1 The case for RHIC Spin

1.1 Future plans/ideas at RHIC

1.1.1 Physics beyond the Standard Model (M.J.Tannenbaum)

At RHIC, the standard model parity violating effects are large. In inclusive single jet production, the leading strong interaction process, the two-spin parity violating asymmetry, A_{LL}^{PV}, due to the interference of gluon and W exchange is $\sim 1\%$ at $\sqrt{s} = 500$ GeV (see Fig. 1 SM). Of course, a more spectacular effect at RHIC concerns the direct production of the Weak Bosons, $W^{\pm}$ and Z^0, visible through their di-jet or di-lepton decay. The peak from $W \rightarrow$ Jets is evident in Fig. 1.

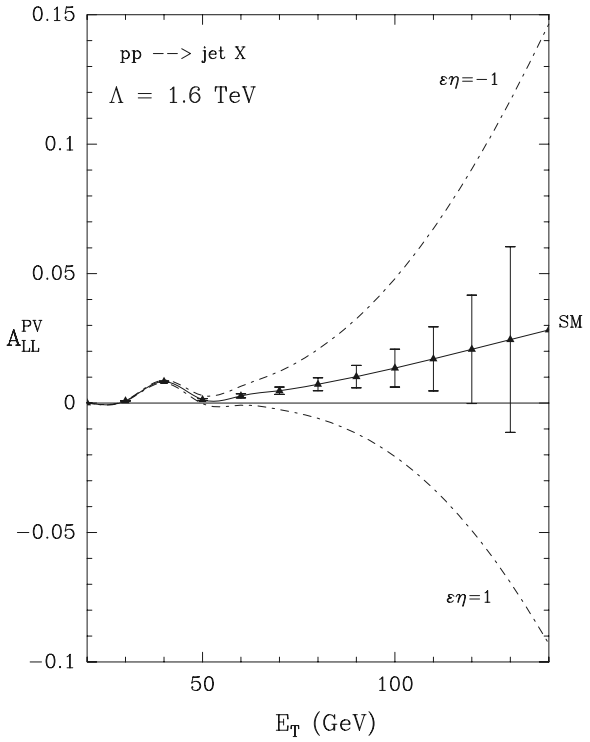

Figure 1: Prediction [4] for A_{LL}^{PV} in inclusive jet production at RHIC. Solid curve is standard model (SM), with error bars corresponding to sensitivity with $L = 0.80$ fb^{-1} integrated luminosity. Dot-dash curves are contact model of quark compositeness with $\Lambda_c = 1.6$ TeV.

Flavor-identified structure function measurements using $W^{\pm}$ production are discussed elsewhere in this document. Here we concentrate on the physics beyond the standard model that is opened up by searches for parity violating effects at RHIC. A typical example of such a possibility is quark compositeness or substructure [1].

Composite models of quarks and leptons [2] generally violate parity, since the scale of compositeness $\Lambda_c \gg M_W$. Without the Parity Violating Asymmetry (PVA) handle, detectors at the Tevatron are limited to searching for substructure by deviations of jet production from QCD predictions at large values of p_T. It is difficult to prove that a small deviation is really due to

something new. However a few % parity-violation effect would be **a clear indication of new physics**. The experimental limit is presently [3] $\Lambda_c \cong 1.6$ TeV. The estimate of sensitivity to compositeness at RHIC [4] with this value of Λ_c is shown on Fig. 1. The error bars shown on the standard model correspond to $L = 0.80$ fb^{-1} integrated luminosity. Structure function uncertainties can be calibrated out using the PVA in $W \rightarrow$ Jet (inclusive) which is clearly visible on the plot.

The limits of sensitivity for Λ_c in the contact model of quark compositeness [5] are tabulated in Table 1 for the standard $L \sim 1$ fb^{-1} integrated luminosity of the original RHIC-spin run plan. The limits increase siginificantly with factors of 10 and 100 increase in luminosity (but for this

$\sqrt{s}$ GeV	L(fb^{-1})	Λ_c (TeV)
500	1	3.3
500	10	5.5
500	100	7.5
650	1	3.8
650	10	6.3
650	100	8.8

Table 1: Limits on $\Lambda(\epsilon = -1)$ at 95% CL, P=0.7, $\Delta\eta = 1$, 10% systematic error in Asymmetry [5].

reaction, are not much improved with increasing c.m. energy). For comparison, at the Tevatron, sensitivity is $\Lambda_c \sim 4$ TeV for L =2 fb^{-1} (Run II) and 5 TeV for 30 fb^{-1} (Run III) and $\Lambda_c \sim$ 20-30 TeV at the LHC for $L = 10 - 100$ fb^{-1}. Of course, even if an anomaly were found at either the Tevatron or the LHC, only RHIC will be able to provide polarization information on the anomaly to determine what its chiral properties are and whether it is a new interaction, a supersymmetric particle, or anything with a non-standard-model spin signature.

References

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