論文の内容の要旨

論文題目　Measurement of longitudinal spin asymmetry in production of muons from W/Z boson decays in polarized p+p collisions at √s = 500 GeV with the PHENIX detector at RHIC

（RHICによる重心系エネルギー500 GeVの偏極陽子・陽子衝突における W/Zボゾンから崩壊したミューオン生成の縦スピン非対称度についての PHENIX検出器を用いた測定）

氏名　生出　秀行

Measurement of polarized parton distribution functions (PDF) of the proton is a key experimental knowledge to understand the spin structure of the proton. A measurement of single spin asymmetry of the production cross section of $W^{\pm}/Z$ bosons in longitudinally polarized proton-proton collision presents a distinctive way to constrain the flavor-separated polarized PDF of quarks of the proton by taking advantage of V-A interactions of weak bosons. This approach is striking to give another measurements of for anti-u and anti-d quark polarized parton distributions in addition to the existing measurements with semi-inclusive polarized deep inelastic scattering experiments that needs to employ the knowledge about fragmentation functions to interpret the experimental results.

In this thesis, the first measurement of longitudinal spin asymmetries of muon production in $W^{\pm}/Z$ boson decays in longitudinally polarized proton-proton collisions at √s = 500 GeV is presented. The proton-proton collision was produced at the RHIC accelerator, and the data were taken at the PHENIX detector, which covers pseudorapidity region of $-2.2 < \eta < -1.4$ and $1.4 < \eta < 2.4$. A likelihood-based analysis was performed to extract $W^{\pm}/Z \to \mu^{\pm}$ signal. As a result, with using single muon events in $16 < p_T < 60$ GeV/c the cross section of $W^{\pm} \to \mu^{\pm}$ was obtained as

$$\sigma(pp \to W^-) \times \mathcal{BR}(W^- \to \mu^-) = 47.8^{+25.0}_{-11.8}\ (\mathrm{pb})\ (68\ \%\ \mathrm{C.L.}),$$
$$\sigma(pp \to W^+) \times \mathcal{BR}(W^+ \to \mu^+) = 129.5^{+102.0}_{-33.5}\ (\mathrm{pb})\ (68\ \%\ \mathrm{C.L.})$$

as the combined values of the measurements in two Muon Arms. The major systematic uncertainty comes from MuTr position resolution and the estimation of the shape of hadronic background events at the signal region, and the size of systematic these uncertainties were larger than statistical uncertainty. Still, we conclude that we observed $W^{\pm} \rightarrow \mu^{\pm}$ events in the data sample used in this thesis. The above statement is also supported by the result that the obtained cross section was consistent with NLO or higher-order theoretical calculations for both W^{+} and W^{-}.

Following the extraction of $W^{\pm}/Z \rightarrow \mu^{\pm}$ signal, we obtained single spin asymmetry of muons from inclusive $W^{\pm}/Z$ bosons as

$$
\begin{aligned}
A_L^{\mu-} &= 0.15^{+0.47}_{-0.47}(\text{stat})^{+0.06}_{-0.06}(\text{sys}) \quad (\eta = -1.72)\ , \\
A_L^{\mu-} &= 0.35^{+0.46}_{-0.47}(\text{stat})^{+0.16}_{-0.12}(\text{sys}) \quad (\eta = 1.72)\ , \\
A_L^{\mu+} &= 0.56^{+0.53}_{-0.55}(\text{stat})^{+0.57}_{-0.14}(\text{sys}) \quad (\eta = -1.61)\ , \\
A_L^{\mu+} &= 0.07^{+0.55}_{-0.54}(\text{stat})^{+0.22}_{-0.11}(\text{sys}) \quad (\eta = 1.61)\ .
\end{aligned}
$$

The current uncertainty on $A_L^{\mu\pm}$ is highly dominated by statistics and we need more of data to constrain polarized sea quark PDFs. This is the world first measurement of single spin asymmetry of charged leptons from $W^{\pm}/Z$ bosons at the given pseudorapidity regions.