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Results from a Precision Measurement of the x, Q^2 and Nuclear Dependence of $R = \sigma_L/\sigma_T$

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Abstract

We report preliminary results from SLAC experiment E140 which measured with high precision the ratio $R = \sigma_L/\sigma_T$ for deep inelastic electron-deuteron and electron-iron scattering in the x, Q^2 range of $0.2 \leq x \leq 0.5$ and $1 \leq Q^2 \leq 10$ $(\text{GeV/c})^2$. The kinematic variation of R is compared to the predictions of QCD. We observe no significant difference between R for deuterium, iron and gold targets. The high precision results for the ratio of cross sections σ_{Fe}/σ_D are in agreement with previous SLAC data and new data from the EMC collaboration.

We have undertaken precision measurements at SLAC of the deep inelastic electron scattering cross sections on deuterium, iron and gold targets. These cross sections, measured in a single experiment using the same 8 GeV spectrometer, permitted an accurate separation of the σ_L and σ_T. Cross sections were measured for up to five different values of ϵ for each (x, Q^2) point by appropriately changing the momentum and angle setting of the spectrometer. The quantity $R = \sigma_L/\sigma_T$ was then extracted by fitting $\Sigma = \Gamma^{-1}d^2/d\Omega dE'(x, Q^2, \epsilon) = \sigma_T(x, Q^2) + \epsilon \cdot \sigma_L(x, Q^2)$ at fixed x and Q^2. The results for the deuteron at $x = 0.2$, 0.35 and 0.5 are plotted versus Q^2 in Fig. 1. Perturbative QCD calculations for R are also plotted. These calculations include logarithmic ($\propto 1/\ln(Q^2/\Lambda^2)$) contributions due to gluon radiation diagrams and target mass corrections ($\propto 1/Q^2$ and $\propto 1/Q^4$). The errors shown on the figure are statistical only. Systematic errors, dominated by the acceptance of the spectrometer and radiative corrections, are currently under investigation. Our results are in good agreement with QCD showing a clear fall off of R with Q^2. The nuclear dependence of R was studied by making fits to the ratio of cross sections σ_{Fe}/σ_D as a function of $\epsilon' = \epsilon/(1 + \epsilon R_D)$. The slopes of such linear fits yielded results for $R_{Fe} - R_D$, which are plotted for various Q^2 values as a function of x in Fig. 2. The single open diamond point is for a gold target. The multiple points at $x = 0.2$ and 0.5 for $Q^2 = 1.0$ and 2.5 $(\text{GeV/c})^2$ are for two different iron targets of radiation length 6% and 2.6%. The rest of the points are for the 6% radiation length iron target. Only statistical errors are shown on the figure. The average value for $R_{Fe} - R_D = 0.04 \pm 0.02(\text{stat}) \pm 0.06(\text{syst})$ is plotted on the figure as a dashed line. Since

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these results are consistent with zero and since we observe no significant Q^2 dependence of the ratios of cross section σ_{Fe}/σ_D, we averaged them at various Q^2 and ϵ values to obtain the following results: $\sigma_{Fe}/\sigma_D = 1.013 \pm 0.004, 0.982 \pm 0.004$, and 0.928 ± 0.005 for $x = 0.2, 0.35$, and 0.5 respectively. The result for the gold target at $x = 0.2$ is 1.015 ± 0.007. These high precision results are in excellent agreement with previous data from SLAC and the new EMC data.

This report is a highly abridged version of the paper submitted to this conference available as University of Rochester preprint UR-1004-1987, S. Dasu et al. For details about the experiment, results and references we refer you to UR-1004.

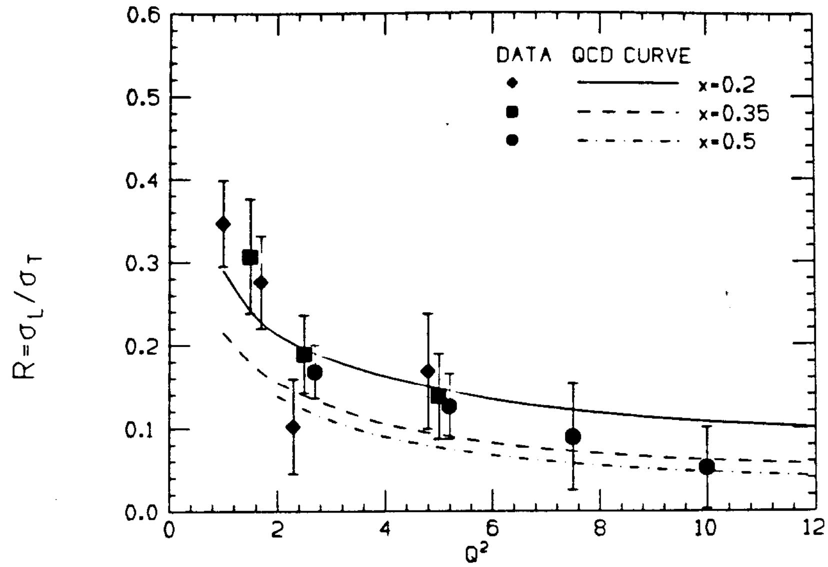

Figure 1. $R = \sigma_L/\sigma_T$ vs Q^2 for the deuteron at $x = 0.2, 0.35$ and 0.5.

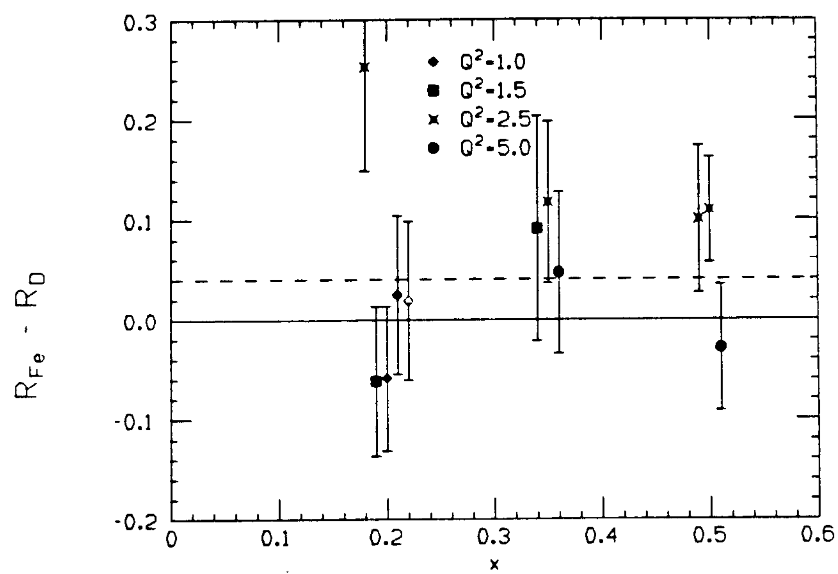

Figure 2. $R_{Fe} - R_D$ vs x at $Q^2 = 1, 1.5, 2.5$ and 5 (GeV/c)^2