Physics – Uspekhi **38** (11) 1269 – 1270 (1995)

PACS numbers: 13.85.–t; 12.38.–t; 13.15.+g; 13.30.–a

Physics news on the Internet (based on electronic preprints)

Measurements of the strong interaction constant

The experiments carried out in the course of 1994 on the HERA accelerator made it possible to determine the strong interaction constant α_s in the energy range $120\ \mathrm{GeV}^2 < Q^2 < 3600\ \mathrm{GeV}^2$. The process associated with neutral currents (strongly inelastic scattering of leptons on protons) were investigated in these experiments. In such lepton – proton scattering the two particles exchange photons or neutral Z^0 bosons of energy Q. Electrons or positrons of energy 27.5 GeV and protons of energy 820 GeV collide in such a way that the energy in the centre-of-mass system is 300 GeV. The particles are detected by a hermetically sealed magnetic detector in which a magnetic field 1.43 T is created by a superconducting solenoid. Among the final reaction products there are hadron jets, which are formed by the interaction of intermediate bosons with quarks. The energies of hadrons and scattered electrons are measured with a uranium scintillation calorimeter.

A comparison of the experimental results and theoretical calculations, in which the strong interaction constant α_s is a free parameter, yielded the value of $\alpha_s(Q)$ in three energy intervals: $Q^2 = 120 - 240$, $240 - 720$, and $720 - 3600\ \mathrm{GeV}^2$. The value of α_s was found to decrease with increase in Q. This is known as the 'drift of the strong interaction constant'. When $\alpha_s(Q)$ is extrapolated to an energy equal to the rest energy of the Z^0 boson, the result is

$$\alpha_s(M_{Z^0}) = 0.117 \pm 0.005^{+0.004}_{-0.005} \pm 0.007 ,$$

where the first error is statistical, the second is the systematic experimental error, and the third is the systematic error resulting from theoretical indeterminacies. In earlier experiments the value of α_s was found by other methods. The good agreement between the results of the HERA measurements and the earlier values provides one more successful confirmation of the predictions of quantum chromodynamics.

Source: levy@zow.desy.de

Cross section of the interaction of a neutrino with a nucleus

Considerable progress in neutrino astrophysics is expected when the neutrino detectors now under construction (such as DUMAND-II, AMANDA, Baikal, and Nestor) are commissioned. It is planned to use these detectors primarily to observe neutrino fluxes from active galactic nuclei and quasars. This should make it possible to identify the nature of the cores of quasars, which are the central objects where an enormous energy release takes place. Under astrophysical conditions a high-energy neutrino appears as a result of pion decay. At energies $10^{12} - 10^{20}$ eV there are a number of advantages that neutrino astronomy has over gamma-ray astronomy. Photons with these energies are scattered by the relic radiation of the universe and do not reach the Earth, whereas neutrinos travel almost without hindrance and carry information on very remote events in the Universe. Moreover, a neutrino telescope can be used to investigate simultaneously a much larger part of the celestial sphere than is possible with a gamma-ray telescope.

Successful interpretation of the future observations will require high-precision values of the cross section of the interaction of a neutrino with the detector material at high energies. In the light of recent measurements of the structure function of the nuclei, carried out on the HERA accelerator in the course of experiments on strongly inelastic scattering at low values of the parameter x describing the process, it was possible to calculate the cross section of the interaction of a neutrino with nuclei right up to energies of 10^{21} eV. At 10^{20} eV the cross section was found to be $4 - 10$ times greater than assumed earlier, which means that the probability of detecting a neutrino by the systems under construction will be considerably greater.

Source: ina@physics.Arizona.EDU (Ina Sarcevic)

Search for antiproton decay

Considerable experimental effort in the search on proton decay established that the proton lifetime exceeds 10^{32} years. According to the CPT theorem, the proton and antiproton lifetimes are identical. Therefore, measurements of the antiproton lifetime provide also a check on the CPT theorem. Rapid antiproton decay would provide a natural explanation of the baryon asymmetry of the universe. In the experimental determination of the antiproton lifetime, a difficulty is encountered because a large number of antiprotons has to be generated. In experiments on protons, use is made of protons contained in 10^4 tonnes of water, whereas in recent antiproton experiments carried out at the Fermi Laboratory only 10^{12} particles were used. The experiments were intended to search for antiproton decay in the Antiproton Accumulator at the Fermi Laboratory. The precision of these experiments was almost three orders of magnitude higher than those of the experiments carried out earlier. The results indicated

Uspekhi Fizicheskikh Nauk **165** (11) 1322 (1995)
Translated by A Tybulewicz

that the antiproton lifetime exceeds several hundreds of thousands of years.

Source: SGEER@FNALV.FNAL.GOV

Antiproton annihilation

At CERN (Switzerland) it is planned to carry out experiments designed to measure the acceleration of antiprotons in a gravitational field, similar to the experiments carried out already on electron acceleration. The antiprotons needed in these experiments are generated in the LEAR (Low Energy Antiproton Ring) accelerator and are then stored in a Penning electric trap. The particles have to be cooled, so as to reduce their kinetic energy, in order to ensure a higher measurement precision. This is done by passing antiprotons through a thin foil. A scintillation detector is used to measure the rate of antiproton annihilation by interaction with gas molecules which remain in the vacuum system. Unexpectedly, cooling of antiprotons to temperatures below 1 eV stopped their annihilation (within the limits of the experimental error). Such behaviour of the annihilation cross section is in conflict with predictions of the existing theory. This property of antiprotons may make it possible to store them for a fairly long time and to transport them from one laboratory to another.

Source: goldman@qmc.lanl.gov

Prepared by *Yu Eroshenko*