Flavor and spin structure of quark fragmentation functions in a diquark model for octet baryons

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(Received 14 November 2001; revised manuscript received 19 February 2002; published 15 May 2002)

We use a simple quark-diquark model to describe unpolarized, longitudinally polarized, and transversely polarized fragmentation functions for the octet baryons. All free parameters of the model are determined based on the experimental data on octet baryon B production in the $e^+e^-\to BX$ process. The SU(3) flavor symmetry breaking effect in the octet baryon fragmentation functions is investigated. The strangeness suppression effect in hyperon production of e^+e^- annihilation is found to be significant, and its relevant consequences for the cross sections of octet hyperon production in pp collisions are estimated. In order to check the flavor structure of the octet hyperon fragmentation functions, hyperon-antihyperon asymmetries in k^+p collisions are provided. Furthermore, we find that the spin observables calculated with the Λ fragmentation functions are compatible with available experimental data on the longitudinally polarized Λ production. Spin observables for other octet baryons produced in various inclusive processes are also predicted for future experiments.

DOI: 10.1103/PhysRevD.65.094035 PACS number(s): 14.20.Jn, 13.65.+i, 13.87.Fh, 13.88.+e

I. INTRODUCTION

The unpolarized, helicity, and transverse quark distributions are three fundamental quark distributions of the nucleon. The quark flavor and spin structure of the nucleon have been extensively studied both theoretically and experimentally over the past several decades [1,2]. However, we have much less knowledge of the quark distributions of the octet hyperons than of those of the nucleon. The main reason lies in the fact that it is difficult for us to access the quark distributions of the octet hyperons because their short lifetime makes them difficult as targets. For this reason, hyperon production is regarded as a very important source from which we can get information on the quark structure properties of the octet hyperons. The Λ hyperon is of special interest in this respect since its decay is self-analyzing with respect to its spin direction because of the dominant weak decay $\Lambda\to p\pi^-$ and the particularly large asymmetry of the angular distribution of the decay proton in the Λ rest frame. So polarization measurements are relatively simple to perform and the polarized fragmentation functions of quarks to the Λ can be measured. Also, the fragmentation of quarks to Σ and Ξ hyperons can be investigated experimentally since the detection technique for Σ and Ξ hyperons is gradually maturing and will allow us to measure various quark to hyperon fragmentation functions [3–6]. Therefore, investigating quark to octet baryon fragmentation functions can shed light on many phenomena in nonperturbative QCD, such as SU(3) symmetry breaking in the quark flavor and spin structure of fragmentation functions, and can enrich our knowledge about the quark structure of hadrons.

There has been some excellent work [7,8] on extracting Λ fragmentation functions based on the available experimental data on Λ production. Recently, with the experimental data on the unpolarized Λ production in e^+e^- annihilation, the unpolarized and polarized fragmentation functions for the Λ were extracted [9] based on a diquark model. It was found that the spin structure of the diquark model fragmentation functions is compatible with available data on Λ production [10–15], which motivates us to extend the analysis from the Λ case to other octet baryons since some experimental data on the proton and other hyperon production in e^+e^- annihilation are available [16–24].

It was found that there exists an SU(3) symmetry breaking in the octet baryon fragmentation functions [25–27], in particular, the strong strangeness suppression [25] in octet hyperon production of e^+e^- annihilation. However, there is a lack of a detailed investigation of the SU(3) symmetry breaking effect on the flavor and spin structure of fragmentation functions. The diquark model has a clear physics motivation and can reflect the SU(3) symmetry breaking effect. The advantage of the model is that it allows us to do such a detailed analysis. We plan to check the SU(3) symmetry breaking effect on some observables that are related to the flavor and spin structure of fragmentation functions for octet baryons. In addition, we will study relevant consequences of the strangeness suppression in other processes such as $pp\to BX$ by estimating the cross sections for octet baryon production.

We have noticed that the Λ fragmentation functions with SU(3) flavor symmetry [7,8] can fit the experimental data as well as those [9] with SU(3) flavor symmetry breaking. Therefore, it seems to be impossible for us to resolve different flavor structures of the Λ fragmentation functions by means of the experimental data on the unpolarized Λ production in e^+e^- annihilation. There exists a similar situation for other octet hyperons. However, the flavor structure of the Λ and other octet hyperon fragmentation functions will be crucially important as well as their spin structure in order to well understand the hadronization mechanism. It was found in recent research [28] that the asymmetry for $\Lambda/\bar{\Lambda}$ production in k^+p collisions can be used to resolve the flavor structure of the Λ fragmentation functions. We will extend this

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analysis to other octet hyperons and use the hyperon-antihyperon asymmetries to check the flavor structure of the hyperon fragmentation functions.

Recently, there has been some great progress in the measurements of polarized Λ production. Longitudinal Λ polarization in e^+e^- annihilation at the Z pole was observed by several collaborations at CERN [10–12]. The HERMES Collaboration at DESY reported a result for the longitudinal spin transfer to the Λ in polarized positron deep inelastic scattering (DIS) [13]. Also, the E665 Collaboration at Fermilab measured the Λ and $\bar{\Lambda}$ spin transfers from muon DIS [14]. Very recently, a measurement of Λ polarization in neutrino DIS was made by the NOMAD Collaboration [15]. The high statistics investigation of polarized Λ production is one of the main future goals of the HERMES Collaboration, who will improve their detector for this purpose by adding so called Lambda wheels. There is also the possibility of measuring the polarization of other hyperon production [3–6]. In addition, the spin asymmetry for a hyperon produced by $p\vec{p}$ collisions at the BNL Relativistic Heavy Ion Collider (RHIC) may be measured with high luminosity [29]. Therefore, it is of great significance to predict some spin observables for near future experiments.

The paper is organized as follows. In Sec. II, we briefly describe fragmentation functions for octet baryons by using a simple diquark model. All free parameters of the model are determined based on the experimental data on octet baryon production in e^+e^- annihilation, and the strangeness suppression in hyperon production is shown. In Sec. III, we propose a possible cross check of the strangeness suppression via octet baryon production in pp collisions. In Sec. IV, we study the flavor structure of the fragmentation functions by means of baryon-antibaryon asymmetries in k^+p collisions. In Sec. V, we investigate the helicity structure of the fragmentation functions by predicting spin observables in various octet baryon production processes. In Sec. VI, the transversely polarized fragmentation functions for the octet baryons are used to predict the transverse quark to baryon polarization transfers in charged lepton DIS on a transversely polarized nucleon target. Finally, we present a discussion and summary with our conclusions in Sec. VII.

II. QUARK FRAGMENTATION FUNCTIONS FOR THE OCTET BARYONS

After more than three decades of experimental studies, we have many data to parametrize quark distributions of the nucleon. In contrast to the nucleon parton distributions, we have much less information on the fragmentation functions for the octet baryons. We can only constrain the shape of the fragmentation functions with the help of models in order to reduce the number of free parameters. Some models such as those using strings and shower algorithms [30] involve many parameters. We have noticed that the diquark model given in Ref. [31] gives a clear physics picture with few parameters. According to the field-theoretical description, fragmentation functions are defined as the Dirac projections of the quark-quark correlation function [31]

$$\Delta_{ij}(k,P_B,S_B)=\sum_X \int \frac{d^4\xi}{(2\pi)^4} e^{ik\cdot\xi}\langle 0|\psi_i(\xi)|P_B,S_B;X\rangle \times\langle P_B,S_B;X|\bar{\psi}_j(0)|0\rangle, \tag{1}$$

which contains information about how a parton fragments into a baryon B. The outgoing baryon states are characterized by the momentum and spin vectors $|P_B,S_B\rangle$ and the quark momentum is denoted by k. The basic idea of the diquark model is to assign a definite mass and the quantum numbers of a diquark system to the intermediate outgoing states $|X\rangle$ together with the baryon B characterized by P_B and S_B. With the diquark assumption, the matrix element appearing in the right-hand side of Eq. (1) can be expressed as

$$\langle P_B,S_B;X_S|\bar{\psi}(0)|0\rangle=\bar{U}(P_B,S_B)\Phi_S\left(\frac{i}{\not{k}-m}\right) \tag{2}$$

in the case of a scalar antidiquark, or by

$$\langle P_B,S_B;X_V|\bar{\psi}(0)|0\rangle=\bar{U}(P_B,S_B)\Phi_V^{\mu}\left(\frac{i}{\not{k}-m}\right)\epsilon_\mu \tag{3}$$

in the case of a vector antidiquark, where $\Phi_{S(V)}$ is a quark-diquark-baryon vertex which connects the quark with the two outgoing particles, and ϵ_μ is a polarization vector in the case of a vector antidiquark. For the quark-diquark-baryon vertex, the following Dirac structure is usually adopted [31]:

$$\Phi_S=\mathbf{1}g_S(k^2) \tag{4}$$

and

$$\Phi_V=\frac{g_V(k^2)}{\sqrt{3}}\gamma_5\left(\gamma^\mu+\frac{P_B^\mu}{M_B}\right). \tag{5}$$

The form factors $g_D(k^2)$ $(D=S,\ V)$, which reflect the composite structure of the baryon and the antidiquark, are chosen in the same form for scalar (S) and axial vector (V) antidiquarks,

$$g_D(k^2)=N\frac{k^2-m^2}{(k^2-\Lambda_0^2)^2}, \tag{6}$$

with a normalization constant N and a mass parameter Λ_0. Putting all ingredients together, the quark-quark correlation functions can be calculated with the assumed form factor. By making the Dirac projections of the obtained quark-quark correlation functions, the probability of finding a quark q splitting into a baryon B with longitudinal momentum fraction z and emitting a scalar or axial vector antidiquark, can be calculated as [31]

$$a_D^{(q/B)}(z)=\frac{N^2z^2(1-z)^3}{64\pi^2}\frac{[2(M_B+m_qz)^2+R^2(z)]}{R^6(z)} \tag{7}$$

with

TABLE I. Quark fragmentation functions of octet baryons in diquark model.

Baryon	$D^B_{q_v}$		$\Delta D^B_{q_v}$		m_q (MeV)	m_V (MeV)	m_S (MeV)
p	$D^p_{u_v}$	$(1/6)a_V^{(u/p)}+(1/2)a_S^{(u/p)}$	$\Delta D^p_{u_v}$	$-(1/18)\tilde{a}_V^{(u/p)}+(1/2)\tilde{a}_S^{(u/p)}$	350	1100	900
(uud)	$D^p_{d_v}$	$(1/3)a_V^{(d/p)}$	$\Delta D^p_{d_v}$	$-(1/9)\tilde{a}_V^{(d/p)}$	350	1100	900
n	$D^n_{u_v}$	$(1/3)a_V^{(u/n)}$	$\Delta D^n_{u_v}$	$-(1/9)\tilde{a}_V^{(u/n)}$	350	1100	900
(udd)	$D^n_{d_v}$	$(1/6)a_V^{(d/n)}+(1/2)a_S^{(d/n)}$	$\Delta D^n_{d_v}$	$-(1/18)\tilde{a}_V^{(d/n)}+(1/2)\tilde{a}_S^{(d/n)}$	350	1100	900
Σ^+	$D^{\Sigma^+}_{u_v}$	$(1/6)a_V^{(u/\Sigma^+)}+(1/2)a_S^{(u/\Sigma^+)}$	$\Delta D^{\Sigma^+}_{u_v}$	$-(1/18)\tilde{a}_V^{(u/\Sigma^+)}+(1/2)\tilde{a}_S^{(u/\Sigma^+)}$	350	1276	1076
(uus)	$D^{\Sigma^+}_{s_v}$	$(1/3)a_V^{(s/\Sigma^+)}$	$\Delta D^{\Sigma^+}_{s_v}$	$-(1/9)\tilde{a}_V^{(s/\Sigma^+)}$	526	1100	900
Σ^0	$D^{\Sigma^0}_{u_v}$	$(1/12)a_V^{(u/\Sigma^0)}+(1/4)a_S^{(u/\Sigma^0)}$	$\Delta D^{\Sigma^0}_{u_v}$	$-(1/36)\tilde{a}_V^{(u/\Sigma^0)}+(1/4)\tilde{a}_S^{(u/\Sigma^0)}$	350	1276	1076
(uds)	$D^{\Sigma^0}_{d_v}$	$(1/12)a_V^{(d/\Sigma^0)}+(1/4)a_S^{(d/\Sigma^0)}$	$\Delta D^{\Sigma^0}_{d_v}$	$-(1/36)\tilde{a}_V^{(d/\Sigma^0)}+(1/4)\tilde{a}_S^{(d/\Sigma^0)}$	350	1276	1076
	$D^{\Sigma^0}_{s_v}$	$(1/3)a_V^{(s/\Sigma^0)}$	$\Delta D^{\Sigma^0}_{s_v}$	$-(1/9)\tilde{a}_V^{(s/\Sigma^0)}$	526	1100	900
Σ^-	$D^{\Sigma^-}_{d_v}$	$(1/6)a_V^{(d/\Sigma^-)}+(1/2)a_S^{(d/\Sigma^-)}$	$\Delta D^{\Sigma^-}_{d_v}$	$-(1/18)\tilde{a}_V^{(d/\Sigma^-)}+(1/2)\tilde{a}_S^{(d/\Sigma^-)}$	350	1276	1076
(dds)	$D^{\Sigma^-}_{s_v}$	$(1/3)a_V^{(s/\Sigma^-)}$	$\Delta D^{\Sigma^-}_{s_v}$	$-(1/9)\tilde{a}_V^{(s/\Sigma^-)}$	526	1100	900
Λ^0	$D^{\Lambda^0}_{u_v}$	$(1/4)a_V^{(u/\Lambda^0)}+(1/12)a_S^{(u/\Lambda^0)}$	$\Delta D^{\Lambda^0}_{u_v}$	$-(1/12)\tilde{a}_V^{(u/\Lambda^0)}+(1/12)\tilde{a}_S^{(u/\Lambda^0)}$	350	1276	1076
(uds)	$D^{\Lambda^0}_{d_v}$	$(1/4)a_V^{(d/\Lambda^0)}+(1/12)a_S^{(d/\Lambda^0)}$	$\Delta D^{\Lambda^0}_{d_v}$	$-(1/12)\tilde{a}_V^{(d/\Lambda^0)}+(1/12)\tilde{a}_S^{(d/\Lambda^0)}$	350	1276	1076
	$D^{\Lambda^0}_{s_v}$	$(1/3)a_S^{(s/\Lambda^0)}$	$\Delta D^{\Lambda^0}_{s_v}$	$(1/3)\tilde{a}_S^{(s/\Lambda^0)}$	526	1100	900
Ξ^-	$D^{\Xi^-}_{d_v}$	$(1/3)a_V^{(d/\Xi^-)}$	$\Delta D^{\Xi^-}_{d_v}$	$-(1/9)\tilde{a}_V^{(d/\Xi^-)}$	350	1452	1252
(dss)	$D^{\Xi^-}_{s_v}$	$(1/6)a_V^{(s/\Xi^-)}+(1/2)a_S^{(s/\Xi^-)}$	$\Delta D^{\Xi^-}_{s_v}$	$-(1/18)\tilde{a}_V^{(s/\Xi^-)}+(1/2)\tilde{a}_S^{(s/\Xi^-)}$	526	1276	1076
Ξ^0	$D^{\Xi^0}_{u}$	$(1/3)a_V^{(u/\Xi^0)}$	$\Delta D^{\Xi^0}_{u_v}$	$-(1/9)\tilde{a}_V^{(u/\Xi^0)}$	350	1452	1252
(uss)	$D^{\Xi^0}_{s_v}$	$(1/6)a_V^{(s/\Xi^0)}+(1/2)a_S^{(s/\Xi^0)}$	$\Delta D^{\Xi^0}_{s_v}$	$-(1/18)\tilde{a}_V^{(s/\Xi^0)}+(1/2)\tilde{a}_S^{(s/\Xi^0)}$	526	1276	1076

$$R(z)=\sqrt{zm_D^2-z(1-z)\Lambda_0^2+(1-z)M_B^2}, \tag{8}$$

where m_q is the quark mass, and M_B and $m_D(D=S$ or $V)$ are the masses of the baryon B and a diquark, respectively.

In order to get the fragmentation function for a specified quark flavor, we need to combine $a_D^{(q/B)}(z)$ with the flavor coupling of the octet wave function from scalar and axial vector diquarks. As an example, the unpolarized valence quark to proton fragmentation functions can be obtained as

$$D^p_{u_v}(z)=\frac{1}{2}a_S^{(u/p)}(z)+\frac{1}{6}a_V^{(u/p)}(z), \tag{9}$$

$$D^p_{d_v}(z)=\frac{1}{3}a_V^{(d/p)}(z). \tag{10}$$

Similarly, the longitudinally and transversely polarized quark to proton fragmentation functions are

$$\Delta D^p_{u_v}(z)=\frac{1}{2}\tilde{a}_S^{(u/p)}(z)-\frac{1}{18}\tilde{a}_V^{(u/p)}(z), \tag{11}$$

$$\Delta D^p_{d_v}(z)=-\frac{1}{9}\tilde{a}_V^{(d/p)}(z), \tag{12}$$

$$\delta D^p_{u_v}(z)=\frac{1}{2}\hat{a}_S^{(u/p)}(z)-\frac{1}{18}\hat{a}_V^{(u/p)}(z), \tag{13}$$

$$\delta D^p_{d_v}(z)=-\frac{1}{9}\hat{a}_V^{(d/p)}(z), \tag{14}$$

with

$$\tilde{a}_D^{(q/B)}(z)=\frac{N^2z^2(1-z)^3}{64\pi^2}\,\frac{[2(M_B+m_qz)^2-R^2(z)]}{R^6(z)}, \tag{15}$$

and

$$\hat{a}_D^{(q/B)}(z)=\frac{N^2z^2(1-z)^3}{32\pi^2}\,\frac{(M_B+m_qz)^2}{R^6(z)}, \tag{16}$$

for $D=S$ or V. The expressions for unpolarized and longitudinally polarized fragmentation functions for all octet baryons are listed in Table I where $a_D^{(q/B)}$ and $\tilde{a}_D^{(q/B)}$ are given in Eqs. (7) and (15), respectively. The expressions for transversely polarized fragmentation functions are the same as those for longitudinally polarized ones but with the replacement of all $\tilde{a}_D^{(q/B)}$ by $\hat{a}_D^{(q/B)}$ which are given in Eq. (16).

There are some parameters in the expression of $a_D^{(q/B)}(z)$. However, the quark, diquark, and baryon masses have some commonly accepted values (see Table I) and only the normalization constant N is a free parameter. We assume that all octet baryons share the same normalization constant N. Following Ref. [31], we take the mass parameter in the form factor (6) as $\Lambda_0 = 500$ MeV. We find that the numerical calculation results are not sensitive to its precise value.

It is valuable to mention that the diquark model neglects a detailed description of final state interactions, which could be relevant in the fragmentation process, in particular regarding the so-called time-reversal odd fragmentation functions, although the difference in the diquark masses can be understood as the results of some state interactions. In addition, the quark-diquark description of fragmentation functions should be reasonable only in the large z region where the valence quark contribution dominates. In the small z region, sea contributions are difficult to include in the framework of the diquark model itself. Therefore, we adopt a simple functional form

$$D_{q_s}^B(z) = D_{\bar{q}}^B(z) = N_s z^{\alpha_s}(1-z)^{\beta_s}, \tag{17}$$

to parametrize fragmentation functions of the sea quark $D_{q_s}^B(z)$ and antiquark $D_{\bar{q}}^B(z)$ for $q = u,d,s$. We assume that D_g^B, ΔD_g^B, δD_g^B, $\Delta D_{q_s(\bar{q})}^B$, and $\delta D_{q_s(\bar{q})}^B$ at the initial scale are zero and they only appear due to QCD evolution. Hence, the input unpolarized and polarized quarks to the baryon B fragmentation functions can be written as

$$D_q^B(z) = D_{q_v}^B(z) + D_{q_s}^B(z), \tag{18}$$

$$\Delta D_q^B(z) = \Delta D_{q_v}^B(z), \tag{19}$$

and

$$\delta D_q^B(z) = \delta D_{q_v}^B(z). \tag{20}$$

The diquark model can be used to partly reflect the SU(3) flavor symmetry breaking effect since the probabilities $a_D^{q/B}(z)$ are different for the various baryons due to the differences in the quark, antidiquark, and baryon masses. However, the measured values for average hadronic multiplicities per hadronic e^+e^- annihilation event [32] indicate that there is significant strangeness suppression for hyperon production as compared with proton production. The flavor symmetry breaking provided by the diquark model is not enough to describe the observed strong strangeness suppression. Actually, we find that the cross sections for Λ, Σ, and Ξ baryons in e^+e^- annihilation would be overestimated by up to two orders of magnitude if we considered only the SU(3) symmetry breaking in the framework of the diquark model. Therefore, it seems that the strangeness suppression effect can only be considered in a separate way. In Ref. [25], the strangeness suppression effect is reached by putting a suppression factor in the u, d, and sea quark fragmentation functions for baryons containing a valence s quark (and a further overall suppression factor for baryons containing two s quarks). In our present analysis, we simply introduce an overall strangeness suppression factor λ_H ($H = \Lambda$, Σ, and Ξ) multiplying all the fragmentation functions of a given hyperon H containing s quarks (one or two).

To sum up, our model, which describes the fragmentation functions of all the octet baryons involves a total seven free parameters

$$N, N_s, \alpha_s, \beta_s, \lambda_\Lambda, \lambda_\Sigma, \lambda_\Xi. \tag{21}$$

It is noteworthy that the flavor structure of fragmentation functions in the diquark model still remains when the overall strangeness suppression factors are introduced. In addition, we also hope that the introduction of the strangeness suppression factors does not alter the spin structure of the fragmentation functions. For this reason, we assume that the polarized fragmentation functions for the octet hyperons have the same strangeness suppression factors as the unpolarized ones.

We determine the free parameters of the model according to some experimental data on the differential cross sections for the semi-inclusive octet baryon production process $e^+e^- \to B + X$ [16–18]. The model fragmentation functions at the initial scale are evolved to the experimental energy scale by using the evolution package of Ref. [33] suitably modified for the evolution of fragmentation functions in leading order with the input scale $Q_0^2 = 1.0$ GeV^2 and the QCD scale parameter $\Lambda_{QCD} = 0.3$ GeV. We perform a leading order analysis since the results in Refs. [7,34] show that the leading order fit can arrive at the same fitting quality as the next-to-leading order fit. In addition, we use only $z > 0.05$ data samples because understanding the very low-z region data needs some further modifications to the evolution of fragmentation functions [7,34]. However, we find that some data in the low z region can still be described by our fragmentation functions. We obtain values for the parameters as follows:

$$N = 32.4228, \quad N_s = 0.6708, \quad \alpha_s = -0.2695, \quad \beta_s = 3.9657,$$

$$\lambda_\Lambda = 0.4416, \quad \lambda_\Sigma = 0.1141, \quad \lambda_\Xi = 0.0401.$$

In Fig. 1, our results for the x_E dependence of the inclusive octet baryon production cross section $(1/\sigma_{tot})d\sigma/dx_E$ in e^+e^- annihilation are compared with some of the experimental data [16–18].

With the obtained values of the parameters, we calculate fragmentation functions for all octet baryons at the initial scale and evolve them into an expected energy scale. We call these fragmentation functions the SU(3) broken ones since they contain SU(3) symmetry breaking due to the strangeness suppression and the differences in the quark, diquark, and baryon masses. We regard the strangeness suppression as an SU(3) symmetry breaking since it actually reflects the SU(3) symmetry breaking in the normalization constants for the fragmentation functions. In order to check the SU(3) symmetry breaking effect, we propose another set of fragmentation functions with an SU(3) symmetry assumption.

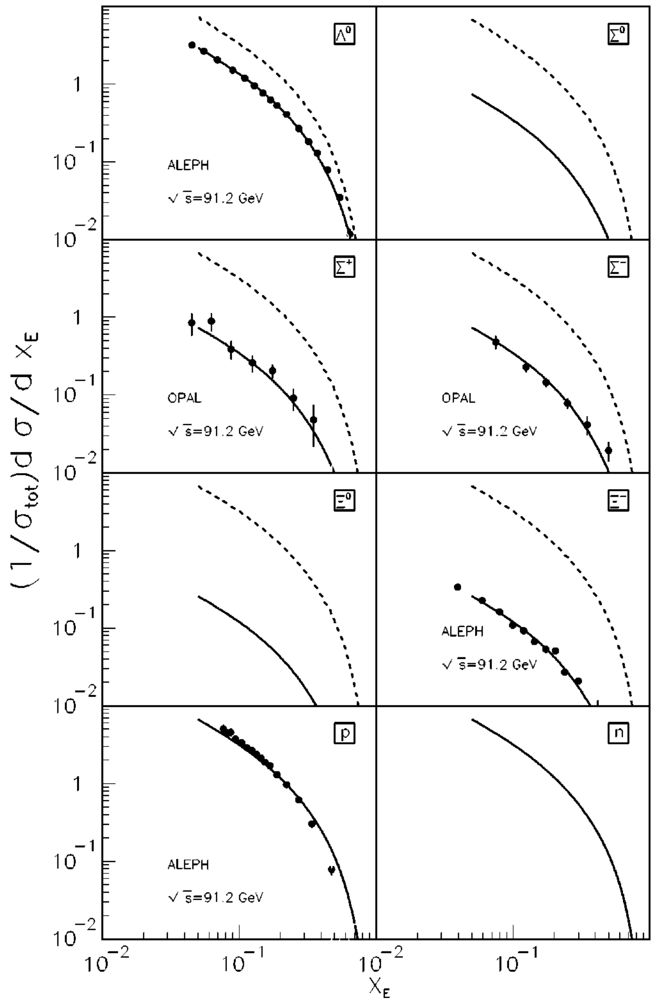

FIG. 1. Comparison of our results for the x_E dependence of the inclusive octet baryon production cross section $(1/\sigma_{tot})d\sigma/dx_E$ in e^+e^- annihilation and some experimental data [16–18]. The dashed and solid curves are predictions with $\sqrt{s}=91.2$ GeV by using the SU(3) symmetry and SU(3) broken fragmentation functions, respectively.

We take the proton fragmentation functions at the initial scale as references and calculate the initial fragmentation functions for all other octet baryons by setting the strangeness suppression factors as $\lambda_H=1.0$ ($H=\Lambda$, Σ, and Ξ) and the quark, diquark, and baryon masses as those of the proton. It should be pointed out that the SU(3) symmetry case is only a supposed reference in order to check the SU(3) symmetry breaking effect. In Fig. 1, we show the results with the SU(3) fragmentation functions (dashed curves) as compared with those with the SU(3) broken fragmentation functions (solid curves). From Fig. 1, one can see that the SU(3) symmetry model overestimates by up to two orders of magnitude the cross sections for hyperon production in e^+e^- annihilation. Therefore, the SU(3) symmetry breaking, especially the strangeness suppression, is necessary in order to understand the data on hyperon production.

III. STRANGENESS SUPPRESSION EFFECT IN *pp* COLLISIONS

The experimental data on octet hyperon production in e^+e^- annihilation indicate that the strangeness suppression effect in octet baryon production is very strong. According to the factorization theorem, the fragmentation functions are independent of the processes. The fragmentation functions determined in the $e^+e^-\to BX$ process can be used for quantitative predictions of inclusive single baryon cross sections in other processes. The strangeness suppression effect should also have relevant consequences for the cross sections of some processes like the $pp\to BX$ process, i.e., the cross sections for the strange baryon production should have a significant suppression as compared with those for nonstrange baryon production. In order to have a cross check of the strangeness suppression effect, we calculate the cross sections for the $pp\to BX$ process.

In leading order perturbative QCD, the differential cross section for the $pp\to BX$ process can be schematically written in a factorized form as

$$E\frac{d^3\sigma}{d^3p}=\sum_{abcd}\int_{\bar{x}_a}^1 dx_a\int_{\bar{x}_b}^1 dx_b f_a^{\tilde{A}}(x_a,Q^2)\times f_b^{\tilde{B}}(x_b,Q^2)D_c^B(z,Q^2)\frac{1}{\pi z}\frac{d\hat{\sigma}}{d\hat{t}}(ab\to cd), \tag{22}$$

with

$$\bar{x}_a=\frac{x_Te^y}{2-x_Te^{-y}},\quad \bar{x}_b=\frac{x_ax_Te^{-y}}{2x_a-x_Te^y},$$

$$z=\frac{x_T}{2x_b}e^{-y}+\frac{x_T}{2x_a}e^y, \tag{23}$$

where $x_T=2p_T/\sqrt{s}$ ($\sqrt{s}$ is the center of mass energy of pp collisions). p_T, E, and y are the transverse momentum, energy, and rapidity of the produced baryon B. $f_a^{\tilde{A}}(x_a,Q^2)$ and $f_b^{\tilde{B}}(x_b,Q^2)$ are unpolarized distribution functions of partons a and b in protons $\tilde{A}$ and $\tilde{B}$, respectively, at the scale $Q^2=p_T^2$. $D_c^B(z,Q^2)$ is the fragmentation function of parton c into the baryon B with the momentum fraction z of parton c. $d\hat{\sigma}/d\hat{t}$ is the differential cross section for the subprocess $a+b\to c+d$ and $\hat{t}=-x_ap_T\sqrt{s}e^{-y}/z$ is the Mandelstam variable at the parton level.

By charge-conjugation invariance, the $e^+e^-\to BX$ cross sections for a baryon production should be equal to those for the corresponding antibaryon production. Therefore, only the combinations $D_q^B+D_q^{\bar{B}}$ can be determined, and similarly for the antiquark fragmentation functions. However, in pp collisions, we can observe differences in the cross sections for baryon and antibaryon production. Therefore, we also predict

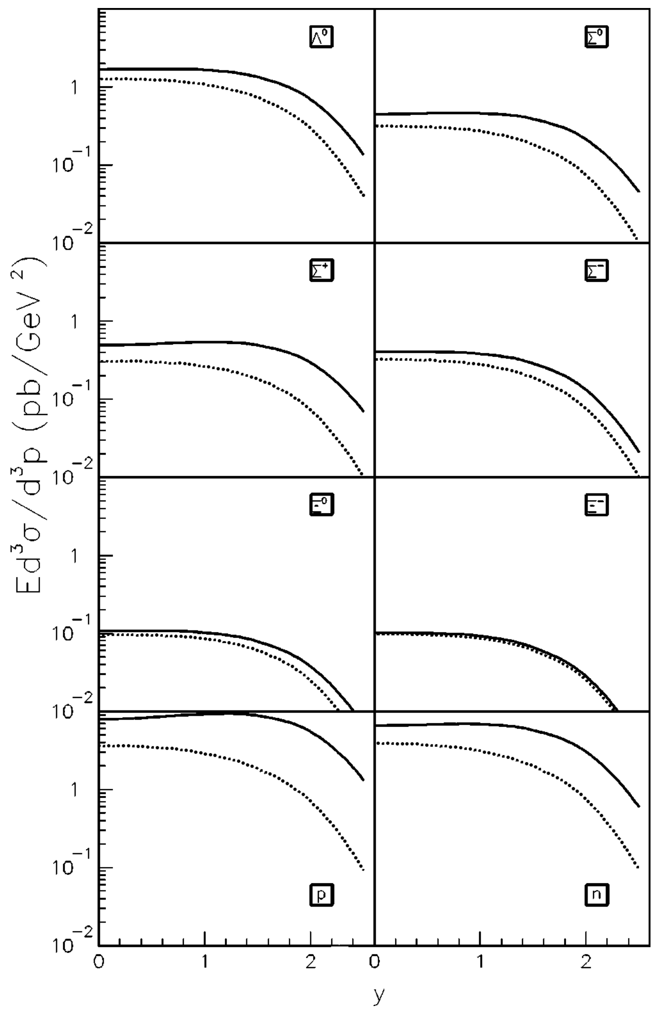

FIG. 2. The cross sections for baryons (solid curves) and antibaryons (dotted curves) production in pp collisions are obtained with the SU(3) broken fragmentation functions at $\sqrt{s}=500$ GeV and $p_T=15$ GeV/c.

the cross sections for the antibaryon $\overline{B}$ whose quark fragmentation functions can be obtained according to matter and antimatter symmetry, i.e., $D^B_{q,\overline{q}}(z)=D^{\overline{B}}_{\overline{q},q}(z)$ and $\Delta D^B_{q,\overline{q}}(z)=\Delta D^{\overline{B}}_{\overline{q},q}(z)$ for a spin observable analysis.

By adopting the leading order (LO) set of unpolarized parton distributions of Ref. [35], we present in Fig. 2 the cross sections for octet baryons (solid curves) and antibaryons (dotted curves) produced in pp collisions and the results are calculated with $\sqrt{s}=500$ GeV and $p_T=15$ GeV/c. By comparing the cross sections of hyperon (antihyperon) production with those of proton (antiproton) production, one can easily find the strangeness suppression effect in hyperon production. Therefore, the cross sections for octet baryon production in pp collisions can be used as a cross check of the strangeness suppression effect. Some experiments have been done with baryon production in pp collisions [36]. Unfortunately, the available data were given in the low p_T region. We need some data at high p_T in order to check our predictions in the partonic framework. This may be realized by RHIC at BNL [29,37,38] in the near future.

IV. BARYON-ANTIBARYON ASYMMETRIES IN k^+p COLLISIONS

We have noticed that the cross section of Λ production in e^+e^- annihilation is not sensitive to the flavor structure of the Λ fragmentation functions, i.e., both the SU(3) flavor symmetry and SU(3) broken fragmentation functions can be used to describe the cross section. However, the flavor structure is an important aspect of fragmentation functions as well as the spin structure. It is of great significance to study some observables which are related to the flavor structure of the fragmentation functions. Recently, it has been found that a measurement of $\Lambda/\overline{\Lambda}$ asymmetry in k^+p collisions can be used to resolve the flavor structure of fragmentation functions for the Λ [28]. In order to check the flavor structure of the obtained fragmentation functions for the octet baryons, we extend this analysis from the Λ to all octet baryons. We consider the reaction

$$k^+ + p \to B + X \tag{24}$$

for inclusive production of a baryon B with the k^+ beam and target proton (p). The x_F distribution of the cross section $d^3\sigma^B/d^3p_B$ of the reaction (24) can be obtained from its expression for the Λ in Ref. [28] by some suitable replacements of other octet baryons. With the parton distributions of the incident hadron and the target nucleon, we can calculate the x_F distribution of the asymmetry for $B/\overline{B}$ production in k^+p collisions,

$$A^B(x_F)=\frac{d^3\sigma^B/d^3p_B - d^3\sigma^{\overline{B}}/d^3p_{\overline{B}}}{d^3\sigma^B/d^3p_B + d^3\sigma^{\overline{B}}/d^3p_{\overline{B}}}. \tag{25}$$

By using the k^+ parton distributions [39], we calculate $A^B(x_F)$ for all octet baryons and antibaryons produced in k^+p collisions and the results are presented as solid curves in Fig. 3 for future test in experiments. In Fig. 3, we also show the results with the SU(3) symmetry fragmentation functions (dashed curves). Actually, the differences between the solid and dashed curves here only reflect the SU(3) symmetry breaking due to the differences in quark, antidiquark, and baryon masses, since the strangeness suppression effect is canceled in the asymmetry $A^B(x_F)$. The same meaning is implied when we refer to the SU(3) symmetry breaking effect in the spin observables to be discussed in the following sections.

The calculated results shown in Fig. 3 indicate that the hyperon-antihyperon asymmetries in k^+p collisions are sensitive to the flavor structure of the hyperon fragmentation functions. The asymmetries A^{Λ^0}, A^{Σ^0}, and A^{Σ^+} in the current fragmentation region are suitable observables to reveal the SU(3) symmetry breaking effect and to check various flavor structures of fragmentation functions. For other octet hyperons, we may observe the SU(3) symmetry breaking effect on their asymmetries in the target fragmentation region. Therefore, a measurement of the hyperon-antihyperon asymmetries in k^+p collisions may be used to resolve the flavor structure of the hyperon fragmentation functions.

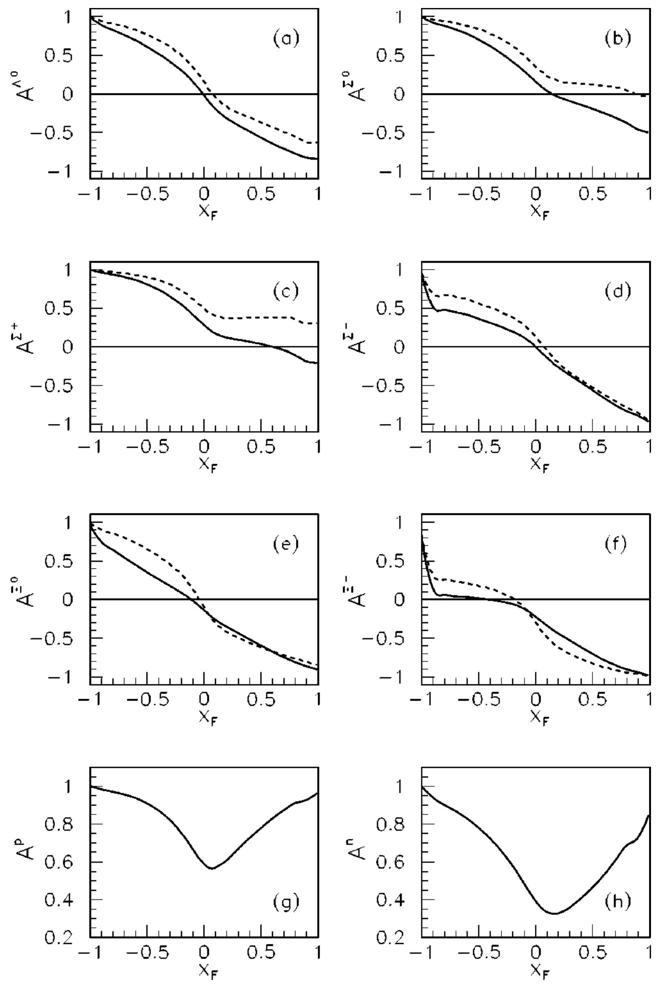

FIG. 3. The baryon-antibaryon asymmetries in k^+p collisions are obtained with $\sqrt{s}=30$ GeV and $p_T=3.0$ GeV/c. The dashed and solid curves are the results with the SU(3) symmetry and SU(3) broken fragmentation functions (see text), respectively.

A comment on the above calculation approach is in order. Usually, experimental data for baryon production in k^+p collisions were given in the low p_T region, e.g., $p_T^2 \leqslant 0.8\ (\mathrm{GeV}/c)^2$ for Λ production in Ref. [40]. Giving consideration to both the experimental preference for low p_T measurements and the limitation of our perturbative treatment, $p_T=3.0$ GeV/c is adopted in our calculation. This value of p_T is still somewhat small for a safe use of the factorized expressions for the cross sections and the approach remains to be verified.

V. HELICITY OBSERVABLES IN OCTET BARYON PRODUCTION

There are available data on polarized Λ fragmentation functions in e^+e^- annihilation at the Z pole and also in lepton DIS. We can check the obtained fragmentation functions based on these experimental data. In addition, it is of significance to make some predictions for other octet hyperons since the detection technique for Σ and Ξ hyperons is gradually maturing.

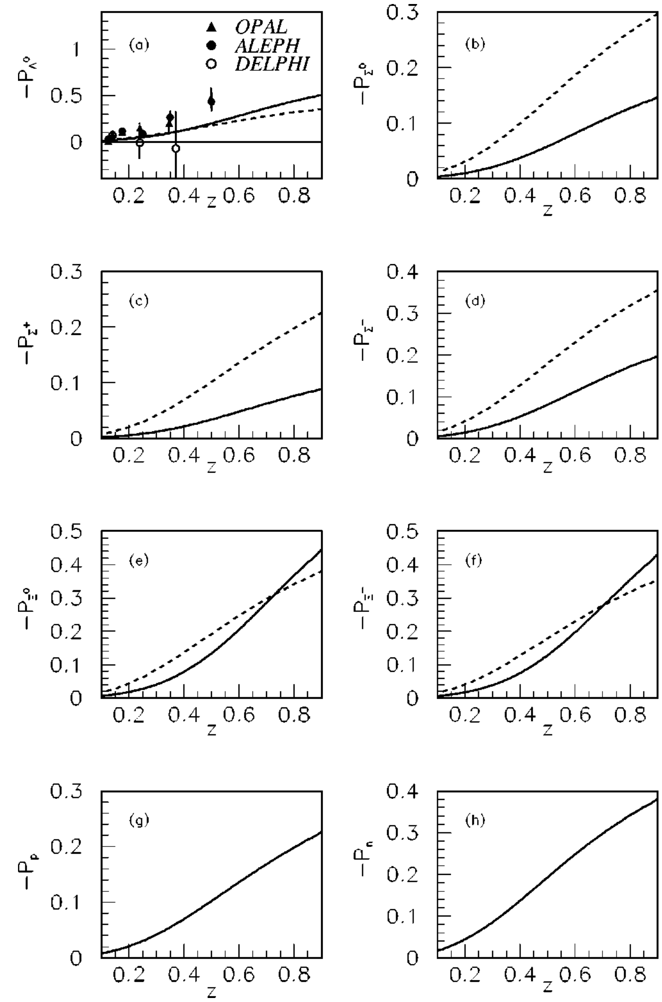

FIG. 4. The longitudinal octet baryon polarization P_B in e^+e^- annihilation at the Z pole. The dashed and solid curves are the predictions using the SU(3) symmetry and SU(3) broken fragmentation functions, respectively. The experimental data for Λ production are taken from Refs. [10–12].

A. Octet baryon polarizations in e^+e^- annihilation

In e^+e^- annihilation near the Z pole, there exists an interference between the vector and axial vector couplings in the standard model of electroweak interactions, which results in the polarization of quarks and antiquarks produced from the Z decay. Then the polarization of quarks and antiquarks will be transferred to the baryons via fragmentation. The baryon polarization can be expressed as

$$P_B = -\frac{\sum_q \hat{A}_q[\Delta D_q^B(z) - \Delta D_{\bar{q}}^B(z)]}{\sum_q \hat{C}_q[D_q^B(z) + D_{\bar{q}}^B(z)]}, \tag{26}$$

where $\hat{A}_q$ and $\hat{C}_q(q=u,\ d,$ and $s)$ can be found in Ref. [41]. The available experimental data on the Λ polarization near the Z pole [10–12] can be used to check the Λ fragmentation functions. Our theoretical predictions for the octet baryon polarizations at the Z pole are shown in Fig. 4 together with

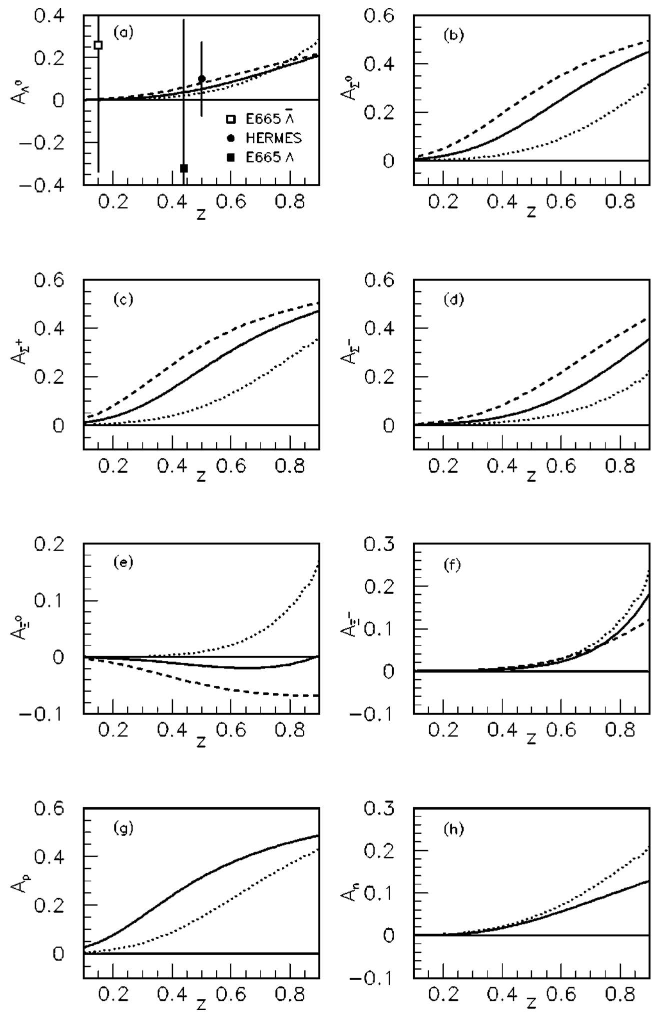

FIG. 5. The predictions of the z dependence for spin transfers to octet baryons and antibaryons in polarized charged lepton DIS on the proton target. The dashed and solid curves are the predictions for the produced baryons by using the SU(3) symmetry and SU(3) broken fragmentation functions, respectively. The dotted curves are the predictions for the produced antibaryons by using the SU(3) broken fragmentation functions. The HERMES data on Λ production are taken from Ref. [13]. The E665 data on Λ and $\bar{\Lambda}$ production are taken from Ref. [14].

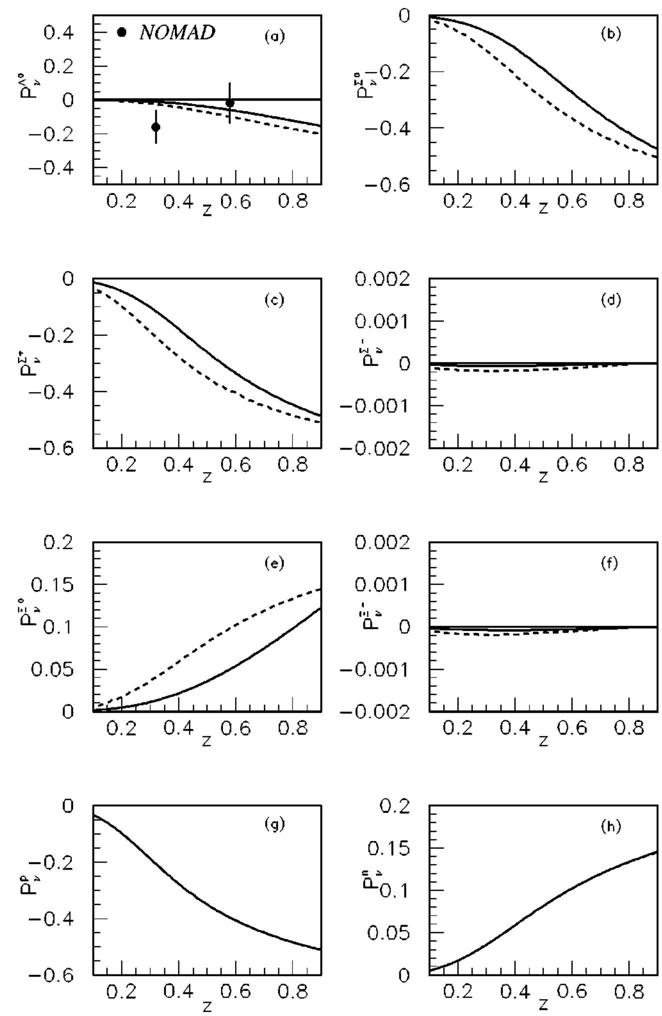

FIG. 6. The predictions of z dependence for octet baryon polarizations in neutrino DIS. The dashed and solid curves correspond to the predictions by using the SU(3) symmetry and SU(3) broken fragmentation functions with the Bjorken variable x integrated over $0.02 \to 0.4$ and y integrated over $0 \to 1$. The experimental data are taken from Ref. [15].

the experimental data for Λ production. From Fig. 4(a), one can see that the prediction of Λ polarization with the SU(3) broken fragmentation functions is a little closer to the experimental data than the prediction with the SU(3) symmetry fragmentation functions although both results are compatible with the experimental data. We also find that the SU(3) symmetry breaking effect on the hyperon polarization mainly exists in the medium and large z region; in particular, the effect on Σ polarization is significant.

B. Spin transfers to octet baryons in polarized charged lepton DIS

Another good observable for checking the helicity structure of the fragmentation functions for a baryon is the spin transfer to the baryon in polarized charged lepton DIS, where the charged lepton beam is longitudinally polarized and the proton target is unpolarized. The baryon polarization along its own momentum axis is given in the quark parton model by [42]

$$P_B(x,y,z) = P_b D(y) A_B(x,z), \tag{27}$$

where P_b is the polarization of the charged lepton beam, which is of the order of 0.7 or so [13,14]. $D(y)$ with $y = \nu/E$ is the longitudinal depolarization factor of the virtual photon with respect to the parent lepton, and

$$A_B(x,z) = \frac{\sum_q e_q^2 [q^N(x,Q^2)\Delta D_q^B(z,Q^2) + (q \to \overline{q})]}{\sum_q e_q^2 [q^N(x,Q^2) D_q^B(z,Q^2) + (q \to \overline{q})]} \tag{28}$$

is the longitudinal spin transfer to the baryon B. In our numerical calculations, the quark distribution $q^N(x,Q^2)$ of the nucleon N target is adopted as the CTEQ5 set 1 parametrization form [43] at $Q^2=4\ \mathrm{GeV}^2$ and the Bjorken variable x is integrated over the range [0.02,0.4]. Similarly, we can also calculate the longitudinal spin transfer to the antibaryon $\bar{B}$. The calculated results for the longitudinal spin transfers to the octet baryons [the dashed and solid curves are for the SU(3) symmetry and SU(3) broken cases, respectively] and antibaryons [the dotted curves with the SU(3) broken fragmentation functions] are shown in Fig. 5. The spin transfer to the Λ is dominated by the u quark fragmentation functions due to the charge factor for the u quark. Moreover, due to isospin symmetry the u and d quark spin transfers to the Λ are expected to be equal. We can check the u and d quark fragmentation functions by means of Λ production in the polarized charged lepton DIS process. As shown in Fig. 5(a), our predictions are compatible with the available experimental data [13,14] on Λ production in the medium z region, which seems to suggest that the u and d quark to Λ fragmentation functions are likely positive polarized in the medium and large z region, and supports our previous studies [41]. The spin transfer to $\bar{\Lambda}$ is also comparable with the E665 data [14]. Another two experimental data points of the E665 Collaboration are not shown in the figure since their central absolute values are larger than 1 with very big errors. The spin transfer to the Ξ^0 at large z seems to be a suitable observable to check various valence quark spin structures of fragmentation functions. The SU(3) symmetry breaking can affect the spin transfers to other octet hyperons somewhat. It is valuable to notice that the spin transfer to the antibaryon $\bar{B}$ is very different from the spin transfer to the baryon B.

C. Octet baryon polarizations in neutrino-antineutrino DIS

Neutrinos (antineutrinos) can be regarded as a purely polarized lepton beam since neutrinos (antineutrinos) are left (right) handed. The scattering of a neutrino beam on a hadronic target provides a source of polarized quarks with specific helicity and flavor structure. The baryons produced via quark fragmentation in neutrino (antineutrino) DIS are polarized. The longitudinal polarizations of the baryon B in its momentum direction for the baryon B in the current fragmentation region can be expressed as [44]

$$P_{\nu}^{B}(x,y,z)=-\frac{[d^N(x)+\varpi s^N(x)]\Delta D_u^B(z)-(1-y)^2\overline{u}^N(x)[\Delta D_{\bar{d}}^B(z)+\varpi\Delta D_{\bar{s}}^B(z)]}{[d^N(x)+\varpi s^N(x)]D_u^B(z)+(1-y)^2\overline{u}^N(x)[D_{\bar{d}}^B(z)+\varpi D_{\bar{s}}^B(z)]}, \tag{29}$$

$$P_{\bar{\nu}}^{B}(x,y,z)=-\frac{(1-y)^2u^N(x)[\Delta D_d^B(z)+\varpi\Delta D_s^B(z)]-[\overline{d}^N(x)+\varpi\overline{s}^N(x)]\Delta D_{\bar{u}}^B(z)}{(1-y)^2u^N(x)[D_d^B(z)+\varpi D_s^B(z)]+[\overline{d}^N(x)+\varpi\overline{s}^N(x)]D_{\bar{u}}^B(z)}, \tag{30}$$

where the terms with the factor $\varpi=\sin^2\theta_c/\cos^2\theta_c$($\theta_c$ is the Cabibbo angle) represent Cabibbo suppressed contributions. There are similar formulas to Eqs. (29),(30) for the antibaryon.

Recently, the NOMAD Collaboration [15] provided some data on Λ polarization in neutrino DIS. The data have much smaller errors than the data for the longitudinal spin transfer to the Λ in polarized charged lepton DIS, which allows us to have a further check of Λ fragmentation functions. For the case of neutrino DIS, we present our predictions of z-dependence for the baryon polarizations in Fig. 6 and antibaryon polarizations in Fig. 7. From Fig. 6(a), we find that our prediction of Λ polarization in neutrino DIS is compatible with the NOMAD data [15]. For the case of antineutrino DIS, we find that the polarizations of baryons and antibaryons can be approximately related to those in neutrino DIS by

$$P_{\bar{\nu}}^{B}\simeq-P_{\nu}^{\bar{B}} \tag{31}$$

for all octet baryons, and

$$P_{\bar{\nu}}^{\bar{B}}\simeq-P_{\nu}^{B} \tag{32}$$

for $B=p,\ n,\ \Sigma^+,\ \Sigma^0,\ \Lambda^0$, and Ξ^0. As for Σ^- and Ξ^-, $P_{\bar{\nu}}^{\bar{B}}$ and P_{ν}^{B} ($B=\Sigma^-,\ \Xi^-$) are very small and their relative sign depends on the magnitude of the polarized sea quark and antiquark fragmentation functions. In our present analysis, we have

$$P_{\bar{\nu}}^{\bar{B}}\simeq P_{\nu}^{B}, \tag{33}$$

for $B=\Sigma^-,\Xi^-$. In addition, the SU(3) symmetry breaking effect on the octet hyperon polarizations in neutrino DIS is not strong. However, $P_{\bar{\nu}}^{\bar{\Xi}^+}$ seems to be a useful observable to distinguish different spin structures of fragmentation functions in the large z region.

D. Spin asymmetries in $p\vec{p}$ collisions

Some programs on spin physics have been undertaken at BNL RHIC [29,38]. Theoretically, it has been pointed out that the Λ polarization in polarized proton-proton collisions is a useful tool to check the spin structure of the Λ fragmentation functions [45,46]. In very recent work [37], the spin asymmetries for the octet baryons produced in $p\vec{p}$ collisions

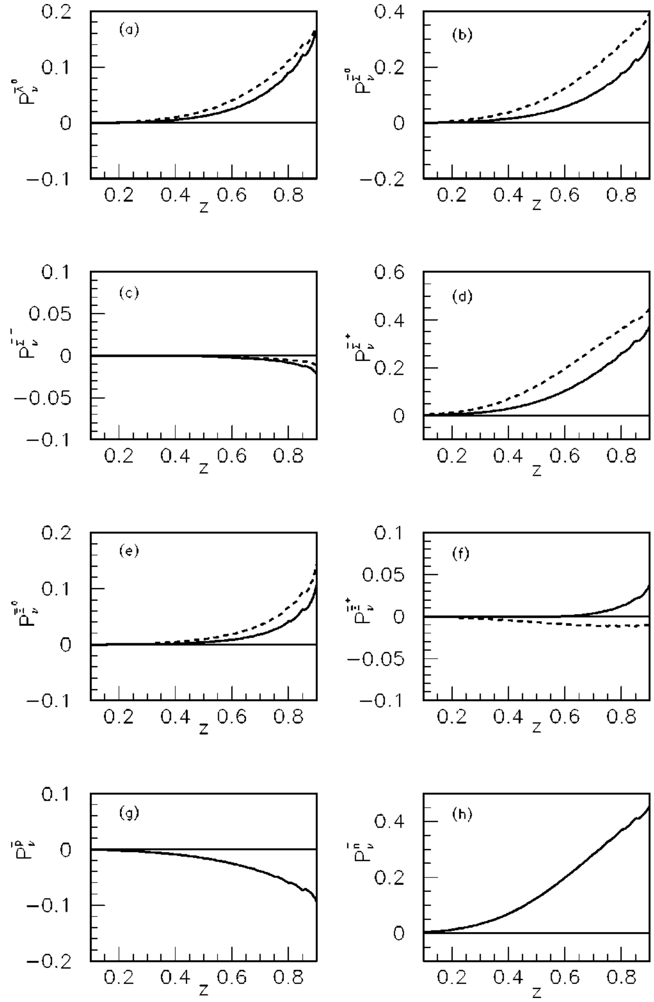

FIG. 7. The same as Fig. 6, but for the octet antibaryon polarizations in neutrino DIS.

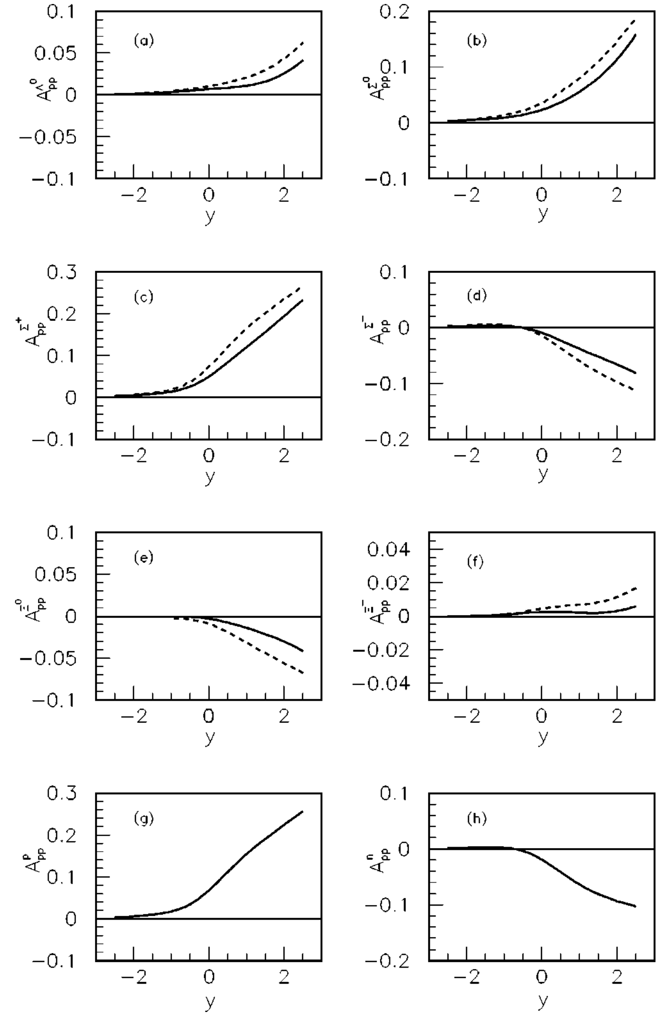

FIG. 8. The predictions of the spin asymmetries as a function of rapidity for octet baryons production in $p\vec{p}$ collisions. The dashed and solid curves are obtained with the SU(3) symmetry and SU(3) broken fragmentation functions, respectively.

were extensively studied and some very useful information was extracted. In order to express the spin asymmetries, we need the polarized differential cross section $Ed^3\Delta\sigma/d^3p$ which can be obtained from the expression of the unpolarized cross section $Ed^3\sigma/d^3p$ in Eq. (22) by replacing $f_b^{\tilde{B}}(x_b,Q^2)$, $D_c^B(z,Q^2)$, and $d\hat{\sigma}/d\hat{t}$ by the corresponding polarzied counterparts $\Delta f_b^{\tilde{B}}(x_b,Q^2)$, $\Delta D_c^B(z,Q^2)$, and $d\Delta\hat{\sigma}/d\hat{t}$, respectively. Then the spin asymmetry can be defined as the ratio

$$A_{pp}^B = \frac{\int_{p_T^{min}} Ed^3\Delta\sigma/d^3p}{\int_{p_T^{min}} Ed^3\sigma/d^3p}. \tag{34}$$

The spin asymmetries as shown in Fig. 8 are obtained by adopting the LO set of unpolarized parton distributions of Ref. [35] and polarized parton distributions of LO Glück-Reya-Stratmann-Vogelsang (GRSV) "standard" scenario [47]. In addition, the total center of mass energy $\sqrt{s}=500$ GeV is used and the transverse momentum p_T is integrated with the lower cutoff $p_T^{min}=13$ GeV/c [45,37]. From Fig. 8, one can see that the SU(3) symmetry breaking decreases somewhat the magnitude of the spin asymmetries.

VI. TRANSVERSELY POLARIZED SPIN TRANSFERS

The transverse polarizations of the octet baryons produced in the current fragmentation region of charged lepton DIS on a transversely polarized nucleon target can provide information on the quark transverse fragmentation functions for octet baryons. Actually, some progress in this direction has been made by recent investigations [41]. For baryon B production in the current fragmentation region along the virtual photon direction [48], the spin transfer to the transversely polarized baryon B can be written as [42,49]

$$\hat{A}_B(x,z) = \frac{\sum_q e_q^2 \delta q^N(x,Q^2)\,\delta D_q^B(z,Q^2)}{\sum_q e_q^2 q^N(x,Q^2) D_q^B(z,Q^2)} \tag{35}$$

for charged lepton DIS on a transversely polarized nucleon N target. In Sec. II, we have obtained the $q\to B$ fragmentation functions $D_q^B(z)$ and $\delta D_q^B(z)$. In order to calculate $\hat{A}_B(x,z)$, we need transverse quark distributions in the nucleon, which can also be described within the framework of the quark-diquark model [9,31]. We may use the following relation to connect the quark transverse distributions with the unpolarized quark distributions [9,41]:

$$\delta u_v^N(x)=\left[u_v^N(x)-\frac{1}{2}d_v^N(x)\right]\hat{M}_S^{(u)}(x)-\frac{1}{6}d_v^N(x)\hat{M}_V^{(u)}(x),$$

$$\delta d_v^N(x)=-\frac{1}{3}d_v^N(x)\hat{M}_V^{(d)}(x), \tag{36}$$

with

$$\hat{M}_D^{(q)}(x)=\frac{\hat{f}_D^{(q)}(x)}{f_D^{(q)}(x)}, \tag{37}$$

where $f_D^{(q)}(x)(D=S$ or $V)$, which is the probability of finding a quark q being scattered while the spectator is in the diquark state D, can be expressed in the quark-diquark model as [31]

$$f_D^{(q)}(x)=\frac{N^2(1-x)^3}{32\pi^2}\frac{[2(xM_p+m_q)^2+\hat{R}^2(x)]}{\hat{R}^6(x)} \tag{38}$$

for unpolarized quark distributions, and

$$\hat{f}_D^{(q)}(x)=\frac{N^2(1-x)^3}{16\pi^2}\frac{(xM_p+m_q)^2}{\hat{R}^6(x)} \tag{39}$$

for the transversely polarized quark distributions. The expression for $\hat{R}(x)$ is

$$\hat{R}(x)=\sqrt{\Lambda_0^2(1-x)+xm_D^2-x(1-x)M_p^2}, \tag{40}$$

where M_p and $m_D(D=S$ or $V)$ are the mass of the proton and a diquark, respectively. In the following numerical calculations, the CTEQ5 set 1 parametrization forms [43] are adopted as inputs for the unpolarized quark distributions of the nucleon in Eq. (36).

The x-integrated spin transfers $\hat{A}_B(x,z)$ for the octet baryons are presented in Fig. 9 where the dashed and solid curves are obtained by using the SU(3) symmetry and SU(3) broken fragmentation functions, respectively. $\hat{A}_B(x,z)$ with integrated x can provide us information on the $q\to B$ fragmentation functions. We can find some similar properties in the longitudinal and transverse spin transfers by making a comparison between the results in Figs. 9 and 5. However, the differences in results for the Σ^- and neutron [cf. panels (d) and (h) in Figs. 9 and 5] stand since the d quark fragmentation functions are dominant for these two baryons and the d quark in the proton target is negatively polarized. In addition,

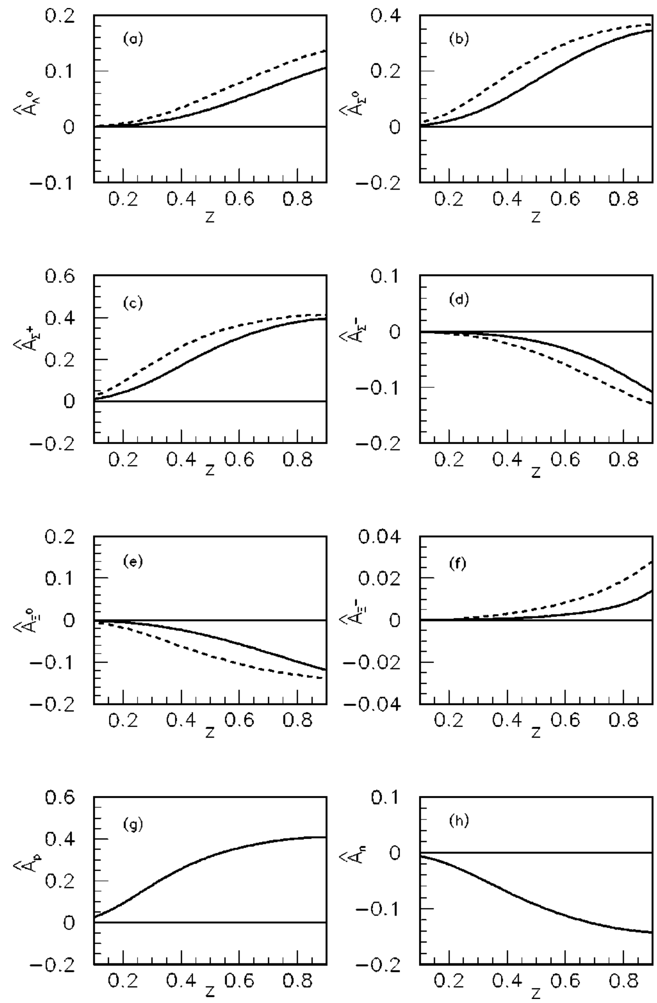

FIG. 9. The x-integrated spin transfers $\hat{A}_B(x,z)$ of baryon B production in charged lepton DIS on a transversely polarized proton target, with x integrated over the range of $0.3\to 1$. The dashed and solid curves are obtained with the SU(3) symmetry and SU(3) broken fragmentation functions, respectively.

some similar behaviors can be found in the z dependence of transverse spin transfers and the y dependence of spin asymmetries in $p\vec{p}$ collisions.

VII. DISCUSSION AND SUMMARY

Experimental setups are usually not able to distinguish between prompt Λ particles and Λ particles coming from the decay of Σ or Ξ baryons. The main contributions from decays are $\Sigma^0\to\Lambda\gamma$ and $\Sigma^*\to\Lambda\pi$ [50]. The parametrization of theoretical fragmentation functions by using the experimental data can in fact generate some effective mixing between the corresponding fragmentation functions. The decay contribution to the Λ production can be effectively included in the unpolarized parton fragmentation functions by a fit to the experimental data. Here, we would like to briefly comment on some possible effects of the decay contributions on the spin observables. For spin transfer in Λ electroproduction where the u quark dominates due to the charge factor for the u quark, we have noticed that $u^{\uparrow}(ds)_{0,0}\to\Lambda$, $u^{\uparrow}(ds)_{0,0}$

$\rightarrow\Sigma^0$, and $u^\uparrow(ds)_{1,0}\rightarrow\Sigma^*$ predicted by the diquark model have similar z dependence. So it is expected that the spin transfer in charged lepton DIS with the effect of the Σ^0 and Σ^* decays can be equivalently expressed by the direct hadronized Λ spin transfer multiplied by a factor. Hence, the qualitative feature of the predicted spin transfer is also expected to be retained after the heavier hyperon decay contributions are also included. The contribution of the Ξ decay might dilute somewhat the spin transfer since the u quark fragmentation function for the Ξ^0 is negatively polarized. If the spin observables are dominated by the s quark, e.g., the Λ polarization in e^+e^- annihilation, the modification due to the Ξ decay should be small because the s quark spin structure of the Ξ is very similar to that of the Λ in the diquark model.

For every octet baryon, there are 18 unpolarized, longitudinally polarized, and transversely polarized quark-antiquark fragmentation functions. In our present analysis, based on the diquark model, we used only seven free parameters to provide unpolarized, longitudinally polarized and transversely polarized fragmentation functions for all octet baryons. The strangeness suppression factors lead to an enormous simplification in our analysis and play an important role in our understanding of the experimental data for unpolarized hyperon production in e^+e^- annihilation. Although we are not able to explain the overall strangeness suppression factors for hyperon production, the experimental data on the cross sections can be well described in our analysis. Further studies are needed in order to have a deeper insight into the mechanism of strangeness suppression. In addition, although the octet baryon fragmentation functions were determined from the $e^+e^-\rightarrow BX$ process, they can be used to predict inclusive single baryon cross sections in other processes, like pp, $p\bar{p}$, ep, νp, and γp scattering. As an example, we predict cross sections for octet baryon production in pp collisions with the purpose of checking the strangeness suppression. Similarly, the strangeness suppression effect is also expected to exist in the hyperon production of other processes.

To summarize, based on the experimental data on unpolarized octet baryon production in e^+e^- annihilation, we extracted a set of fragmentation functions for the octet baryons with the diquark model. The spin observable predictions with the obtained fragmentation functions for the Λ are compatible with the available experimental data for Λ production. We investigated some observables that are related to the strangeness suppression, the flavor and spin structure of the obtained fragmentation functions. We found the following points: (1) The strangeness suppression effect in the octet baryon fragmentation functions is significant and the cross sections for the octet baryon production in pp collisions may be used to make a cross check of the effect; (2) a measurement of the hyperon-antihyperon asymmetries in k^+p collisions can resolve the flavor structure of the hyperon fragmentation functions; (3) the spin transfers to the octet baryons in charged lepton DIS are very different from those to the octet antibaryons; (4) the SU(3) symmetry breaking effect on the flavor and spin structure of fragmentation functions can affect the relative observables somewhat. We expect that all these points together with our predictions for several observables may be useful in improving the knowledge of hadronization mechanism and baryon structure.

ACKNOWLEDGMENTS

I am grateful to P. J. Mulders and J. Rodrigues for their kind correspondence about the quark-diquark model. I also would like to express my great thanks to I. Schmidt and J. Soffer for their constructive suggestions and valuable comments on strangeness suppression. In addition, this work was partially supported by National Natural Science Foundation of China under Grants Numbers 19875024 and 10175074, and Fondecyt (Chile) Projects 8000017 and 3990048, and also by the Foundation for University Key Teacher of the Ministry of Education (China).

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