# A search for jet handedness in hadronic Z^0 decays(Abstracts of Doctoral Dissertations,Annual Report (from April 1994 to March 1995))


| | |
|---|---|
| 著者 | HASEGAWA　Yoji |
| journal or publication title | The science reports of the Tohoku University. Ser. 8, Physics and astronomy |
| volume | 16 |
| number | 1 |
| page range | 147-148 |
| year | 1995-10-17 |
| URL | http://hdl.handle.net/10097/25892 |

# A search for jet handedness in hadronic $Z^0$ decays

Yoji HASEGAWA

Department of Physics

The transport of parton polarization through the hadronization process is of fundamental interest. It is at present an open question whether the polarization of a parton produced in a hard collisions in observable via the final-state fragmentation products in the resulting jet. The $Z^0$ resonance is an ideal place to study this issue as the fermions in $Z^0 \to q\bar{q}$ decays are predicted by the Standard Model(SM) to be highly longitudinally polarized. If a method of observing such polarization were developed, it could be applied to jets produce in a variety of hard processes, elucidating the underlying spin dynamics.

At the SLAC Linear Collider(SLC) $Z^0$ bosons are produced in collisions of longitudinally polarized electrons with unpolarized positrons. In 1993 the average polarization was $P_{e^-} = 0.630 \pm 0.011$. We defined the "helicity-based" polarization of jets: $P_{hel}(cos\theta, P_{e^-}) = -2\frac{A_e - P_{e^-}}{1-A_e P_{e^-}}\frac{\cos\theta}{1+\cos^2\theta}$ and the "chirality-based" polarization of jets: $P^f_{chi} = -A_{,f}$ where $\theta$ is polar angle and $A_f$ is asymmetry in coupling strength of left- and right-handed fermions $f$ to $Z^0$ boson. One expects that $A_e = 0.16$ and $P_{chi} = 0.39$, 0.34 and 0.44 for all-, light-(u, d and s quarks) and heavy-flavor(c and b quarks) samples respectively.

Nachtmann [1] and Efremov *et al.* [2] have speculated that the polarization of the underlying quarks may be observable inclusively via a triple vector product of track momenta in jets. Arguing that quark fragmentation may resemble an n-body strong decay, they note that the simplest spin-sensitive observable has the form: $\Omega \equiv \hat{t} \cdot (\vec{k}_1 \times \vec{k}_2)$ where $\hat{t}$ is a unit vector along the jet axis, corresponding to the spin direction of a parton that produced the jet, and $\vec{k}_1$ and $\vec{k}_2$ are the momenta of two particles in the jets chosen by some charge-independent prescription, e.g., $\Omega_{hel} = \hat{t} \cdot (\vec{k}_1 \times \vec{k}_2)$, where $|\vec{k}_1| > |\vec{k}_2|$. If the cross product can be orderd by particle charge, then $\Omega_{chi} = \hat{t} \cdot (\vec{k}_+ \times \vec{k}_-)$. A jet may be defined as left- and right-handed if $\Omega$ is negative and positive respectively. For an ensemble of jets the jet handedness $H$ is defined as the asymmetry in the number of left- and right-handed jets: $H \equiv \frac{N_{\Omega<0} - N_{\Omega>0}}{N_{\Omega<0} + N_{\Omega>0}}$. It can then be asserted that $H = \alpha P$ where $P$ is the expected polarization of undelying partons in the ensemble of jets, and $\alpha$ is the analyzing power of the method.

We used a sample of $\sim$ 50000 hadronic $Z^0$ decays collected by the SLD experiments in 1993 for the analysis. We have applied the methods suggested in [2] and [3], and have extended them to be more inclusive. For each method we used both helicity and chirality-based definitions of $\Omega$ to calculate $H$. The events were divided into two samples, light- and the heavy-flavor samples. This analysis used charged tracks measured in the central drift chamber and vertex detector. We applied suitable 2-jet event selection criteria. The 17853 events were selected and comprised the global sample. 9977 events out of the events were assigend to the light-flavor sample and all other events to the heavy-flavor events.

The jet handedness for the helicity-based analysis $H_{hel}^{meas}(\cos\theta)$ was calculated in bins of jet $\cos\theta$ separately for events produced with left- and right-polarized electrons. Then $H_{hel} = \alpha P_{hel}$ was fitted simultaneously to the two $H_{hel}^{meas}$ allowing the analyzing power $\alpha$ to vary. The fitted analyzing powers for all three flavor samples are listed in Table 1. The jet handedness for the chirality-based analysis was calculated from the unbinned $\Omega_{chi}$ and the analyzing powers, shown in Table 1, were calculated from $\alpha = H_{chi}^{meas}/P_{chi}$. Since all $\alpha$ are consistent with zero, we set upper limits at the 95 % confidence level on their magnitudes, also shown in Table 1.

In conclusion, we found no evidence for a nonzero jet handedness, implying that the transport of polarization through the quark fragmentation process is small. The method proposed in [2], applied to a sample of light-flavor jets, yielded upper limits of 0.108 and 0.125 on the magnitudes of the analyzing powers of helicity- and chirality-based analyses, respectively. Similar limits were derived for all other methods we applied.

**References**

[1] O. Nachtman, Nucl. Phys. **B127**, 314(1977)

[2] A. V. Efremov *st al.* Phys. Lett. B **284**, 394(1992);(**291**,473(1992)

[3] M. G. Ryskin, Phys. Lett. B **319**, 346(1993)

| Sample | Analyzing power | |
|---|---|---|
| | Helicity | chirality |
| Global | $-0.029\pm0.024\pm0.000$ (0.069) | $-0.001\pm0.026^{+0.000}_{-0.003}$ (0.052) |
| Light-flavor | $-0.057\pm0.031\pm0.000$ (0.108) | $0.052\pm0.0038\pm0.000$ (0.125) |
| Heavy-flavor | $0.007\pm0.038^{+0.001}_{-0.000}$ (0.075) | $-0.058\pm 0.035 \pm0.000$ (0.115) |

Table 1: Analyzing powers. The second and third numbers are statistical and systematic errors. Numbers in parensitheses are upper limits at the 95% confidence level on the analyzing powers.