A Measurement of the Diffractive Proton Structure Function $F_2^{D(3)}$ at Low Q^2 at the H1 Experiment at HERA

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Abstract

A measurement is presented of the diffractive proton structure function describing the process $ep \rightarrow eXY$, where X and Y represent the hadronic final states into which the exchanged virtual photon and the proton dissociate respectively. The data, with an integrated luminosity of 3.74 pb^{-1}, were collected with unbiased triggers using the H1 detector at the HERA positron proton collider in 1999. The measurement is presented in the form of a 3-dimensional structure function $F_2^{D(3)}(\beta, Q^2, x_{I\!P})$, integrated over the region $M_Y < 1.6$ GeV and $|t| < 1$ GeV^2. The kinematic range covered is 1.5 $\mathrm{GeV}^2 < Q^2 < 45$ GeV^2, $0.001 < \beta < 0.9$ and $10^{-4} \lesssim x_{I\!P} < 0.05$. Previous published H1 results for $F_2^{D(3)}(\beta, Q^2, x_{I\!P})$ only exist for $Q^2 \geq 4.5$ GeV^2 and $\beta \geq 0.01$ hence not only does this analysis provide a new high precision measurement of $F_2^{D(3)}(\beta, Q^2, x_{I\!P})$ but it also provides kinematic coverage at lower Q^2 and β values than has previously been possible. The results were extracted with full statistical and systematic errors and a good agreement is generally observed in the region of overlap with previous H1 measurements. The Q^2 dependence at fixed values of $x_{I\!P}$ exhibits rising scaling violations for most of the β range, which start to fall only at the highest values of β. This behaviour is expected for the exchange of a gluon-dominated pomeron which evolves according to the DGLAP equations. Comparisons with different models of diffraction were made and a value for the effective pomeron intercept $\alpha_{I\!P}(0) = 1.107 \pm 0.026$ (stat.) was obtained from a Regge-motivated fit.