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MUON CHARGE ASYMMETRY FROM W DECAYS AT THE DØ DETECTOR

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Preliminary results on the charge asymmetry of muons from W decays, as a function of the muon pseudorapidity, from the 1992-1995 run of the Tevatron, using the DØ detector, are presented.

1 Introduction

At the Tevatron ($\sqrt{s} = 1.8$ TeV), W bosons are produced in $p\bar{p}$ collisions primarily by quark-antiquark annihilations

$$u + \bar{d} \rightarrow W^+ \rightarrow \mu^+ + \nu_\mu, \qquad \bar{u} + d \rightarrow W^- \rightarrow \mu^- + \bar{\nu_\mu}.$$

On the average, the $u(\bar{u})$ quarks carry a larger fraction of the momentum of the $p(\bar{p})$ than do the $d(\bar{d})$ quarks. Thus upon production, the $W^+(W^-)$ are preferentially boosted in the direction of the $p(\bar{p})$ beam direction. This leads to a production asymmetry in the rapidity of the W, y_W, defined by

$$A(y_W) \equiv \frac{d\sigma_{W^+}(y)/dy_W - d\sigma_{W^-}(y)/dy_W}{d\sigma_{W^+}(y)/dy_W + d\sigma_{W^-}(y)/dy_W} \approx \frac{u_1 d_2 - u_2 d_1}{u_1 d_2 + u_2 d_1} = \frac{d_2/u_2 - d_1/u_1}{d_2/u_2 + d_1/u_1} \quad (1)$$

$A(y_W)$ is thus related to the difference in the d/u ratio between parton 1 in the proton and parton 2 in the anti-proton. The density functions u and d are functions of Bjorken x, given at leading order by $x_{1,2} = (M_W/\sqrt{s})\, e^{\pm y}$. Since the longitudinal momentum of the neutrino from W decays cannot be determined, the asymmetry of the muon from the decay is used. The distribution of muons due to the production asymmetry gets convoluted with their decay distribution due to $V - A$. The overall muon charge asymmetry is defined as a function of the pseudorapidity of the muon, η_μ, as

$$A(|\eta_\mu|) = \frac{N^+(|\eta_\mu|) - N^-(|\eta_\mu|)}{N^+(|\eta_\mu|) + N^-(|\eta_\mu|)}, \qquad \eta_\mu = -\ln\{\tan(\theta_\mu/2)\} \qquad (2)$$

where, N^+ = number of μ^+ in the region $\eta > 0$ and μ^- in the region $\eta < 0$
and N^- = number of μ^+ in the region $\eta < 0$ and μ^- in the region $\eta > 0$.
This measurement may be used to constrain knowledge of parton distribution functions of the proton, specifically the d/u ratio.[1]

[c]for the DØ collaboration

2 Data

The data consists of 6.5 pb^{-1} from the 1992-1993 run (run 1a). From the 1994-1995 run (run 1b), there is 55 pb^{-1} for $|\eta_\mu| < 1.0$ and 35 pb^{-1} for $1.0 < |\eta_\mu| < 1.7$ of the DØ detector. The data is obtained with a trigger that requires at least one good muon with $p_T^\mu \geq 15$ GeV/c . Additional track quality cuts and kinematic cuts of $p_T^\mu \geq 20$ GeV/c and $\not{E}_T \geq 20$ GeV are imposed offline. Charge asymmetry measurements at DØ can only be done with muons since there is no central field to distinguish electrons from positrons. The muon charge is determined using the toroidal magnets of the muon detector.

3 Backgrounds and Systematic Errors

The main contaminants in the W sample are cosmic ray muons, combinatorics, muons from QCD processes, $W \to \tau \to \mu$, $Z^0 \to (\mu)\mu$, and $Z^0 \to \tau\tau \to (\mu)\mu$, where only one of the muons is detected. With a kinematic cut of 20 GeV/c on the muon and the neutrino, $W \to \tau \to \mu$ has the same asymmetry as that of $W \to \mu+\nu$ and need not be subtracted. The background fractions for the first three sources are obtained from data by fitting the candidate distribution with a background and a signal distribution. The background for the Z-sources is obtained from Monte Carlo. These fractions are then subtracted out from each eta bin of the candidate sample taking into account the charge asymmetry of the background sources.

The sample is corrected for detector asymmetries. The detection efficiencies for μ^+ and μ^- can be different in regions with cracks in the DØ muon detector coverage where muons of one charge may be bent into a chamber while those with the other charge can go undetected into a crack. This effect is largely compensated for by flipping the polarity of the toroid periodically. The data is corrected in proportion to the unbalanced luminosity.

Misidentification of the muon sign can dilute the charge asymmetry. The charge misidentification probability is obtained by taking a sample of high quality Z events and finding the ratio of the number of same sign pairs to the total number of pairs. The probability per track is 0.088 ± 0.052 for run 1a and 0.027 ± 0.007 for run 1b and have been used to correct the data.

4 Results

The combined charge asymmetry from run 1a and run 1b data, after background subtraction and corrections for various systematic effects, is shown in Figure 1. The theoretical curves in Figure 1 are obtained from a fast Monte

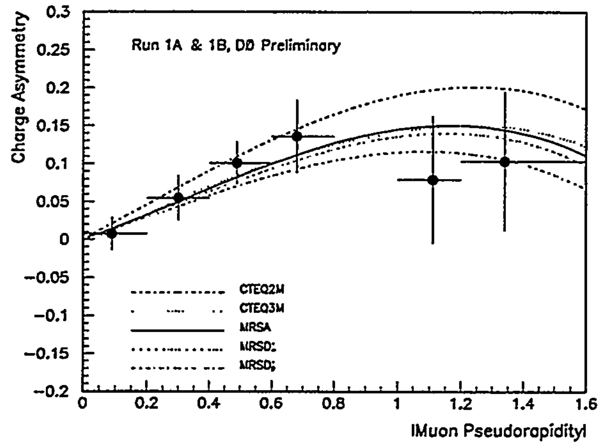

Figure 1: Charge asymmetry from muons from W decays.

Carlo program that does a leading order treatment with input $p_T^W(y)$ obtained from a next-to-leading order resummation calculation.[4] The input parton distribution functions are varied to obtain the different curves which are so labelled. The match between data and theory is quantified by a reduced χ^2 shown in Table 1. The values obtained show that all the parton distribution functions considered are consistent with the data but none of these is particularly favoured.

Table 1: Reduced χ^2 for some recent parton distribution functions.

PDF	$\chi^2/$ 6 $d.o.f$
CTEQ2M	0.6394
CTEQ3M	0.2587
MRSA	0.2927
MRSD'$_-$	0.3211
MRSD'$_0$	0.4061

References

1. Martin A. D., Roberts R. G. and Stirling W. J., *Phys. Rev. Lett.* **D50**, 6734 (1994).
2. Ladinsky G.A. and Yuan C.P., *Phys. Rev. Lett.* **D50**, 4239 (1994).