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Physics news on the Internet

1. Measurements on the HERA accelerator

(1) The HERA electron – proton accelerator was used in direct measurements of the gluon density inside the proton. A study was made of the process of strongly inelastic scattering of electrons by protons. Virtual photons, emitted by the electron, interact with gluons and this generates hadron jets detected with the H1 detector. The experiments were carried out in the hitherto uninvestigated range of kinematic parameters describing the process. The parameter $x_{g/p}$, representing the relative momentum of a gluon, varied within the range $1.9 \times 10^{-3} < x_{g/p} < 0.18$. The gluon density was found to increase considerably on reduction in $x_{g/p}$. The experimental results are in agreement with the available indirect data on the gluon density. In the majority of cases these indirect data had been obtained from calculations carried out within the framework of quantum chromodynamics and, therefore, the experiments described represent one more important test of this chromodynamics.

(2) The H1 detector was used for the first time to determine the total cross section of $e^+p \to \bar{\nu}_e +$ hadrons process accompanied by the transfer of the transverse momentum greater than 25 GeV. The W – boson exchange plays an important role in such momentum transfer.

The cross section was found to be $\sigma(e^+p/p_\perp > 25\ \text{GeV}) = 21.9 \pm 3.4 \pm 2.0$ pb, where the first error is statistical and the second is systematic.

Source: joel@dice2.desy.de

2. Lifetime of the τ lepton

The Stanford linear accelerator was used in determination of the τ lepton lifetime by the decay length, the collision parameter, and the differential collision parameter methods. The measurements were carried out with the aid of the SLC detector. The τ leptons originated from the decay of the W^0 bosons. The measurements by these three methods gave $\tau = 297 \pm 9 \pm 5$ fs, where the first error is statistical and the second is systematic. The value of τ agreed with the average lifetime reported earlier. It is planned to improve considerably the precision of these measurements in future experiments.

Source: The CLD Collaboration,
Stanford Linear Acceleration Centre, Stanford CA 94309

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Translated by A Tybulewicz

3. Do the physical constants change with time?

Measurements carried out at the Hawaii University set a new upper limit to a possible variation in the dimensionless fundamental constants during cosmological time. The limit is based on extremely fine measurements of the spectra of H_2, Si^{3+}, and C on the basis of the absorption lines of quasars characterised by a large red shift. Had the fundamental constants at the moment of the emission of light differed somewhat from the current values, the spectra would have been deformed. At the level of one standard deviation the rate of changes in the constants does not exceed the following values: in the case of the ratio of the electron and proton masses (m_e/m_p), the relative change is $(-7.6 - 9.7) \times 10^{-14}$ per year; in the case of the fine-structure constant, the corresponding relative change is $(-4.6 - 4.2) \times 10^{-14}$ per year; the quantity $\alpha^2 g_p (m_e/m_p)$, where g_p is the gyromagnetic ratio of the proton, changes at the relative rate of $(-2.2 - 4.2) \times 10^{-15}$ per year.

The values of the Hubble constant and of the acceleration parameter were assumed to be, respectively, $H_0 = 75$ km s^{-1} Mps^{-1} and $q_0 = 0.5$. These limitations can serve to check theories of the Kaluza – Klein type and the theory of superstrings in which there are solutions with varying fundamental constants.

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4. Measurements of the electric and magnetic polarisability of the proton

The electric and magnetic polarisabilities α and β are important quantities which represent the influence of a constant or a slowly varying electromagnetic field on the proton. Knowledge of these quantities makes it possible to understand better the internal structure of the proton. The polarisabilties α and β were calculated on the basis of the dispersion relationships from the value of the Compton scattering cross section determined experimentally.

The new experiments were carried out at the Accelerator Laboratory in Saskatchewan. A new experimental method was used and the photon energies were in the range 70 – 148 MeV. The photons were detected with a high-resolution spectrometer containing an NaI : Tl crystal. The values obtained were:

$$\alpha + \beta = (15.0 \pm 2.9 \pm 1.1 \pm 0.4) \times 10^{-4}\ \text{fm}^3,$$
$$\alpha - \beta = (10.8 \pm 1.1 \pm 1.4 \pm 1.0) \times 10^{-4}\ \text{fm}^3,$$

where the errors are, respectively, statistical, systematic, and that resulting from the choice of the model.

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