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**A MEASUREMENT OF THE RATIO OF $W + 1$ Jet TO
 $W + 0$ Jets CROSS SECTIONS AND COMPARISONS TO QCD**

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A preliminary measurement of the ratio, $\mathcal{R}^{10}$, of the production cross sections for $W + 1$ Jet and $W + 0$ Jets processes at a center of mass energy, $\sqrt{s}$, of 1800 GeV by the DØ Collaboration is presented. A comparison of this ratio is made to next-to-leading order, NLO, calculations and the implications of these comparisons, especially for the extraction of a value for the strong coupling constant $\alpha_s(M_W^2)$, are discussed.

The UA1 and UA2 experiments^{1,2} used $W(\rightarrow e\nu) + \text{Jets}$ to measure the ratio, $\mathcal{R}^{10}$, of the production cross sections for $W + 1$ Jet events to $W + 0$ Jets events and then used theoretical calculations to extract a value for $\alpha_s(M_W^2)$. The DØ collaboration has also published³ a measurement of the ratio of production cross sections using the data from the 1992-1993 run of the Fermilab Tevatron Collider. The preliminary result presented here is from the 1994-1995 run and uses a data set more than six times as large as that used for the previous DØ result.

The DØ detector and the details of the DØ triggering system have been described elsewhere.⁵

The data sample used for this study is defined offline by selecting $W \rightarrow e\nu$ candidates without a cut on the jet multiplicity. The cuts on the electron include a transverse energy, E_T , cut of 25 GeV, and several quality cuts. The missing E_T , $\cancel{E}_T$, in the event is also required to be greater than 25 GeV. Jets in these events are identified using a fixed cone algorithm with a radius of 0.7 in η - ϕ space. The analysis has been performed using several different minimum E_T , E_T^{min} , requirements used to define the jets. The standard value is chosen to be 25 GeV.

Backgrounds due to multi-jet events, which are the dominant background, are estimated using data. The backgrounds due to Drell-Yan, $Z \rightarrow e^+e^-$ and $Z \rightarrow \tau\tau$ events is estimated using the ISAJET⁶ Monte Carlo.

For 75.9 pb⁻¹ of data from the 1994-1995 run we obtain 36,891 $W \rightarrow e\nu$ candidates with electrons restricted to the central part of the DØ calorimeter ($|\eta| < 1.1$). For a cut on E_T^{min} of 25 GeV there are 33,511 $W + 0$ Jets candidates and 2,841 $W + 1$ Jet candidates. After subtracting the background contributions from multi-jet events and from other electroweak processes these numbers become 32,835 for $W + 0$ Jets and 2,599 for $W + 1$ Jet. This results

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in a ratio of

$$\mathcal{R}_{exp}^{10}(\text{preliminary}) = 0.079 \pm 0.002^{stat} \pm 0.005^{sys}.$$

The dominant systematic error is due to the uncertainty in the jet energy scale.

A comparison of this result with theoretical calculations (Figure 1) using the DYRAD ⁴, a NLO QCD prediction, and the CTEQ3 ⁷ family of parton distribution functions, pdf, in which the distributions were refit for several fixed values of Λ_{QCD} , shows that not only is the prediction significantly below the experimental result, but the calculations also exhibit little dependence on α_s making an extraction of α_s by this method impossible.

Figure 1: The ratio, $\mathcal{R}^{10}$, for $E_T^{min} = 25$ GeV. The experimental result is the solid line. Dotted lines indicate the statistical errors and the shaded region represents statistical and systematic errors added in quadrature. The points are DYRAD calculations using the CTEQ3 pdf family.

Figure 2: The ratio, $\mathcal{R}^{10}$, decreases as E_T^{min} is increased. Inner error bars are statistical, outer error bars are statistical and systematic added in quadrature. The solid curve is for the preferred CTEQ3M parton distribution functions and the other CTEQ3 curves span the extremes in α_s .

One can also vary E_T^{min} and compare the experimental trend to that of the theoretical predictions (see Figure 2). The theoretical predictions describe the shape of the E_T^{min} dependence for the different parton distribution functions, however all are consistently below the data.

A comparison of the theoretical calculations for $D\phi$ to those for UA1/UA2 points to a fundamental difference between the experiments, the center of mass energy of the collisions. Because UA1/UA2 ran at a lower $\sqrt{s}$ than $D\phi$, the average momentum fraction of the initial state partons was larger than the average momentum fraction of the initial partons for W production at $D\phi$. This

difference results in more of the $D\bar{D}$ $W + 1$ Jet events being produced from a quark-gluon initial state than the $W + 1$ Jet events at UA1/UA2.⁸ Theoretical predictions for $\mathcal{R}^{10}$ at $D\bar{D}$ are therefore more sensitive to the gluon distribution in the proton.

The gluon distribution is not well constrained by current experiments. When the CTEQ3 pdf's are plotted for the different partons in the proton it can be seen that the gluon distribution changes significantly as Λ_{QCD} is varied. This variation contributes to the flattening of the theoretical predictions for $\mathcal{R}^{10}$ vs. α_s by compensating for the changes in the matrix element as α_s increases.

In conclusion, $D\bar{D}$ has made a preliminary measurement of the ratio of production cross sections for $W + 1$ Jet to $W + 0$ Jets processes with the data from the 1994-1995 run of the Fermilab Tevatron Collider. Comparisons to NLO QCD calculations show that the theoretical predictions are consistently lower than the data for different values of α_s given the currently available parton distribution functions. Also, the theoretical calculations underestimate the rate of jet production in association with W bosons as a function of the minimum jet E_T . It appears that incorporating the $D\bar{D}$ and the UA1/UA2 data in global QCD fits could lead to modifications of the conventional understanding of the gluon distribution in the proton.

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