Corrections to the $Zb\bar{b}$ and $Z\tau\bar{\tau}$ vertices in a realistic one-family technicolor model

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By means of the effective Lagrangian approach we calculate the vertex corrections to the $Zb\bar{b}$ and $Z\tau\bar{\tau}$ vertices from sideways extended technicolor (ETC) boson exchange and diagonal ETC boson exchange in a realistic one-family technicolor (TC) model without exact custodial symmetry. We find that the Z partial width $\Gamma_b = \Gamma(Z \to b\bar{b})$, branching ratio R_b, and τ asymmetry parameter A_τ increase, all in agreement with present experimental data.

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I. INTRODUCTION

Technicolor (TC) models [1] can give contributions to electroweak observables. Precision measurements of electroweak observables give strong constraints on TC models. The general approach to confronting TC models with precision measurements is based on the parametrization of vacuum polarizations and vertex corrections. This is based on the observation that there are three independent oblique parameters, named either S, T, U [2], or $\varepsilon_{1,2,3}$ [3], to be constrained by precision electroweak measurements at a scale $Q = M_Z$. This observation has been extended to include corrections to the $Zb\bar{b}$ [4,5] and $Z\tau\bar{\tau}$ vertices [6].

It has been shown [2] that one-family TC models with exact custodial symmetry seem to be already excluded by studying the electroweak radiative corrections parameter S. However, according to Ref. [7], this is not the case for TC models without exact custodial symmetry. A realistic model is proposed for a one-family TC model in Ref. [7]. This model has assumed that isospin is a good approximate symmetry only for techniquarks, but is broken for technileptons. Isospin splitting contributes to the parameter S in negative sign, without making a large contribution to the parameter T. Recently, it was shown that its extended technicolor (ETC) model [8] can explain the puzzling feature of the quark-lepton mass spectrum.

The "high-energy" TC contributions to the $Zb\bar{b}$ vertex from "integrating out" technifermions have been given [4,5]. These contributions decrease the $Zb\bar{b}$ branching ratio R_b and are large, even in walking technicolor models [9]. There are also "low-energy" contributions to the $Zb\bar{b}$ vertex coming from pseudo Goldstone bosons (PGB's). For a one-family TC model with exact custodial symmetry, the effects have been found to decrease R_b by a few percent [10]. The current data [11] from the CERN e^+e^- collider LEP are likely to exclude TC models if the top quark mass is 100 GeV or greater. However, noncommuting ETC models [12] have been proposed to give a position correction to the ratio R_b. More recently it was found [13] that an extra gauge boson existing in certain types of dynamical electroweak symmetry-breaking models can give positive corrections to R_b and the τ asymmetry parameter A_τ.

In this paper we reconsider and calculate nonoblique corrections to the $Zb\bar{b}$ and $Z\tau\bar{\tau}$ vertices from ETC dynamics in a one-family TC model without exact custodial symmetry. We find that sideways ETC boson exchange decreases the width $\Gamma_b = \Gamma(Z \to b\bar{b})$ and $R_b = \Gamma_b/\Gamma_h$, while diagonal ETC boson exchange increases Γ_b and R_b, which is contrary to the result in Ref. [5]. In the model [7], one of the isospin-breaking effects appears in the difference between the decay constant of the technipion in each sector (techniquark sector, technilepton sector). The decay constant of the technipion in the technilepton sector is smaller than the decay constant in the techniquark sector. So corrections to the $Z\tau\bar{\tau}$ vertex are much smaller than corrections to the $Zb\bar{b}$ vertex. However, we find that the correction to the τ asymmetry parameter A_τ is positive and in agreement with present experimental data.

In the next section we discuss the masses of the quark and lepton in a realistic one-family TC model. In Sec. III we estimate the corrections to the $Zb\bar{b}$ vertex from ETC boson exchange. In Sec. IV we estimate the correction to the τ asymmetry parameter A_τ from ETC boson exchange. We present our conclusions in Sec. V.

II. MASSES OF QUARKS AND LEPTONS

In the model, the approximate global chiral symmetry of one-family technifermions is $G = \mathrm{SU}(6)_L \times \mathrm{SU}(6)_R \times \mathrm{U}(1)_{2R} \times \mathrm{U}(1)_{8L} \times \mathrm{U}(1)_{8R} \times \mathrm{U}(1)_V$. The mass spectrum of technifermions is [7]

$$M_U \approx M_D, \quad M_N < M_E < M_U .$$

These technifermions can be assigned to the following representations of $\mathrm{SU}(3)_C \times \mathrm{SU}(2) \times \mathrm{U}(1)_Y \times \mathrm{SU}(N_{\mathrm{TC}})$:

$$Q_L = (U, D)_L = \left(3, 2, \frac{Y_{Lq}}{2}, N_{\mathrm{TC}}\right) ,$$

$$U_R = \left(3, 1, \frac{Y_{Lq}}{2} + \frac{1}{2}, N_{\rm TC}\right) ,$$

$$D_R = \left(3, 1, \frac{Y_{Lq}}{2} - \frac{1}{2}, N_{\rm TC}\right) ,$$

$$L_L = (N, E)_L = \left(1, 2, \frac{Y_{Ll}}{2}, N_{\rm TC}\right) ,$$

$$E_R = \left(1, 1, \frac{Y_{Ll}}{2} - \frac{1}{2}, N_{\rm TC}\right) ,$$

$$N_R = \left(1, 1, \frac{Y_{Ll}}{2} + \frac{1}{2}, N_{\rm TC}\right) ,$$

where Y_{Lq} (Y_{Ll}) is the hypercharge of the left-handed techniquark (technilepton) and $Y_{Lq} = \frac{1}{3}$, $Y_{Ll} = -1$.

The Lagrangian which describes the sideways ETC gauge interaction of a realistic one-family TC model between the third family fermion and technifermion is [6]

$$\begin{aligned} L = g_E(&\xi_t \overline{Q_L} W_E^\nu \gamma_\nu q_L + \xi_{\rm Rt} \overline{U_R} W_E^\nu \gamma_\nu t_R \\ &+ \xi_b \overline{D_R} W_E^\nu \gamma_\nu b_R + \text{H.c.} + \xi_\tau \overline{L_L} W_E^\nu \gamma_\nu l_L \\ &+ \xi_\nu \overline{N_R} W_E^\nu \gamma_\nu \nu_R + \xi_{R\tau} \overline{E_R} W_E^\nu \gamma_\nu \tau_R + \text{H.c.}) , \end{aligned} \quad (1)$$

where $q_L = (t, b)_L$, t_R and b_R represent the third family of quarks, and $l_L = (\nu, \tau)_L$, ν_R, and τ_R represent the third family of leptons. A summation over the color index is implied. Ordinary fermions couple to the technifermions via sideways ETC interactions with the coupling constants g_E, and ξ_i is the coefficient of the left- or the right-handed coupling [6]. W_E is a sideways ETC boson which mediates between the third family of ordinary fermions and technifermions.

Using the rules of naive dimensional analysis [14], the ordinary fermion mass can be written as $m_i = (g_E^2/m_E^2)(4\pi f_i^3)$. From Eq. (1) the masses of ordinary fermions are given as

$$m_t = \xi_t \xi_{Rt} \frac{g_E^2}{m_S^2} \langle \bar{U} U \rangle = \xi_t \xi_{Rt} \frac{g_E^2}{m_S^2} 4\pi f_Q^3 , \quad (2)$$

$$m_b = \xi_t \xi_b \frac{g_E^2}{m_S^2} \langle \bar{D} D \rangle = \xi_t \xi_b \frac{g_E^2}{m_S^2} 4\pi f_Q^3 , \quad (3)$$

$$m_\nu = \xi_\tau \xi_\nu \frac{g_E^2}{m_S^2} \langle \bar{N} N \rangle = \xi_\tau \xi_\nu \frac{g_E^2}{m_S^2} 4\pi f_N^3 , \quad (4)$$

$$m_\tau = \xi_\tau \xi_{RE} \frac{g_E^2}{m_S^2} \langle \bar{E} E \rangle = \xi_\tau \xi_{RE} \frac{g_E^2}{m_S^2} 4\pi f_E^3 , \quad (5)$$

where m_S is the mass of a sideways ETC boson and f_Q, f_E, and f_N are the decay constants for the techniquark, technielectron, and technineutrino, respectively.

In one-family TC models with custodial symmetry, the constraint of the pion decay constant is $4F_\pi^2 = (250\ \text{GeV})^2$. In the present model the decay constant in the technilepton sector is different from that in the techniquark sector. We have the following constraint [7]:

$$N_C f_Q^2 + \tfrac{1}{2} f_N^2 + \tfrac{1}{2} f_E^2 \approx (250\ \text{GeV})^2 , \quad (6)$$

where $N_C = 3$ is the color index of QCD. In a realistic one-family TC model, the technileptons could be much lighter than the nearly degenerate techniquarks in order to keep the electroweak parameter S small or even negative while not violating the experimental bound on the parameter T and $N_C f_Q^2 = 3F_6^2 \gg \frac{1}{2}(f_N^2 + f_E^2) \approx F_2^2$. It has been estimated [7] that the decay constant F_6 for the techniquark sector is 140 GeV. From Eq. (8) we have $F_2 \approx 60$ GeV.

From Eqs. (2)–(5), the relation between ξ_i's can be written

$$\xi_t = \xi_{RT}^{-1} , \quad \xi_b = \xi_t^{-1} \frac{m_b}{m_t} , \quad (7)$$

$$\xi_\tau = \xi_{RE}^{-1} , \quad \xi_\nu = \xi_\tau^{-1} \frac{m_\nu}{m_\tau} . \quad (8)$$

If we take $m_t = 175$ GeV, $m_b = 4.8$ GeV, $m_\nu = 0.164$ GeV, and $m_\tau = 1.78$ GeV, then we have $\xi_b \approx 0.028 \xi_t^{-1}$, $\xi_\nu \approx 0.089 \xi_\tau^{-1}$.

III. CORRECTIONS TO THE $Zb\bar{b}$ VERTEX

The corrections to the $Zb\bar{b}$ vertex arise from sideways ETC boson exchange and diagonal ETC boson exchange. From Eq. (1) we can write the four-fermion operators for sideways ETC boson exchange:

$$-\frac{g_E^2}{m_S^2} [\xi_t^2 (\overline{Q_L} \gamma^\nu q_L)(\overline{q_L} \gamma_\nu Q_L) + \xi_b^2 (\overline{D_R} \gamma^\nu b_R)(\overline{b_R} \gamma_\nu D_R)] . \quad (9)$$

Performing a Fierz reordering, the above four-fermion operators can be written as

$$-\frac{g_E^2}{2m_S^2} \frac{1}{N_C} [\xi_t^2 (\overline{Q_L} \gamma^\nu \tau^a Q_L)(\overline{q_L} \gamma_\nu \tau^a q_L) + \xi_b^2 (\overline{D_R} \gamma^\nu D_R)(\overline{b_R} \gamma_\nu b_R)] , \quad (10)$$

where color and technicolor summation is implied and τ^a ($a = 1, 2, 3$) are weak isospin Pauli matrices. We consider the dominant contributions to the $Zb\bar{b}$ vertex and have neglected terms of high order. The color-octet pieces do not couple to Z and thus have no contributions to the $Zb\bar{b}$ vertex.

Adopting an effective chiral Lagrangian description appropriate below the technicolor chiral symmetry-breaking scale, the technifermion current may be replaced by the corresponding Σ model current [15]:

$$(\overline{Q_L} \gamma_\nu \tau^a Q_L) = \frac{N_C F_6^2}{2} \text{Tr}(\Sigma^\dagger \tau^a i D_{\nu L} \Sigma) , \quad (11)$$

$$(\overline{D_R}\gamma_\nu D_R) = \frac{N_C F_6^2}{2}\mathrm{Tr}(\Sigma i D_{\nu R}\Sigma^\dagger) , \quad (12)$$

where $\Sigma = \exp(2i\psi/F_6)$ transforms as $\Sigma \to L\Sigma R^+$ under $SU(2)_L \times SU(2)_R$ and ψ is a Nambu-Goldstone boson field. The covariant derivatives $D_{\nu L}$, $D_{\nu R}$ are

$$D_{\nu L}\Sigma = \partial_\nu\Sigma + i\frac{e}{\sqrt{2}S_\theta}(W_\nu^+\tau^+ + W_\nu^-\tau^-)\Sigma + i\frac{e}{S_\theta C_\theta}Z_\nu(\tfrac{1}{2}\tau_3\Sigma - S_\theta^2[Q,\Sigma]) + ieA_\nu[Q,\Sigma] , \quad (13)$$

$$D_{\nu R}\Sigma = \partial_\nu\Sigma - i\frac{e}{S_\theta C_\theta}Z_\nu(\tfrac{1}{2}\tau_3\Sigma + C_\theta^2\{Q,\Sigma\}) + ieA_\nu[Q,\Sigma] . \quad (14)$$

In the unitary gauge $\Sigma = 1$, we can give the terms which are relevant to the $Zb\bar{b}$ vertex from the operator (10):

$$\frac{g_E^2}{2m_S^2}\frac{F_6^2 e}{S_\theta C_\theta}\left[\xi_t^2\overline{q_L}Z\frac{\tau_3}{2}q_L - \xi_b^2\overline{b_R}Z\frac{\tau_3}{2}b_R\right] , \quad (15)$$

where $S_\theta = \sin\theta$, $C_\theta = \cos\theta$ with θ is the Weinberg angle. These yield corrections to the tree-level vertex of $Zb\bar{b}$ couplings:

$$g_L^b = \frac{e}{S_\theta C_\theta}(-\tfrac{1}{2} + \tfrac{1}{3}S_\theta^2) , \quad g_R^b = \frac{e}{S_\theta C_\theta}(\tfrac{1}{3}S_\theta^2) , \quad (16)$$

$$\delta g_{LS}^b = \frac{\xi_t^2}{4}\frac{g_E^2 F_6^2}{m_S^2}\frac{e}{S_\theta C_\theta} = \frac{\xi_t^2}{4}\frac{m_t}{4\pi F_6}\frac{e}{S_\theta C_\theta} , \quad (17)$$

$$\delta g_{RS}^b = -\frac{\xi_b^2}{4}\frac{g_E^2 F_6^2}{m_S^2}\frac{e}{S_\theta C_\theta} = -\frac{\xi_b^2}{4}\frac{m_t}{4\pi F_6}\frac{e}{S_\theta C_\theta} . \quad (18)$$

Since the tree-level $Zb_L\overline{b_L}$ coupling g_L^b is negative and the $Zb_R\overline{b_R}$ coupling g_R^b is positive, the sideways ETC boson exchange decreases the width Γ_b relative to the standard model prediction. This disfavors recent precision electroweak measurements.

To generate the masses of the quarks and leptons, the ETC gauge group $SU(N_{TC}+1)$ is assumed to hierarchically break down to the TC gauge group $SU(N_{TC})$. In the process of this breaking, many ETC gauge bosons become massive. Some of them are called sideways bosons and some of them called "diagonal" bosons. Sideways ETC bosons must exist in realistic models to generate the masses of quarks and leptons, while the existence of diagonal ETC bosons is model dependent. In a realistic one-family TC model, we assume that diagonal ETC bosons exist which interact with both ordinary fermions and technifermions [5]. For a given technicolor index N_{TC}, we can obtain the diagonal coupling of technifermions by multiplying the factor $-1/\sqrt{2N_{TC}(N_{TC}+1)}$ to their sideways coupling and that of ordinary fermions multiplying the factor $\sqrt{N_{TC}/2(N_{TC}+1)}$ to their sideways coupling. These factors come from the normalization, Hermiton, and traceless properties of the diagonal generator. Diagonal boson exchange gives rise to the four-fermion operators

$$\frac{1}{2}\left(\frac{m_S}{m_D}\right)^2\frac{g_E^2}{m_S^2}\frac{1}{N_{TC}+1}[(\overline{U_R}\gamma^\nu U_R)(\overline{q_L}\gamma_\nu q_L) + \xi_t\xi_b(\overline{D_R}\gamma^\nu D_R)(\overline{q_L}\gamma_\nu q_L) + \xi_t^{-1}\xi_b(\overline{U_R}\gamma^\nu U_R)(\overline{b_R}\gamma_\nu b_R)] . \quad (19)$$

The corrections to g_L^b, g_R^b from diagonal ETC boson exchange are derived as Eqs. (17) and (18):

$$\delta g_{LD}^b = -\frac{1}{4}\frac{m_t}{4\pi F_6}\frac{e}{S_\theta C_\theta}\left(\frac{m_S}{m_D}\right)^2\frac{N_C}{N_{TC}+1}\xi_t(\xi_t^{-1}+\xi_b) , \quad (20)$$

$$\delta g_{RD}^b = -\frac{1}{4}\frac{m_t}{4\pi F_6}\frac{e}{S_\theta C_\theta}\left(\frac{m_S}{m_D}\right)^2\frac{N_C}{N_{TC}+1}\xi_t^{-1}\xi_b . \quad (21)$$

Diagonal ETC boson exchange gives a negative correction to g_L^b and g_R^b. The total effect increases the widths Γ_b and R_b, contrary to sideways ETC boson exchange. The result differs by a minus sign from the loop estimate in Ref. [5] (Ref. [16] has given a similar result). Note that the size of diagonal ETC boson exchange corrections becomes smaller with increasing the technicolor index N_{TC}. From Eqs. (18) and (21), we can see the contribution to the right-handed $Zb\bar{b}$ coupling from sideways ETC boson exchange and diagonal ETC boson exchange is suppressed by $(m_b/m_t)^2$ and (m_b/m_t), respectively. Therefore, the δg_{RS}^b and the δg_{RD}^b can be ignored.

Summing up the corrections to the $Zb\bar{b}$ vertex from sideways and diagonal ETC boson exchange, we obtain the total correction:

$$\delta g_{LE}^b = -\frac{1}{4}\frac{m_t}{4\pi F_6}\frac{e}{S_\theta C_\theta} \times\left[\left(\frac{m_S}{m_D}\right)^2\frac{N_C}{N_{TC}+1}\xi_t(\xi_t^{-1}+\xi_b) - \xi_t^2\right] , \quad (22)$$

$$\delta g_{RE}^b \approx 0 . \quad (23)$$

It is seen from the above expression that the two contributions are comparable in magnitude and that for large N_{TC} the sideways ETC boson exchange contribution dominates. However, the size of the ratio of the masses of sideways and diagonal ETC bosons are ETC model dependent. Therefore, it is possible for ETC boson exchange to give a positive correction to R_b.

From Eqs. (22) and (23), we can estimate the total corrections to Γ_b and R_b in a realistic one-family TC model:

$$\left(\frac{\delta\Gamma}{\Gamma_b}\right)_E = \frac{2(g_L^b\delta g_{LE}^b + g_R^b\delta g_{RE}^b)}{g_L^{b2}+g_R^{b2}} \approx +1.26\%\left(\frac{m_t}{175\ \mathrm{GeV}}\right) , \quad (24)$$

$$\delta R_{bE} = \delta\left(\frac{\Gamma}{\Gamma_b}\right)_E = \left(\frac{\delta\Gamma}{\Gamma_b}\right)_E\left(\frac{\Gamma_b}{\Gamma_h}\right)\left(1-\frac{\Gamma_b}{\Gamma_h}\right) \approx +0.99\%\left(\frac{m_t}{175\ \mathrm{GeV}}\right)R_b . \quad (25)$$

In the above estimation, we take $\xi_t = 1/\sqrt{2}$, $\xi_b \approx 0.028\xi_t^{-1}$, and $N_{\rm TC} = 4$ and assume $m_S \approx m_D$.

For the ratio R_b, all oblique effects and leading QCD corrections cancel. The δR_{bE} is the purely nonolique correction to the $Zb\bar{b}$ vertex. The recent measurement of R_b at the CERN e^+e^- collider LEP [11], $R_b = 0.2202 \pm 0.002$, already differs by more than two standard deviations from the value $R_b^{\rm SM} = 0.2157$ predicted by the minimal standard model. So the result is particularly interesting.

So far, we have focused on the "high-energy" technicolor corrections to the $Zb\bar{b}$ vertex from ETC boson exchange; there are "low-energy" corrections coming from the PGB's [10]. However, the masses of PGB's could be significantly enhanced by either dynamics or technifermion condensates in a realistic one-family TC model. The size of PGB contributions is model dependent, but if the PGB's are heavy, their contributions could be small.

IV. CORRECTIONS TO THE $Z\tau\bar{\tau}$ VERTEX

In this section we will give the corrections to the $Z\tau\bar{\tau}$ vertex from sideways ETC boson exchange and diagonal ETC boson exchange and estimate the effect of these corrections on the τ asymmetry parameter A_τ.

From Eq. (1) we can write the four-fermion operators which contribute to the $Z\tau\bar{\tau}$ vertex from sideways ETC boson exchange after Fierz transformation:

$$-\frac{g_E^2}{2m_S^2}[\xi_\tau^2(\overline{L_L}\gamma^\nu\tau^a L_L)(\bar{l}_L\gamma_\nu\tau^a l_L) +\xi_\tau^{-2}(\overline{E_R}\gamma^\nu E_R)(\overline{\tau_R}\gamma_\nu\tau_R)] \ . \quad (26)$$

Similarly deriving Eq. (19), we can write the four-fermion operators for diagonal ETC boson exchange in the technilepton sector:

$$\frac{1}{2}\left(\frac{m_S}{m_D}\right)^2\frac{g_E^2}{m_S^2}\frac{1}{N_{\rm TC}+1}[\xi_\tau\xi_\nu(\overline{N_R}\gamma^\nu N_R)(\overline{l_L}\gamma_\nu l_L) +(\overline{E_R}\gamma^\nu E_R)(\overline{l_L}\gamma_\nu l_L) +\xi_\tau^{-1}\xi_\nu(\overline{N_R}\gamma^\nu N_R)(\overline{\tau_R}\gamma_\nu\tau_R)] \ . \quad (27)$$

By means of the effective Lagrangian approach, we can give the corrections to the tree-level vertex of $Z\tau\bar{\tau}$ couplings:

$$g_L^\tau = \frac{e}{S_\theta C_\theta}(-\tfrac{1}{2}+S_\theta^2) \ , \quad g_R^\tau = \left(\frac{e}{S_\theta C_\theta}\right)S_\theta^2 \ , \quad (28)$$

$$\delta g_{LE}^\tau = -\frac{1}{4}\frac{m_t}{4\pi}\frac{F_2^2}{F_6^3}\frac{e}{S_\theta C_\theta}\left[\left(\frac{m_S}{m_D}\right)^2\frac{N_C}{N_{\rm TC}+1}(1 +\xi_\tau\xi_\nu)-\xi_\tau^2\right] \ , \quad (29)$$

$$\delta g_{RE}^\tau \approx -\frac{1}{4}\frac{m_t}{4\pi}\frac{F_2^2}{F_6^3}\frac{e}{S_\theta C_\theta}\left[\left(\frac{m_S}{m_D}\right)^2\frac{N_C}{N_{\rm TC}+1}\xi_\tau^{-1}\xi_\nu+\xi_\tau^{-2}\right] . \quad (30)$$

The PGB correction to the $Z\tau\bar{\tau}$ vertex will be suppressed by the square of the small-τ mass m_S and thus be ignored [16]. However, the other larger effect of the isospin breaking in the technilepton sector comes from the techni vector mesons composed of technileptons. The corrections to the $Z\tau\bar{\tau}$ vertex which comes from neutral techni vector mesons cannot be ignored. In Ref. [6], the correction to g_L^τ coupling has been computed and the difference between the corrections for the $Z\tau_L\tau_L$ vertex and $W\tau\nu$ has been given. We will give a detailed examination of the correction to the g_R^τ coupling coming from neutral techni vector mesons in future work.

The best constraints on the $Z\tau\bar{\tau}$ vertex come from the τ asymmetry parameter $A_\tau = [(g_L^\tau)^2-(g_R^\tau)^2]/[(g_L^\tau)^2+(g_R^\tau)^2]$. The sensitivity of the parameter A_τ to new physics can be appreciated by

$$\frac{\delta A_\tau}{A_\tau} = \frac{4(g_L^\tau)^2(g_R^\tau)^2}{(g_L^\tau)^4-(g_R^\tau)^4}\left(\frac{\delta g_L^\tau}{g_L^\tau}-\frac{\delta g_R^\tau}{g_R^\tau}\right) = -\left(\frac{e}{S_\theta C_\theta}\right)^{-1}(24.04\delta g_L^\tau+27.99\delta g_R^\tau) \ . \quad (31)$$

In order to compare the corrections to the $Z\tau\bar{\tau}$ vertex from ETC boson exchange with experiments, we consider the τ asymmetry parameter A_τ. By using Eqs. (29), (30), and (31), we find $(\delta A_\tau/A_\tau)_E = 0.245$. In this estimation we take $\xi_\tau = 1/\sqrt{2}$ and $\xi_\nu \approx 0.089\xi_\tau^{-1}$ and assume $m_S \approx m_D$. A recent measurement of the parameter A_τ is $\delta A_\tau/A_\tau = 0.31 \pm 0.13$ [13]. The one-family TC model without exact custodial symmetry is consistent with experimental constraint from the τ asymmetry parameter A_τ.

V. CONCLUSIONS

We have computed the corrections to the $Zb\bar{b}$ and $Z\tau\bar{\tau}$ vertices from ETC boson exchange in a realistic one-family TC model. In assuming that the diagonal ETC boson exists in the model, we estimated the effect on the $Zb\bar{b}$ couplings from sideways ETC boson exchange and diagonal ETC boson exchange. We found that sideways ETC boson exchange decreases the width Γ_b, while diagonal ETC boson exchange tends to increase it. The two corrections are comparable, and the total correction to the $Zb\bar{b}$ vertex gives a positive value to R_b.

We assumed that the mass of fermion ν is not equal to zero and considered corrections to the tree-level vertex of $Z\tau\bar{\tau}$ couplings g_L^τ, g_R^τ from ETC boson exchange. We found that the correction to g_R^τ is not smaller than that of g_L^τ and cannot be ignored. We gave the estimate of $\delta A_\tau/A_\tau$ by relating the $Z\tau\bar{\tau}$ couplings g_L^τ, g_R^τ. The $\delta A_\tau/A_\tau$ can be extracted from lepton asymmetry measurements at LEP. Thus future experimental improvements on the precise lepton asymmetry measurement will start constraining TC theories.

In this paper, we have competently analyzed corrections to $Zb\bar{b}$ and $Z\tau\bar{\tau}$ vertices due to the different possible ETC gauge boson exchanges in a realistic one-family TC model. Analyses for other TC models may have similar qualitative features.

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