EXTRACTION OF TRIPLE GAUGE COUPLINGS (TGC’S)

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Fourteen independent couplings, 7 each for $ZWW$ and $\gamma WW$, 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 $[1,2]$ 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 parameters $\kappa_Z$ and $\lambda_Z$ are related to the other three due to constraints of gauge invariance as follows: $\kappa_Z = g_1^Z - (\kappa_\gamma - 1)\tan^2 \theta_W$ and $\lambda_Z = \lambda_\gamma$, where $\theta_W$ is the weak mixing angle. The $W$ magnetic dipole moment, $\mu_W$, 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. 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 bremsstrahlung 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

2. G. Gounaris et al., CERN 96-01 p. 525.