Final State Interaction in $B \rightarrow K\pi$ Decays

Hongying Jin *

Institute of High Energy Physics, Academia Sinica, P.O.Box 918(4), Beijing 100039, China†

Abstract

We discuss the rescattering effects in decays $B \rightarrow \pi + K$. The picture we take is very simple: first, B decay into $K^* \rho$, then $K^*$ and $\rho$ go to kaon and pion by exchanging a pion. We find a up to ten percent CP violation asymmetry rate. We also discuss its correction to the constraint of angle $\gamma$ proposed recently.

PACS numbers 13.25.Hw 12.28.Lg

*Email: jhy@hptc5.ihep.ac.cn,
†Mailing address
Introduction

B meson’s weak decay plays an important role in Standard Model. It provides a tool to testing unitarity of CKM matrix and the possibility of the first CP violation evidence out of the kaon system. However, the relation between the experimental observables and theoretical parameters sometimes is not clear, for instance, in the $B$ rare decay, the tree level amplitudes and one loop penguin amplitudes both give competing contributions, this situation makes it difficult to extract the angle $\gamma (arg[-\frac{V_{ud}V_{us}^*}{V_{cd}V_{cs}^*}])$ of the unitary triangle from $B$ decays.

Recently CLEO collaboration has presented the branching ratios\(^1\)

\[
\frac{1}{2}[Br(B^0 \to \pi^-K^+) + Br(\bar{B}^0 \to \pi^+K^-)] = (1.5^{+0.5}_{-0.4} \pm 0.1 \pm 0.1) \times 10^{-5} \tag{1}
\]

\[
\frac{1}{2}[Br(B^- \to \pi^-K^0) + Br(B^+ \to \pi^+K^0)] = (2.3^{+0.1}_{-1.0} \pm 0.3 \pm 0.2) \times 10^{-5}. \tag{2}
\]

It attracted much interest. On the one hand, (2) may provide a constraint of the angle $\gamma$. As pointed by Fleischer and Mannel\(^2\), using the branching ratios of these four $B \to \pi K$ decay modes, it is possible to derive a bound on the angle $\gamma$ of the unitarity triangle which, under certain circumstance, is free of hadronic uncertainties. On the other hand, it is believed that the direct CP violation asymmetry is small in $B^\pm \to K\pi^\pm$, so (4) can be used to search new physics. However, these two arguments are based on perturbative QCD, the long distance strong interaction such as final state interaction may not be negligible. As discussed in \(^3\), after taking account of $K\pi \to K\pi$ rescattering, the recent observes (2) do not lead to a significant bound on the angle $\gamma$; Besides, authors claim that a sizable CP violation asymmetry rate is possible in $B^\pm \to \pi^\pm K$. More rescattering channels such as $\eta K, K^*\pi \to \pi K$ have been discussed in \(^4\) \(^5\) \(^6\), the authors also found a $10-20\%$ correction to the up bound of $\gamma$ and $O(10\%)$ CP violation asymmetry rate.

The final state interaction in $B \to K\pi$ can be through many channels, for instance, the rescattering channels $B \to VV \to K\pi$ have not been discussed yet. In this paper, we will discuss the channel $B \to \rho K^* \to K\pi$, the reason is that the branching ratio of $B \to \rho K^*$ may be larger than $B \to K\pi$, rescattering effect may not be small. Besides, in the rescattering
process, $B^- \rightarrow \rho^0 K^{*-} \rightarrow \pi^- K^0$ the tree amplitude’s contribution is non-zero, which can provide a correction to the constraint of angle $\gamma$ and the direct CP asymmetry in the charge $B$ decay $B \rightarrow K^0 \pi$.

The final state interaction is a long distance strong interaction, how to dual with it in theory is not clear so far. A common method is Regge pole model, which was used in \[5, 6\]. In our case, this model is not valid. However, we can use a rather similar estimate which has been used in \[7\]. The picture is, first $B$ decays into $K^* \rho$, then $K^*$ and $\rho$ go to $\pi K$ by exchanging a pion instead of a vector meson such as $K^*$ and $\rho$, the coupling of $\rho \pi \pi$ and $K^* K \pi$ can be determined by the decay $\rho \rightarrow 2\pi$ and $K^* \rightarrow K \pi$. In order to give a numerical result, BSW model is used to calculate the form factor of $B \rightarrow K^* \rho$ and $B \rightarrow K \pi$.

**Effects of Final state interaction**

In general, the amplitudes of the relevant $B \rightarrow K \pi$ decays may be represented as \[4\]

$$A(\bar{B}^0 \rightarrow \pi^- K^+) = A_P^0 - A_T^0 e^{-i\gamma}$$

$$A(B^0 \rightarrow \pi^+ K^-) = A_P^0 - A_T^0 e^{i\gamma}$$

$$A(B^- \rightarrow \pi^- \bar{K}^0) = A_P^- - A_T^- e^{-i\gamma}$$

$$A(B^+ \rightarrow \pi^+ K^0) = A_P^+ - A_T^+ e^{i\gamma}$$

where $A_P$ and $A_T$ are penguin and tree amplitudes respectively. QCD penguin keeps $SU(2)$ isospin symmetry, compared with it, the electroweak penguin contribution is small. We can roughly think $A_P^0 = A_P^0 = A_P^- = A_P^+ = A_P$; In the Standard Model, CP violation rises from CKM matrix, therefore $A_T^0 = A_T^0$, $A_T^- = A_T^+$, $\delta_- = \delta_+$. Defining $A_T^0/A_P = re^{i\delta}$, $A_T^-/A_P = \epsilon e^{i\delta_-}$ one may get the rate

$$R = \frac{\Gamma(B^0 \rightarrow \pi^- K^+) + \Gamma(\bar{B}^0 \rightarrow \pi^+ K^-)}{\Gamma(B^0 \rightarrow \pi^- K^0) + \Gamma(B^+ \rightarrow \pi^+ K^0)} = \frac{1 - 2r \cos \gamma \cos \delta_0 + r^2}{1 - 2 \epsilon \cos \gamma \cos \delta_- + \epsilon^2}$$

and direct CP asymmetry $A_{CP}^{dir} \equiv A_{CP}^{dir}(B^- \rightarrow \pi^- \bar{B}^0)$ \[4\]

$$A_{CP}^{dir} = \frac{BR(B^+ \rightarrow \pi^+ K^0) - BR(B^- \rightarrow \pi^- \bar{K}^0)}{BR(B^+ \rightarrow \pi^+ K^0) + BR(B^- \rightarrow \pi^- \bar{K}^0)} = \frac{2 \epsilon \sin \gamma \sin \delta_-}{1 - 2 \epsilon \cos \gamma \cos \delta_- + \epsilon^2}$$

\[9\]
If rescattering effects are not taken into account, tree amplitudes have no contribution to charge $B$ decay, i.e. $A_F = 0$. Then one can minimizes $R$ with respect to the parameter $r$ and obtain an inequality $sin^2\gamma \leq R$; Moreover, the direct CP asymmetry rate can be negligible.

The rescattering process involves an intermediate on-shell $X$, such that $B \to X \to K\pi$. In this paper, we choose $X$ as $\rho K^*$. We denote direct amplitude of $B \to \pi K$ and rescattering amplitude of $B \to \rho K^* \to \pi K$ as $A_{dir}$ and $A_{res}$ respectively. Similarly to (8), $A_{dir}$ and $A_{res}$ can be written as

$$A^0_{dir} = A^0_F - A^0_T e^{-i\gamma},$$
$$A^{\bar{r}}_{dir} = A^\bar{T},$$
$$A^0_{res} = A^0_F - A^0_T e^{-i\gamma},$$
$$A^{\bar{r}}_{res} = A^\bar{T} - A^\bar{T} e^{-i\gamma}.\quad (10)$$

Correspondingly, the parameters $r = \left| \frac{A^0_T + A^0_F}{A^0_T + A^0_F} \right|, \epsilon = \left| \frac{A^{\bar{r}}_T}{A^\bar{T} + A^\bar{T}} \right|$ and $\delta_\epsilon = \arccos \left[ \frac{A^{\bar{r}}_T}{A^\bar{T} + A^\bar{T}} \right]$. The numerical values of $\Delta = 1$ Hamiltonian, which takes the form

$$H_{eff} = \frac{G_F}{\sqrt{2}} [V_{ub}V^*_{us}(c_1O_1^u + c_2O_2^u) + V_{cb}V^*_{cs}(c_1O_1^c + c_2O_2^c) - V_{tb}V^*_{ts} \sum_{i=3}^{10} c_iO_i] + h.c.,\quad (11)$$

where

$$O_1^u = (\bar{s}b)_{V-A}(\bar{u}u)_{V-A}, \quad O_2^u = (\bar{u}b)_{V-A}(\bar{s}u)_{V-A},$$
$$O_3(5) = (\bar{s}b)_{V-A} \sum_{q'} (\bar{q}' q')_{V-A(V+A)}, \quad O_4(6) = (\bar{s}_\alpha b_\beta)_{V-A} \sum_{q'} (\bar{q}'_\alpha q'_\beta)_{V-A(V+A)},$$
$$O_7(9) = \frac{3}{2} (\bar{s}b)_{V-A} \sum_{q'} e_{q'} (\bar{q}' q')_{V+A(V-A)}, \quad O_8(10) = \frac{3}{2} (\bar{s}_\alpha b_\beta)_{V-A} \sum_{q'} e_{q'} (\bar{q}'_\alpha q'_\beta)_{V+A(V-A)},\quad (12)$$

with $O_1 - O_2$ being current current operators, $O_3 - O_6$ being the QCD penguin operators and $O_7 - O_{10}$ the electroweak penguin operators. To the next-to-leading order, the Wilson coefficients $c_i(\mu)$ depends on the renormalization scheme chosen, it is convenient to use the effective Wilson coefficients $c_i^{eff}$ instead, which is independent of the renormalization scheme and defined by $[8]$

$$c_i^{eff} = [1 + \frac{\alpha_s(\mu)}{4\pi} m_s^T(\mu) + \frac{\alpha(\mu)}{4\pi} m_e^T(\mu)]_{ij} c_j(\mu)\quad (13)$$

The numerical values of $c_i^{eff}$ have been given in $[8]$ in the ’t Hooft Veltman (HV) scheme and
naive dimension regularization scheme at $\mu = m_b(m_b), \Lambda_{MS} = 225 Mev$ and $m_t = 170 Mev$:

$$
c^e_{1} = \frac{1.149}{N_c}, \quad c^e_{2} = \frac{-0.325}{N_c},
$$

$$
c^e_{3} = \frac{0.0211 + i 0.0045}{N_c}, \quad c^e_{4} = \frac{-0.0450 - i 0.0136}{N_c},
$$

$$
c^e_{5} = \frac{0.0134 + i 0.0045}{N_c}, \quad c^e_{6} = \frac{-0.0560 - i 0.0136}{N_c},
$$

$$
c^e_{7} = \frac{-0.0276 + i 0.0369}{N_c}, \quad c^e_{8} = \frac{0.054}{N_c},
$$

$$
c^e_{9} = \frac{-1.318 + i 0.0369}{N_c}, \quad c^e_{10} = \frac{0.263}{N_c},
$$

(14)

Then, the factorization approximation can be applied to the hadronic matrix elements of the operator $O_i$ at the tree level. The direct decay amplitudes of $B \to K\pi$ and $B \to K^*\rho$ in factorization approximation can be written as

$$
A_{dir}(\bar{B}^0 \to \pi^+ K^-) = \frac{G_F}{\sqrt{2}} \left( V_{ub}V_{us}a_1 + V_{cb}V_{cs}[a_3 + \frac{3}{2} e_u a_9 - \frac{2m_K^2}{m_{s} + m_{u}}(2a_5 + 3e_u a_7)] \right) M^2_{K^-\pi^+}
$$

$$
A_{dir}(B^- \to \pi^- \bar{K}^0) = \frac{G_F}{\sqrt{2}} \left( V_{ub}V_{us}^*[a_3 + \frac{3}{2} e_u a_9 - \frac{2m_K^2}{m_{s} + m_{u}}(2a_5 + 3e_u a_7)] \right) M^4_{K^0\pi^-}
$$

$$
A_{dir}(\bar{B}^0 \to K^{*+} \rho^-) = \frac{G_F}{\sqrt{2}} \left( V_{ub}V_{us}^*[a_2 M^1_{K^*\rho^0} + V_{cb}V_{cs}^*[a_3 + \frac{3}{2} e_u a_9]} \right) M^2_{K^{*+}\rho^-}
$$

$$
A_{dir}(\bar{B}^0 \to \bar{K}^{*0} \rho^0) = \frac{G_F}{\sqrt{2}} \left( V_{ub}V_{us}[a_2 M^1_{K^*\rho^0} + V_{cb}V_{cs}^*[a_3 + \frac{3}{2} e_u a_9]} \right) M^4_{K^{*0}\rho^0}
$$

$$
A_{dir}(B^- \to K^{*-} \rho^-) = \frac{G_F}{\sqrt{2}} \left( V_{ub}V_{us}[a_2 M^1_{K^*\rho^0} + a_2 M^1_{K^{*+}\rho^-}] + V_{cb}V_{cs}^*[a_3 + \frac{3}{2} e_u a_9]} \right) M^2_{K^{*-}\rho^-}
$$

$$
A_{dir}(B^- \to K^{*0} \rho^-) = \frac{G_F}{\sqrt{2}} \left( V_{cb}V_{cs}^*[a_3 + \frac{3}{2} e_u a_9]} \right) M^4_{K^{*0}\rho^-}
$$

(15)

where $a_i$ are defined as

$$
a_{2i-1} = \frac{e^e_{2i-1}}{N_c}, \quad a_{2i} = \frac{e^e_{2i}}{N_c},
$$

(16)

and $M^i_{ab}$ are the matrix elements of the operators $O_i$ inserted in the states of $ab(K\pi$ pseudo-scalar,vector mesons) and $B$. Obviously, the rate of electroweak penguin to QCD penguin is only $A_{p EW}^{QCD}/A_{p QCD}^{EW} \sim a_9/a_3 \sim 1/30$, so we omit $A_{p EW}^{EW}$.

Using vacuum-saturation approximation, we can write, for instance, $M_1$ and $M_3$ as

$$
M^2_{K^-\pi^+} = -i \langle K^-|\bar{s}u|0\rangle_{V-A}(\pi^+|\bar{u}b|\bar{B}^0)_{V-A} = f_K(m_B^2 - m_{\pi}^2) F_0(m_K^2)
$$

$$
M^2_{K^*\rho^-} = -i \langle K^{*-}|(c^*)|\bar{s}u|0\rangle_{V-A}(\rho^+|\bar{u}b|\bar{B}^0)_{V-A}
$$

$$
= -f_{K^*}\langle c^* | \mu \bar{\mu}^{\mu\alpha\beta} \eta_{\mu\nu} p_i^B \bar{p_j}^\rho V(m_{K^*}) \rangle
$$

$$
+ [\eta_{\mu}(m_B + m_{\rho}) A_1(m_{K^*}) - \frac{\eta \cdot p_{K^*}}{m_B + m_{\rho}} (p_B + p^\rho) \mu A_2(m_{K^*})]
$$

(17)
In (17), we use the definitions\[\]
\[
\langle X|j_\mu|B\rangle_{V-A} = (P^\mu + P^X - \frac{m_B^2 - m_X^2}{q^2} q_\mu) F_1(q^2) + \frac{m_B^2 - m_X^2}{q^2} q_\mu F_0(q^2),
\]
\[
\langle X^*(\eta)|j_\mu|B\rangle_{V-A} = \frac{2}{m_B + m_X} i \epsilon^{\mu\nu\alpha\beta} \eta_\mu p_\alpha p_{\beta}^{X*} V(q^2) + [\eta_\mu (m_B + m_{X*}) A_1(q^2) - \frac{\eta \cdot q}{m_B + m_{X*}} (p_B + p_{X*})_\mu A_2(q^2) - \frac{\eta \cdot q}{q^2} 2 m_X q_\mu A_3(q^2)] + \frac{\eta \cdot q}{q^2} 2 m_X q_\mu A_0(q^2),
\]
with \(q = p_B - p_{X*}(p_{X*})\), where \(X(X^*)\) is an arbitrary pseudo-scalar (vector) meson. The numerical values of the form factors in (18) are estimated by using WBS model.

Now let's discuss the amplitudes of \(K^*\rho \rightarrow K\pi\). This soft process can be described by the low energy effective Lagrangian. As showed in fig. 1, \(K^*\rho\) can go to \(K\pi\) by exchanging one pion. Only keeping the lowest dimension operators, we can write the interaction of \(K^*K\pi\)
and \(\rho\pi\pi\) in term of \(SU(2)\) isospin symmetry as

\[
L_{K^*K\pi} = i g_{K^*K\pi} K^\mu \{\partial^\mu K - \partial^\mu \pi K\} + h.c.,
\]
\[
L_{\rho\pi\pi} = g_{\rho\pi\pi} \epsilon_{ijk} \rho^i \partial_j \pi^j \pi^k,
\]
with

\[
\pi = \begin{pmatrix} \pi^0 & \pi^+ \\ \pi^- & -\frac{\pi^0}{\sqrt{2}} \end{pmatrix}, \quad K = \begin{pmatrix} K^+ \\ K^0 \end{pmatrix}, \quad K^\mu = \begin{pmatrix} K^*+ \\ K^{*0} \end{pmatrix}_\mu
\]

\[
\pi^\pm (\rho^+) = \frac{1}{\sqrt{2}} [\pi^1 (\rho^1) \pm i \pi^2 (\rho^2)], \quad \pi^0 (\rho^0) = \pi^3 (\rho^3)
\]

Using the interaction (19), we obtain the amplitudes of \(K^*\rho \rightarrow K\pi\)

\[
\langle K^0\pi^-|K^*(e^-)\rho^0(\eta)\rangle = g_{K^*K\pi} g_{\rho\pi\pi} \eta \cdot (p_{\pi^-} - q) e^* \cdot (p_{K^0} + q) \frac{i}{q^2}
\]
\[
\langle K^0\pi^-|K^0(e^+)\rho^-(\eta)\rangle = \frac{1}{\sqrt{2}} g_{K^*K\pi} g_{\rho\pi\pi} \eta \cdot (p_{\pi^-} - q) e^* \cdot (p_{K^0} + q) \frac{i}{q^2}
\]
\[
\langle K^-\pi^+|K^*(e^-)\rho^+(\eta)\rangle = \frac{1}{\sqrt{2}} g_{K^*K\pi} g_{\rho\pi\pi} \eta \cdot (p_{\pi^+} + q) e^* \cdot (p_{K^-} + q) \frac{i}{q^2}
\]
\[
\langle K^-\pi^+|K^0(e^+)\rho^0(\eta)\rangle = -g_{K^*K\pi} g_{\rho\pi\pi} \eta \cdot (p_{\pi^+} + q) e^* \cdot (p_{K^-} + q) \frac{i}{q^2}
\]

where \(q = p_{K^*} - p_K\) is the momentum of the exchanged pion.

Finally, the rescattering amplitude of \(B \rightarrow K^*\rho \rightarrow K\pi\) are written as

\[
A_{res}^- = \frac{1}{2} \sum_{K^*\rho} \int \frac{d^3 p^\rho}{(2\pi)^3 2E^\rho} \frac{d^3 p^{K^*}}{(2\pi)^3 2E^{K^*}} \langle K^0\pi^-|K^*\rho\rangle \langle K^*\rho|B^-\rangle,
\]

(22)
where $\sum K^*\rho$ sums all possible intermediate states $K^*\rho$

The numerical calculation is carried out with the parameters and form factors \[9\]

$$
m_b = 4.7\text{GeV} \quad , \quad m_s = 0.15\text{GeV} \quad , \quad m_{u,d} = 0.01\text{GeV},$$
$$f_{K^*} = 0.2\text{GeV}^2 \quad , \quad f_\rho = 0.2\text{GeV}^2 \quad , \quad N_c = 3$$
$$F_0(q^2) = \frac{0.39}{1-q^2/m_B^2} \quad , \quad A_1(q^2) = \frac{0.36}{1-q^2/m_B^2} \quad , \quad A_2(q^2) = \frac{0.36}{1-q^2/m_B^2}$$

The values of coupling constants $g_{K^*K\pi}$ and $g_{\rho\pi\pi}$ in \[19\] can be determined by the decay widths of $K^* \to K\pi$ and $\rho \to \pi\pi$ respectively,

$$\Gamma(K^* \to K\pi) = \frac{3g_{K^*K\pi}^2}{2} \left[ m_{K^*}^2 - (m_K + m_\pi)^2 \right]^{\frac{3}{2}} \left[ m_{K^*}^2 - (m_K - m_\pi)^2 \right]^{\frac{3}{2}} \frac{48\pi m_{K^*}^3}{m_{K^*}^3} = 50\text{MeV}$$
$$\Gamma(\rho \to K\pi) = g_{\rho\pi\pi}^2 \left[ m_\rho^2 - 4m_{\pi}^2 \right]^{\frac{3}{2}} \frac{48\pi m_\rho^3}{m_\rho^3} = 150\text{MeV}$$

However, \[24\] cannot determine their sign; This is not sensitive in our discussion here, we just choose positive sign, it may be important when one wants to sum all rescattering effects.

The momentum integral of $K^*\rho$ in \[23\] cannot be performed in the total phase space. When $K^*$ and $K$ go back to back, the momentum of the exchanged pion is very large, $|p_{ex}| = 5\text{GeV}$. On the other hand, final state interaction is a long distance process, we describe it by using the low energy effective lagrangian \[19\] which is not valid at very high energy. So we need a cut-off $p_c$ to distinguish soft and hard regions. We choose $p_c = 2\text{GeV}$, since in a short distance process, $K^*$ and $\rho$ should exchange at least two gluons, then they can go to $K$ and $\pi$, the typical momentum of each gluon is $\sim 1\text{GeV}$. We do the integration in the region $|p_{ex}| < p_c$, when $|p_{ex}| > p_c$, $K^*$ and $\rho$ should exchange hard gluons instead, this short distance process should be strongly suppressed\[?\], however it is beyond our discussion.

The numerical results are showed in the table 1.

**Table 1.** Amplitudes of decays $B \to K\pi$

| \hspace{1cm} | tree $(V_{ub}V_{us}^*)$ | penguin $(V_{cb}V_{cs}^*)$ |
|-----------------|-----------------|-----------------|
| $A_{dir}(\bar{B}^0 \to K^-\pi^+)$ | $-1.5 \times 10^{-5}$ | $(10.1 + i2.8) \times 10^{-7}$ |
| $A_{dir}(B^- \to \bar{K}^0\pi^-)$ | 0 | $(10.1 + i2.8) \times 10^{-7}$ |
| $A_{res}(\bar{B}^0 \to K^-\pi^+)$ | $i3.3 \times 10^{-6}$ | $(0.73 - i2.3) \times 10^{-5}$ |
| $A_{dir}(B^- \to \bar{K}^0\pi^-)$ | $i3.5 \times 10^{-6}$ | $(0.73 - i2.3) \times 10^{-5}$ |
Form table.1, we obtain a large strong phase $\delta_- \sim \frac{\pi}{2}$, because compared to direct amplitudes, rescattering amplitudes almost have a $\frac{\pi}{2}$ phase transition. If we take $|\frac{V_{cb}V_{cs}^*}{V_{cb}V_{cs}^*}| \sim 0.02$ [4], $\epsilon \approx 0.06$. Substitute these values into (9) and keep in mind that $\gamma$ may be larger than $\pi/3$, we conclude there is a 10% CP violation asymmetry rate, which is comparable with [5, 6]. In our case, there is almost no correction to (9), the up bound of $\gamma$ is not changed.

In conclusions, we discuss the final state interaction in decays $B \rightarrow K\pi$ via rescattering channel $K^*\rho \rightarrow K\pi$. By using BCW model and low energy effective lagrangian, we estimate that this channel gives a 10% CP violation asymmetry rate, which is comparable with other rescattering channels.

Acknowledgement

The author thanks Dr.Z.T.Wei and Dr. M.Z. Yang for useful discussions. He also thanks Dr. Frank Krueger for his pointing out a misprint. This work is supported in part by the National Natural Science Foundation.
References

[1] R. Godang et al., CLEO 97-27, CLNS 97/1522, hep-ex/9711010.

[2] R. Fleischer and T. Mannel, hep-ph/9704423.

[3] J.-M. Gérard, J. Wegers, hep-ph/9711469.

[4] Robert Fleischer, hep-ph/9804319.

[5] A.F. Falk, A.L. Kagan, Y. Nir and A.A. Petrov, hep-ph/9712225.

[6] D. Atwood and A. Soni, hep-ph/9712287.

[7] Xue-Qian Li and Bing-Song Zou, Phys. Lett. B399 297 (1997);

[8] H.Y. Cheng and B. Tseng, hep-th/9803457.

[9] M. Bauer, B. Stech and M. Wirbel, Z Phys. C34 103 (1987);

[10] J.-M. Gérard and W. S. Hou, Phys. Lett. B253 478 (1991);

[11] H. Simma and D. Wyler, Phys. Lett. B272 395 (1991);

[12] R. Fleischer, Z. Phys. C58 483 (1993), C62 81 (1994).
Fig. 1