs boson mass, and it can in principle fill in energies available with LEP2. Other expectations are related to supersymmetric particles. If supersymmetry theory holds true, the lightest from supersymmetric particles, the chargino, might be observed at LEP2.

Source: http://www.cern.ch/Press/List.html
CERN Press Releases

Uspekhi Fizicheskikh Nauk **166** (8) 917 (1996)
Translated by S D Danilov

3. Exciton analogue of laser

The holes (non-filled valence states) in a semiconductor crystal behave similar to positive charges. They may combine with electrons to form a system resembling a hydrogen atom or positronium. Such systems are referred to as excitons. Having an integer spin and being bosons, the excitons are capable of forming Bose–Einstein condensate and condensing into clusters. Researches from Canada and France developed an analogue of laser in which a beam of excitons, instead of photons, is amplified. Under the action of conventional laser, a bath of excitons is created in a small semiconductor sample. Another laser produces a moving exciton cloud with size of 350 – 400 microns. As the cloud moves through the crystal, its density grows owing to the simulated scattering of excitons on the cloud. As a result the exciton beam is amplified. Since at present 'exciton mirrors' do not yet exist, the beam amplification occurs only over its single pass through the sample. Another characteristics of the exciton laser is that the exciton beam exists only within the semiconductor sample. The exciton laser may offer new possibilities in studying the coherent energy and charge fluxes in a solid matter.

Source: htp://www.hep.net/documents/newsletters/newsletters.html
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4. Search for axions

Axions, to now still undiscovered elementary particles, were introduced theoretically in relation to the problem of CP-invariance in quantum chromodynamics. At present they are considered as main candidates for the role of dark matter, the hidden mass of the Universe. The axion mass m_a is still unknown, however there are a number of astrophysical and cosmological arguments which confine it to 10^{-6} eV< $m_a < 10^{-3}$ eV. In 1996 in USA, an installation was set into operation designed to search for galactic axions, those, which probably constitute the dark halo of our Galaxy. The instrument sensitivity exceeds 50 times that of previously designed installations. This sensitivity is so high that if the axion indeed form the dark halo, they will be discovered. Thus, the installation fills into the second generation of instruments of that kind. The essence of the axion detection procedure is based on the Primakov effect: an axion decays into microwave photons in a static magnetic field. The signal is then amplified with the help of high-frequency microwave generator. For three years to come, a search will be launched for axions with masses of $(1.3 - 13) \times 10^{-6}$ eV. So far an energy interval of $(2.7 - 3) \times 10^{-6}$ eV is scanned. No axions with masses in this interval were detected. This implies that axions with $m_a = (2.7 - 3) \times 10^{-6}$ eV cannot compose the dark halo of the Galaxy.

Source: http://xxx/langl.gov
astro-ph/9607022

5. Estimation of the Gravitational Constant changes with time

S E Thorsett from the Princeton University has obtained a new bound on the possible rate of temporal variation of the Gravitational Constant G. Calculations hinge on the dependence of a neutron star mass on G: $M \propto G^{-3/2}$. This came to be known as the Chandrasekar limit which follows from the balance between the pressure of the degenerate electron gas and gravitational forces in the interior of the neutron star. Astronomical data on the masses of components in five known to date binary neutron stars were used. The upper bound on pulsar age is found departing from the deceleration observed in rotation periods of pulsars. As a result, following estimate was obtained: $\dot{G}/G = (-0.6 \pm 2.0) \times 10^{-12}$ year^{-1}, five times better than previous ones. Earlier, the quantity $\dot{G}/G$ was assessed from direct radio-location measurements in the Solar system; by observing the character of orbital motion of stars in binary systems including pulsars; by comparing the deuterium abundance in the Universe with that predicted by the theory of primary nucleosynthesis, and also from calculations of stellar evolution.

Source: http://xxx/langl.gov
astro-ph/9607003

6. New observations with the Hubble Space Telescope

1. Distant galaxies. Analyzing Hubble's images astronomers discovered the objects which are perhaps the most distant from those seen so far. Of 2000 galaxies analyzed, 7 are located further from the Sun that all known quasars. The distance to galaxies was determined from redshifts of their spectral lines which owe their existence to the Universe's expansion. The radiation arriving to the Earth was emitted by these galaxies when the Universe's age was only several hundred millions years (about 5% of its current age). In case the estimations of the distances will be corroborated the observational data may prove to be helpful in assessing the number of galaxies born at the early stages of the Universe's evolution.

2. Diameters of pulsating stars. The Hubble Space Telescope has been used successfully to measure the diameters of a special class of variable stars, termed as Mira variables. These are red supergiants which periodically, with periods from 90 to 1000 days, alter their size. This leads to variations in their brightness with visual amplitude of $3^m - 7^m$. Two stars, R Leonis and W Hidrae were observed with the Hubble Telescope. Their diameters reach that of Jupiter orbit. Besides, it was observed that stars are of elliptical rather than spherical shape. It is not however excluded that the illusion of ellipticity is due to large dark spots on the stellar surfaces. The observations described are important as judged from the viewpoint of theory of evolution of stars, the Sun in particular. It is believed that in 5 milliard years the Sun will also transform into a red supergiant.

Source: http://www.hq.nasa.gov/office/pao/NewsRoom/releases.html
NASA Press Releases

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