Cross Section Calculation

- **The general cross section formula:**
  - **C1, C2: T' produce and decay coupling parameters**
  - **Gamma: total decay width of T'**

$$\sigma(C_1, C_2, m_{\mathrm{B}}, \Gamma_B) = C_1^2\, C_2^2\, \tilde{\sigma}_{FW}(m_{\mathrm{B}}, \Gamma_B)$$

- **When $\frac{\Gamma_{T'}}{m_{T'}} \to 0$ (NWA) the formula can be simplified:**
  - **C1: coupling corresponding to T' production interaction**

$$c_Z^X = \frac{e}{2c_w s_w}\kappa_Z^X, \quad c_W^X = \frac{e}{\sqrt{2}s_w}\kappa_W^X \quad \text{and} \quad \boxed{c_H^X = \frac{M_B}{v}\kappa_H^X}$$

this may not for C1

  - **$\hat{\sigma}$(NWA): Check the github tables**
  - **BR(T'->tH): 0.25**

$$\sigma(C_1, C_2, m_{\mathrm{X}}, \Gamma_X) = \sigma_P(C_1, m_{\mathrm{X}}) BR_{X\to\text{decay channel}} = C_1^2 \hat{\sigma}_{NWA}(m_{\mathrm{X}}) BR_{X\to\text{decay channel}}$$

NWA Regime

- **Narrow Width Approximation: $\frac{\Gamma_{T'}}{m_{T'}} \to 0$**
  - **Calculate $\Gamma_{T'}$ to prove it**
  - **$\Gamma_{T'} = \Gamma_{T'->Ht} + \Gamma_{T'->Zt} + \Gamma_{T'->Wb}$**

$$\Gamma_{X\to Hq}[\kappa_{HX_L}, \kappa_{HX_R}, M_X, m_q] = 3 * (\kappa^2_{HX_L} + \kappa^2_{HX_R}) \frac{\lambda(m_q, M_X, M_H)}{96\pi M_X^3}$$
$$(m_q^2 + M_X^2 - M_H^2 + 4\frac{\kappa^2_{HX_L}\kappa^2_{HX_R}}{\kappa^2_{HX_L} + \kappa^2_{HX_R}} m_q M_X)$$

$$\Gamma_{X\to Vq}[\kappa_{VX_L}, \kappa_{VX_R}] = d_V \times (\kappa^2_{VX_L} + \kappa^2_{VX_R}) \frac{3e^2}{4s_w^2} \frac{\lambda(m_q, M_X, M_H)}{(96.\pi * M_X^3)} \times$$

A typo?
Should be M_V?

$$(m_q^2 + M_X^2 + \frac{m_q^4 - 2m_q^2 M_X^2 + M_X^4}{m_V^2} - 2m_V^2$$
$$-12\frac{\kappa^2_{VX_L}\kappa^2_{VX_R}}{\kappa^2_{VX_L} + \kappa^2_{VX_R}} m_q M_X)$$

  - **Doing cross check with TotalWidth_x_coupling_SingleT_NWA.txt**
    - **For T' singlet, main coupling chirality is L: Can we make κ_V^{TR}=0?**

Cross Section Calculation (NWA)

$$\sigma(C_1, C_2, m_X, \Gamma_X) = \sigma_P(C_1, m_X) BR_{X\to\text{decay channel}} = C_1^2 \hat{\sigma}_{NWA}(m_X) BR_{X\to\text{decay channel}}$$

- Get σˆ(NWA) from CrossSections_BR_SingleT_NWA.txt

	MQ	sigmaHat(Tbj)(pb)			QCDscaleUp(%)		QCDscaleUp(%)	sigmaHat(Tbj)(pb)	
2	600	4303.83	26.5	−19.2	200.13	26.1	−19	0.22127620349551208	0.511
3	650	4096.14	27.3	−19.7	203.148	26.6	−19.3	0.20205726514449626	0.508
4	700	50.9587	27.9	−20	4.21476	27.2	−19.6	0.18196062965372217	0.506
5	800	34.9723	29.1	−20.7	2.99493	28.1	−20.1	0.15802464837853522	0.504
6	900	24.5265	30.3	−21.3	2.16676	29	−20.6	0.13975345806095826	0.515
7	1000	17.572	31.3	−21.8	1.59232	29.8	−21	0.1253245640045215	0.508
8	1100	12.7958	32.3	−22.3	1.18243	30.5	−21.4	0.1136288609745443	0.506
9	1200	9.44201	33.2	−22.7	0.888825		31.3 −21.8	0.10395010776979453	

which σˆ should I use?

- Get C1 from Coupling_x_FixedTotalWidth_SingleT_NWA.txt
  - Obtain κ by fixing Γ_T'/m_T' to 1% or 2%

MQ	G/MQ=1%(singlet)
600	0.22127620349551208
650	0.20205726514449626
700	0.18196062965372217

Is this value C1 or κ?

- BR(T'->tH) = 0.25