More Events than expected from the Standard Model

Deep inelastic electron-proton scattering measurements at the DESY accelerator HERA in a previously unexplored kinematic region.
DESY Information

The two HERA experiments H1 and ZEUS, observe an excess of events above expectation at high-x (or $M=(xs)^{1/2}$), y, and Q^2. For $Q^2 > 15000$ GeV^2 the joint distribution has a probability of less than 1% to come from Standard Model NC DIS processes. Within this model, the predictions are known with confidence. Similar probabilities occur for masses M larger than 175 GeV. The events at high Q^2 and large M are particularly interesting because they occur in a previously unexplored region for deep inelastic scattering. Increased luminosities from the forthcoming data-taking period, March-October 1997, will clarify whether the observed effect is a statistical fluctuation or a sign of new physics.

Both international teams, H1 and ZEUS, independently analysed their data sample of high-energy deep inelastic scattering accumulated at HERA since 1994. During these three years HERA ran with 27.5 GeV positrons colliding head-on with 820 GeV protons. The observed events show the typical signature of DIS reactions: the positron is scattered through a large angle off a parton inside the proton; the struck parton generates a high-energy hadron jet. Both groups compared their measurements with Monte Carlo calculations based on the Standard Model of NC DIS.

Both HERA collaborations, H1 and ZEUS, presented their results in a DESY seminar on 19th. February 1997. Both papers were submitted to *Zeitschrift für Physik* on 24th. February 1997. The preprints can be found on the World Wide Web. The title of the H1 paper is *"Observation of Events at very high Q^2 in e-p Collisions at HERA"*. DESY preprint No. 97-024. http://www-h1.desy.de/ h1/www/publications/org_publ.html. The title of the ZEUS paper is *"Comparison of ZEUS Data with Standard Model Predictions for $e+p \rightarrow e+X$ Scattering at High x and Q^2"*. DESY preprint No. 97-025. http://www-zeus.desy.de/zeus_papers/ zeus_papers.html.

Symbols

HERA	= Hadron-Electron Ring Accelerator facility
DIS	= deep inelastic scattering
NC	= neutral current (exchange of a Z-boson or a photon)
x	= Bjorken scaling variable (fraction of the proton momentum carried by the scattered parton)
s	= centre-of-mass energy of the electron-proton collision
Q^2	= squared momentum transfer of the collision
y	= Q^2/M^2
M	= centre-of-mass energy of the electron-parton system
GeV	= Gigaelectronvolt

The H1 group has about 400 members from the following 12 countries: Belgium, Czech Republic, France, Germany, Italy, Poland, Russia, Slovak Republic, Sweden, Switzerland, United Kingdom, United States of America. The Zeus group has about 430 members from the following 12 countries: Canada, Germany, Israel, Italy, Japan, Korea, Netherlands, Poland, Russia, Spain, United Kingdom, United States of America. Both detectors were planned, financed, constructed and are operated by these joint international groups.

The Deutsches Elektronen Synchrotron DESY is the German research centre for basic research in particle physics and investigations with synchrotron radiation. It is a publicly funded national research centre in Hamburg, with a branch institute in Zeuthen near Berlin. The annual budget is DM 275 million. The Federal Government (BMBF) carries 90% of the budget and the City of Hamburg, or the Federal State of Brandenburg, the remaining 10%. DESY is a member of the Hermann von Helmholtz Association of German Research Centres (HGF). Three thousand scientists from 280 universities and research institutes from 35 countries worldwide participate in the research at DESY, 1300 of them in particle physics, 1700 in experiments using synchrotron radiation.

The Hadron-Electron Ring Accelerator facility at HERA is the only facility in the world in which electrons or positrons and protons collide. At HERA physicists are able to observe electron/positron-proton collisions at centre-of-mass energies which are an order of magnitude higher than energies previously available. In this type of collision, structures inside the proton can be studied down to one part in a thousand of the size of the proton itself.

Inside HERA the two particle beams circulate in opposite directions in separate storage rings and are brought to head-on collision at two interaction points. These are equipped with the detectors H1 and ZEUS, which have both been taking data since the beginning of the HERA research programme in 1992. Besides these collision experiments, HERA accommodates two beam-target experiments: HERMES, in operation since 1995, uses the polarized electron beam to investigate the origin of nucleon spin; HERA-B, scheduled to start in 1998, will use the proton beam for the study of CP violation in the B-meson system.

The underground storage ring facility HERA has a circumference of 6336 m. It was built from 1984 to the end of 1990, when operation began. The first particle collisions were observed in October 1991; the research programme started in June 1992. Since then the integrated HERA luminosity increased continuously from 0.05 pb^{-1} (1992), to 1.0 pb^{-1} (1993), to 6.2 pb^{-1} (1994), to 12.3 pb^{-1} (1995), and to 17.2 pb^{-1} (1996). For the 1997 HERA run an integrated luminosity of 25 pb^{-1} is expected.

HERA was set up by international collaboration: about 15% of the total cost of some DM 1110 million came from foreign countries. Institutions in Canada, China, Czech Republic, France, Israel, Italy, Netherlands, Poland, United Kingdom and the USA contributed through components and delegations of physicists, engineers and technicians to Hamburg during the construction.

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