CP Violating TGC Coupling

TGC Group Meeting

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Theory

CP-Conserving TGC Parameters

Usually the CP violating coupling are left out of the effective Lagrangian and only the CP conserving ones ($\alpha_W, \alpha_{W\phi}, \alpha_{B\phi}$) are considered.

These are studied using the usual 5 angles:

$$Cos\theta_W, Cos\theta_l^*, \phi_l^*, Cos\theta_{had}^*, \phi_{had}^*$$

CP-violating TGC Parameters

The CP-violating interactions can be included in the effective Lagrangian as:

$$\mathcal{L}_{TGC} = eg_{VWW}\{g_4^V W_\nu^+ W_\mu^- (\partial^\mu V^\nu + \partial^\nu V^\mu) + \\ i\tilde{\kappa}_V W_\nu^+ W_\mu^- \mathcal{V}^{\mu\nu} + i\frac{\tilde{\lambda}_V}{m_W^2} W_\nu^{+\mu} W_{\rho\mu}^- \mathcal{V}^{\nu\rho}\}$$

where:

$$V_{\mu\nu} = \partial_\mu V_\nu - \partial_\nu V_\mu \qquad W_{\mu\nu}^\pm = \partial_{mu} W_\nu^\pm - \partial_{nu} W_\mu^\pm$$

and:

$$\mathcal{V}^{\mu\nu} = \frac{1}{2}\varepsilon^{\mu\nu\rho\sigma} V_{\rho\sigma}$$

$W^\pm$ is the W-boson field, $V = Z^0$ or γ, $g_{\gamma WW} = 1$, $g_{ZWW} = cot\theta_W$, $e = gsin\theta_W = g' cos\theta_W$.

C. G. Papadopoulos (J. Phys. G: Nucl. Part. Phys **24** (1998) 405-419) suggest using the following parameters:

$$\tilde{\kappa}_\gamma = \tilde{\alpha}_{BW} \qquad \tilde{\lambda}_\gamma = \tilde{\alpha}_W$$

$$\tilde{\kappa}_Z = -tan^2\theta_W \tilde{\kappa}_\gamma \qquad \tilde{\lambda}_Z = \tilde{\lambda}_\gamma$$

Analysis Plans/Options

Monte Carlo

We need an Event Generator that can incorporate the CP-violating parameters:

- ERATO does have this facility but has not be used by OPAL.
- EXCALIBUR is supposed to have this option added but when that will happen nobody knows.

So work needs to be done in this area.

Analysis Plans/Options Cont:

Analysis Method

There are a number of options for the analysis base:

- 5 Angles Method: Could generate MC with the CP violating parameters and analysis in the usual way. There are at least three options here:
  - S.Bett's nearest neighbour method.
  - J.Couchman's spin density method.
  - A.Skillman's unbinned maximum likelihood method.
- Asymmetry Method: The lepton polar angle is sensitive to the CP-violating parameters.
  - V C Spanos and W.J Stirling, Constraining a CP-violating WWV coupling from the W^+W^- threshold cross section at LEP2. DTP-96-54 . (hep-ph/9607420)

Asymmetry Method

The polar angle distribution of the charged lepton $l^- = e^-, \mu^-, \tau^-$ from $W^- \to l^- \overline{\nu}_l$ decay.

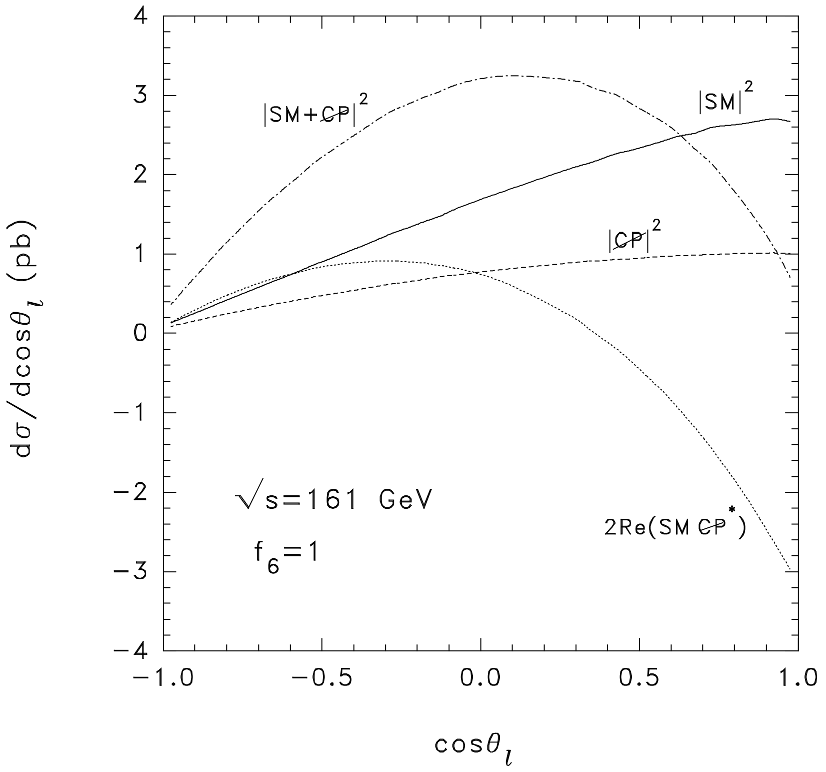


Figure 4 (a)

The curves show the SM and anomalous contributions for CP-violating parameter $f_6 = 1$ $(tilde\kappa)$

Asymmetry Method

Can form an asymmetry:

$$A = \frac{d\sigma/dcos\theta(l^-,cos\theta) - d\sigma/dcos\theta(l^+,-cos\theta)}{d\sigma/dcos\theta(l^-,cos\theta) + d\sigma/dcos\theta(l^+,-cos\theta)}$$

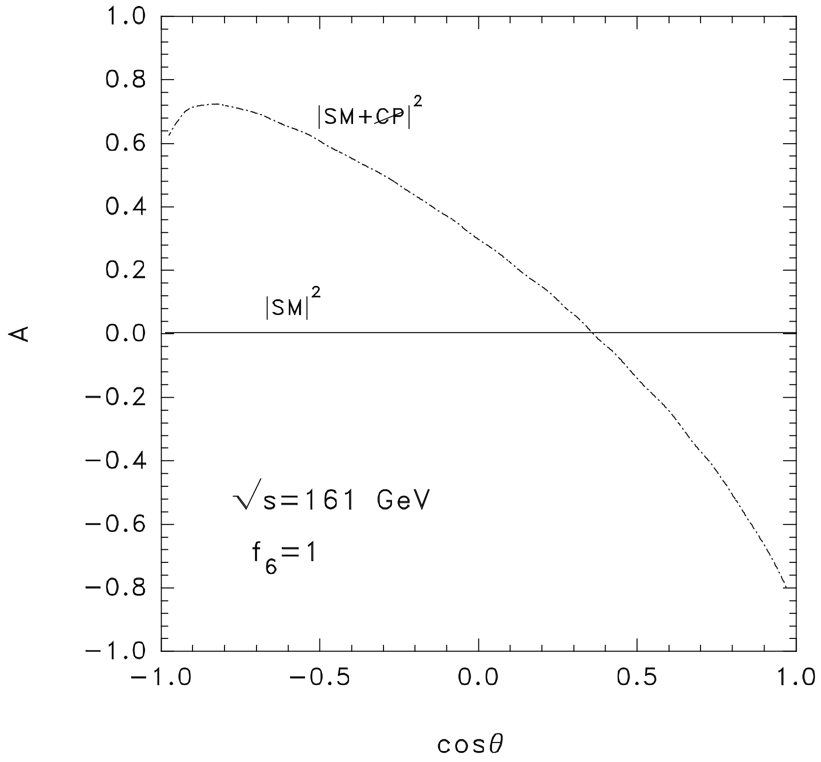
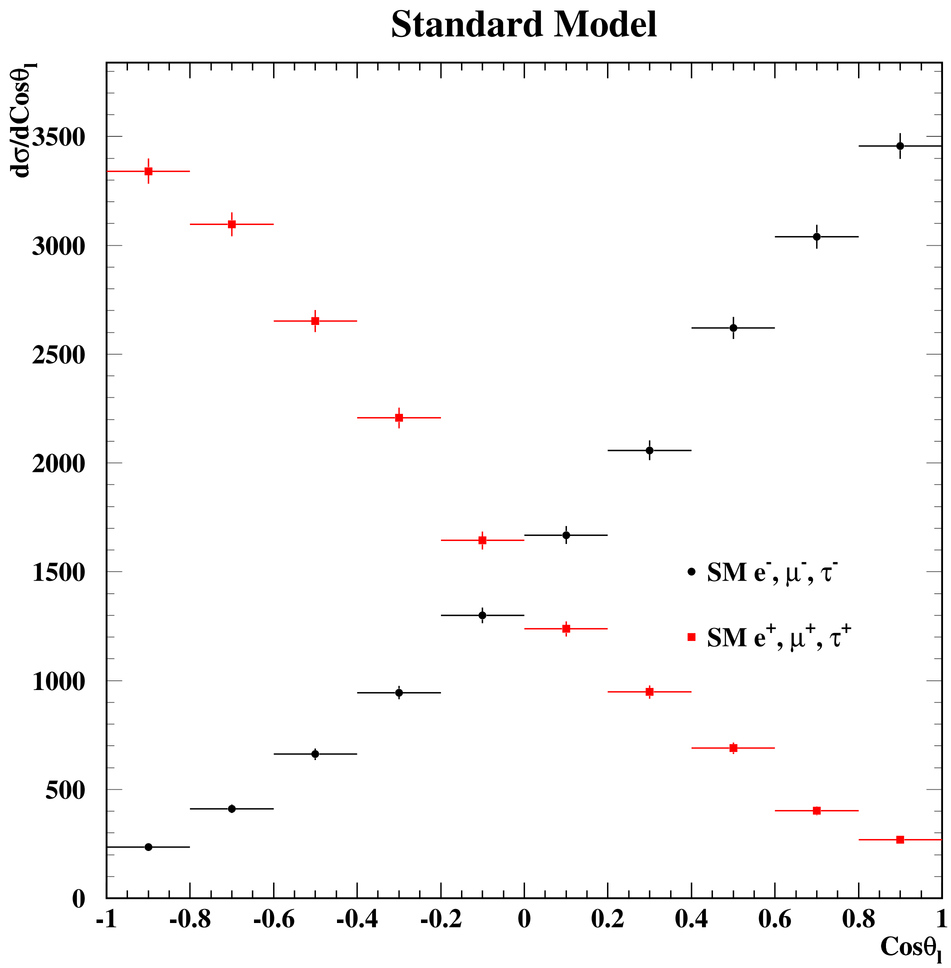


Figure 4 (b)

First Look at SM MC

Using Standard Model Excalibur MC (S.Betts) calculated the polar angle distribution for all leptons and anti-leptons.



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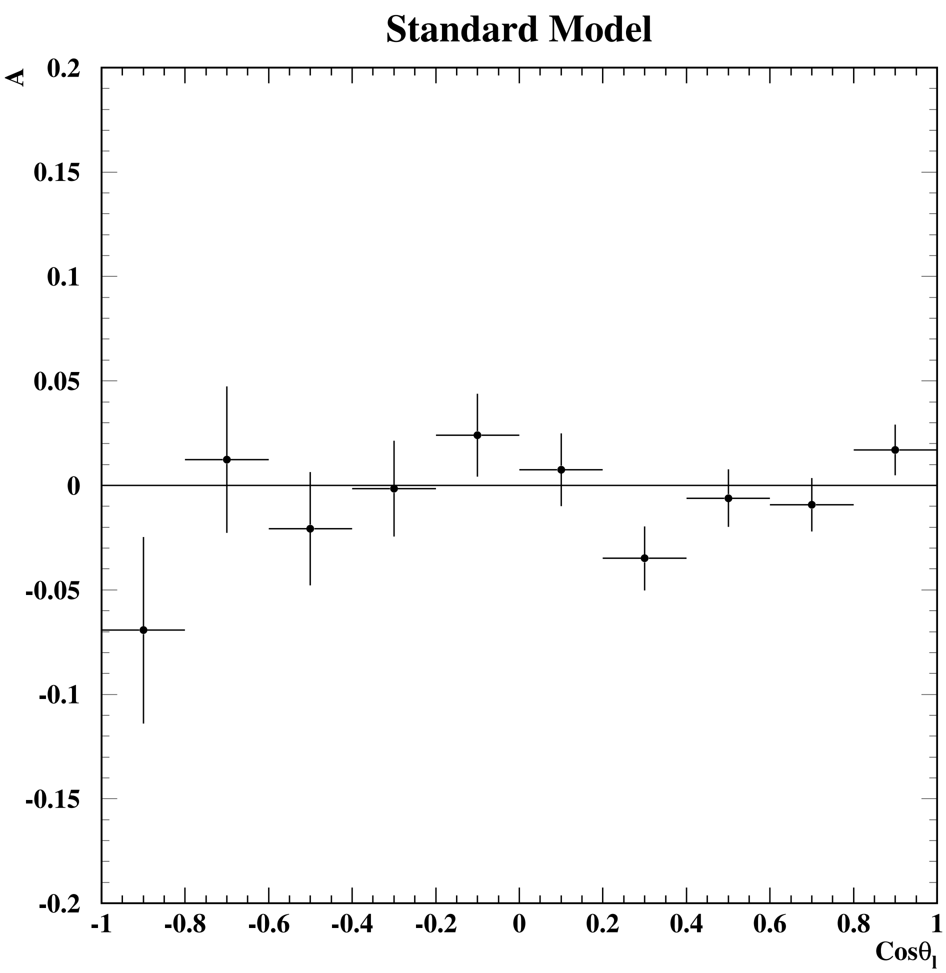
Aysmmetry

For the Standard model we expect the distribution to be flat



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Aysmmetry

For all SM leptons, e, μ, τ separetly

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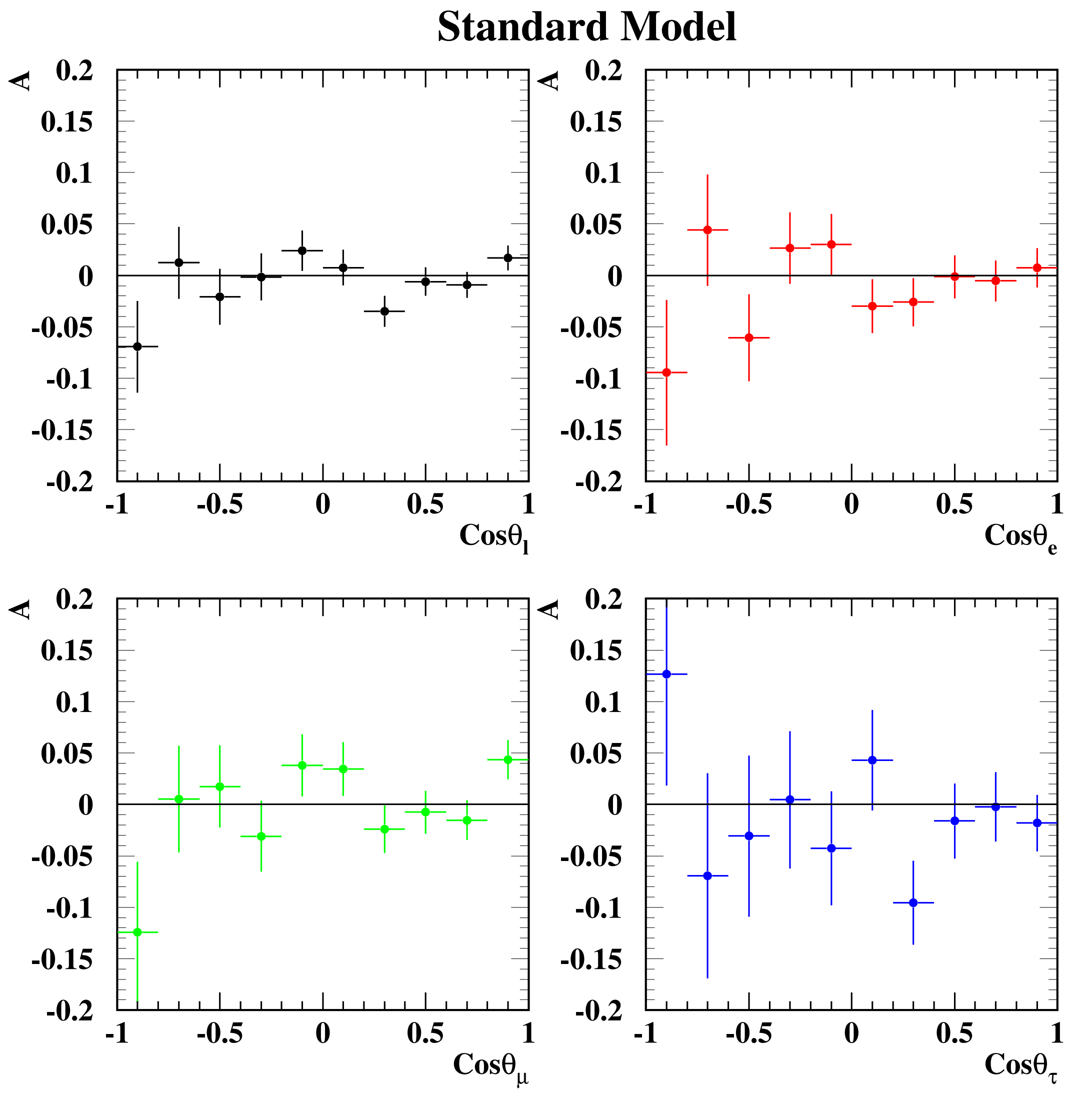

To Do List

- Get MC with CP-violating couplings
- Choose an analysis method
- Asymmetry Method
  - Check to see if the non-CP-violating MC ($\alpha_{W\phi}$ etc...) has an asymmetry. If it does this method is dead.