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A Measurement and QCD Analysis of the Diffractive Structure Function $F_2^{D(3)}$

H1 Collaboration

An analysis of diffractive deep-inelastic ep scattering at HERA is presented using data taken in 1994 with the H1 detector. The data correspond to an integrated luminosity of $\sim 2\,\mathrm{pb}^{-1}$ and represent an increase of almost a factor 10 in statistical significance when compared to the previous measurement, allowing the analysis to reach a higher precision and to extend to both lower and higher values of Q^2. The cross section is measured in terms of a diffractive structure function $F_2^{D(3)}(\beta, Q^2, x_{I\!P})$ over the kinematic range in the appropriate deep-inelastic scattering variables of $2.5 < Q^2 < 65$ GeV$^2/c^2$, $0.01 < \beta < 0.9$ and $0.0001 < x_{I\!P} < 0.05$. The dependence of $F_2^{D(3)}$ on $x_{I\!P}$ is found not to depend on Q^2 but to depend on β, demonstrating that the factorisation of the $\gamma^* p$ cross section into a universal diffractive flux (depending only on $x_{I\!P}$) and a structure function (depending only on β and Q^2) is not tenable. The Q^2 and β dependences of $F_2^{D(3)}$ are examined in the form of $\tilde{F}_2^D(\beta, Q^2)$ after integrating over the dependence on $x_{I\!P}$. For different β, violations of scale invariance are observed in the form of rising dependences of $\tilde{F}_2^D$ on $\log Q^2$ which persist to high values of β, and which are consistent with a substantial gluon component in diffractive exchange. When confronted with the DGLAP evolution equations in perturbative QCD, the data yield first estimates of the partonic content of the diffractive exchange in which gluons carry about 80% of the momentum at $Q^2 \sim Q_0^2 = 2.5\,\mathrm{GeV}^2/\mathrm{c}^2$ and are concentrated near $x_{g/I\!P} = 1$. The results of a search for charged current ep interactions which involve the exchange of a colour singlet are presented.