EXTRACTION OF TRIPLE GAUGE COUPLINGS (TGC'S)

Revised March 2000 by C. Caso (Univ. of Genova) and A. Gurtu (Tata Inst.)

Fourteen independent couplings, 7 each for ZWW and γWW, completely describe the VWW vertices within the most general framework of the electroweak Standard Model (SM) consistent with Lorentz invariance and $U(1)$ gauge invariance. Of each of the 7 TGC's, 3 conserve C and P individually, 3 violate CP, and one TGC violates C and P individually while conserving CP. Assumption of C and P conservation and electromagnetic gauge invariance reduces the independent VWW couplings to five: one common set is $(\kappa_\gamma, \kappa_Z, \lambda_\gamma, \lambda_Z, g_1^Z)$, where $\kappa_\gamma = \kappa_Z = g_1^Z = 1$ and $\lambda_\gamma = \lambda_Z = 0$ in the Standard Model at the tree level. The W magnetic dipole moment, μ_W, and the W electric quadrupole moment, q_W, are expressed as $\mu_W = e\ (1 + \kappa_\gamma + \lambda_\gamma)/2M_W$ and $q_W = -e\ (\kappa_\gamma - \lambda_\gamma)/M_W^2$.

Precision measurements of suitable observables at LEP1 has already led to an exploration of much of the TGC parameter space. Three linear combinations of the TGC's, $\alpha_{W\phi}$, $\alpha_{B\phi}$ and α_W, have been proposed to investigate the leftover "blind" directions in the CP-conserving TGC parameter space, and two linear couplings, $\widetilde{\alpha}_{BW}$ and $\widetilde{\alpha}_W$ in the CP-violating TGC parameter space (see *e.g.*, papers by Hagiwara [1], Bilenky [2], and Gounaris [3,4]). The relations between these parameters and those contained in the above set, expressed as *deviations* from the SM, are $\Delta g_1^Z = \alpha_{W\phi}/c_w^2$, $\Delta\kappa_\gamma = \alpha_{W\phi} + \alpha_{B\phi}$, $\Delta\kappa_Z = \alpha_{W\phi} - t_w^2\alpha_{B\phi}$ and $\lambda_\gamma = \lambda_Z = \alpha_W$, where c_w and t_w are the cosine and tangent of the electroweak mixing angle. Similarly, $\widetilde{\kappa}_\gamma = \widetilde{\alpha}_{BW}, \widetilde{\kappa}_Z = t_w^2\widetilde{\alpha}_{BW}$ and $\widetilde{\lambda}_\gamma = \widetilde{\lambda}_Z = \widetilde{\alpha}_W$ within the CP-violating sector. The LEP Collaborations have recently agreed to express their results directly in terms of the parameters Δg_1^Z, $\Delta\kappa_\gamma$ and λ_γ.

At LEP2 the VWW coupling arises in W-pair production via s-channel exchange or in single W production via the radiation of a virtual photon off the incident e^+ or e^-. At the TEVATRON hard photon bremstrahlung off a produced W or Z signals the presence of a triple gauge vertex. In order to

extract the value of one TGC the others are generally kept fixed to their SM values.

References

1. K. Hagiwara *et al.*, Nucl. Phys. **B282**, 253 (1987).
2. M. Bilenky *et al.*, Nucl. Phys. **B409**, 22 (1993).
3. G. Gounaris *et al.*, CERN 96-01 525.
4. G. Gounaris *et al.*, Eur. Phys. J. **C2**, 365 (1998).