A Measurement of the Diffractive Proton Structure Function at HERA

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Abstract

A measurement of the diffractive structure function of the proton, $F_2^{D(3)}(\beta, x_{I\!P}, Q^2)$, is presented, based on an analysis of 1995 data from the HERA experiment H1. An extension of the accessible kinematic range in Q^2 and β has been achieved using the the upgraded backward region of the H1 detector.

A new backward calorimeter has been installed which increases the acceptance for scattered electrons up to polar angles of 178.6° for collisions where the interaction vertex is shifted by 70cm. The calorimeter is of a spaghetti (SPACAL) lead-fibre design, and is also required to provide timing information for the rejection of beam-induced backgrounds. A time-to-digital converter (TDC) system monitors the timing performance of SPACAL. Results from beam tests and early use in H1 are presented in this thesis and demonstrate that the required performance of the SPACAL and the TDC system has been achieved.

Diffractive deep-inelastic scattering events were selected by requiring the detection of an electron in SPACAL and an absence of hadronic activity in the forward region (pseudo-rapidity > 3.2). The cross section for the process $ep \rightarrow eXY$ with $M_Y < 1.6$ GeV has been measured, from which the structure function $F_2^{D(3)}(\beta, x_{I\!P}, Q^2)$ has been determined in the region $0.3 < Q^2 < 12\,\mathrm{GeV}^2$, $0.005 < \beta < 0.8$ and $0.0001 < x_{I\!P} < 0.075$. The results are consistent with the previous measurement in the region of overlap. A fit to the data of the form $F_2^{D(3)} = A(Q^2, \beta) x_{I\!P}^{-n}$ shows a variation of n as a function of β, consistent with the previous measurement and demonstrating violation of factorisation of the diffractive structure function. At high β, n is observed to have a value of approximately 1.25. Tentative first evidence for a decrease of n with decreasing $\log(Q^2)$ is observed.