## $e^+e^- \to W_L^+ W_L^-$ for longitudinal $W_L^\pm$

Calculate the cross section (in CMS) in the high-energy limit ($s \gg M_W^2$) without the WWZ and WWγ couplings, and show the increase of $\sigma$ with $\sigma \sim s$

## Z-boson decay width $Z \to f\bar{f}$

Calculate the width $\Gamma(Z \to f\bar{f})$, fermion masses can be neglected. Helicities of $f, \bar{f}$ have to be summed, helicities of Z have to be averaged.

Some formulae:

$$(\overline{w}_1 \Gamma w_2)^* = \overline{w}_2 \overline{\Gamma} w_1 \quad (w_{1,2} = u \text{ or } v)$$

$$\boxed{\overline{\Gamma} = \gamma^0 \Gamma^+ \gamma^0} \qquad \Gamma = \text{any Dirac-matrix (or product)}$$

$$\sum_{\text{helicities}} u(p)\,\bar{u}(p) = \not{p} + m,$$

$$\sum_{\text{helicities}} v(p)\,\bar{v}(p) = \not{p} - m,$$

$$\mathrm{Tr}\left(w_1 \overline{w}_1 \, \Gamma \, w_2 \overline{w}_2 \, \overline{\Gamma}\right)$$
$$= \overline{w}_1 \Gamma w_2 \cdot \overline{w}_2 \overline{\Gamma} w_1$$