Loop Update

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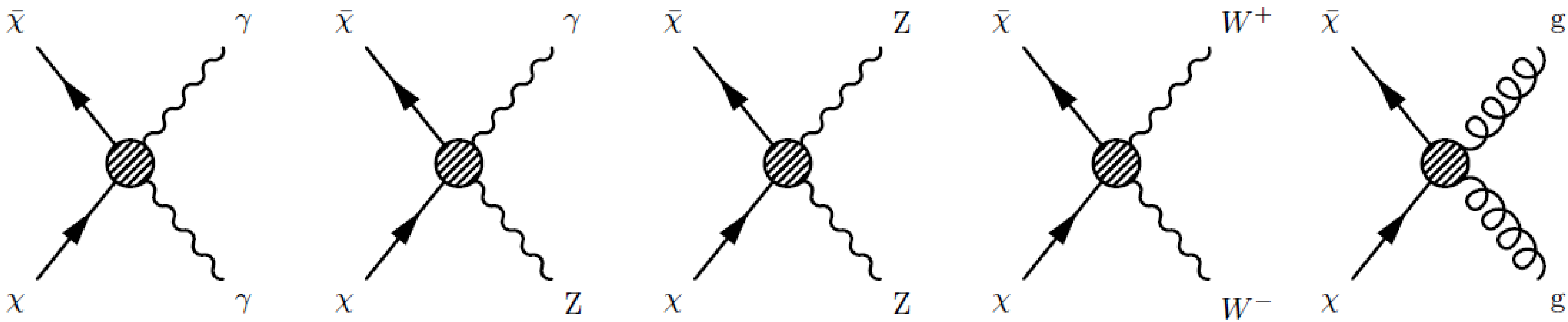
EFT → Simplified Model

$$\mathcal{L} = \frac{\kappa_1}{\Lambda^3}\bar{\chi}\ \Gamma\chi B_{\mu\nu}B^{\mu\nu} + \frac{\kappa_2}{\Lambda^3}\bar{\chi}\ \Gamma\chi W^i_{\mu\nu}W_i^{\mu\nu} + \frac{\kappa_3}{\Lambda^3}\bar{\chi}\ \Gamma\chi G^a_{\mu\nu}G_a^{\mu\nu}$$

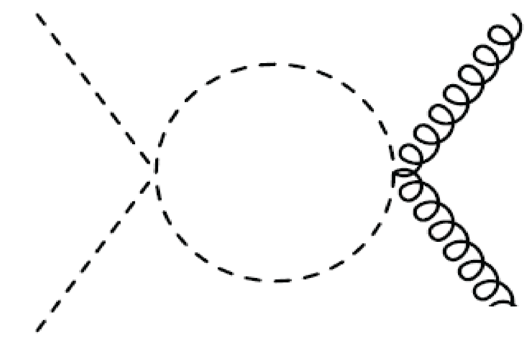


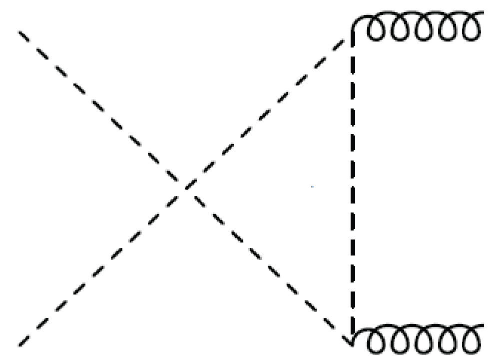
$$\kappa 1/\Lambda^2\ \phi\phi\ B_{\mu\nu}B^{\mu\nu} + \kappa 2/\Lambda^2\ \phi\phi W_{\mu\nu}W^{\mu\nu} + \kappa 3/\Lambda^2\ \phi\phi\ G_{\mu\nu}G^{\mu\nu}$$

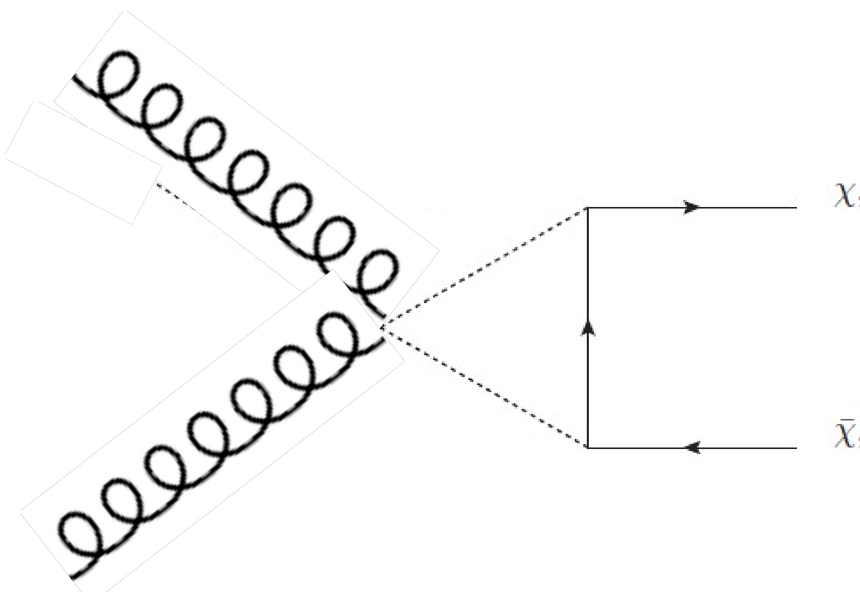
Scalar or Fermion Coupling to Vector Boson Pairs

Scalar/fermion mediators charged under SM gauge groups

$$-\lambda|\phi|^2|\chi|^2 + m_\phi^2|\phi|^2 + m_\chi|\chi|^2$$







$$y_\chi \, \chi Q\phi + m_f \, QQ + m^2\phi\phi$$

Large m_f limit

Higgs Models

$\mathcal{L} = 1/\Lambda\ \chi\chi HH$

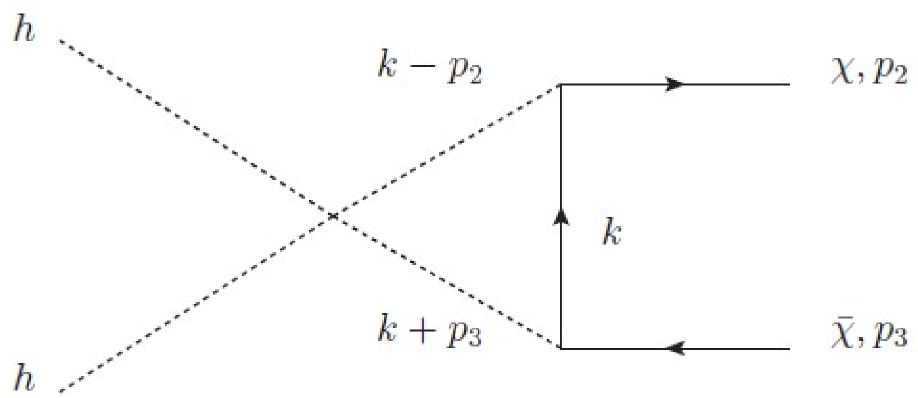
Limiting Benchmarks

m_f-> Large

m_f=m

m>>m_f

Mediators onshell



$y_\chi\ \chi F\phi + m_f\ FF + m^2\phi\phi$

Large m_f limit

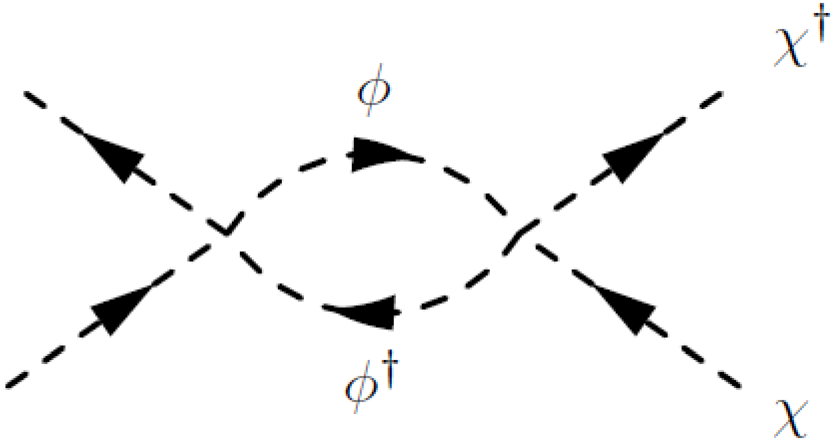
Implement for Event Generation

New FeynRules Tools allow event generation for more complicated models

Challenge: NLOCT > subtlety putting in things charged under broken gauge group

http://arxiv.org/abs/1406.3030

Effects of Momentum Scaling



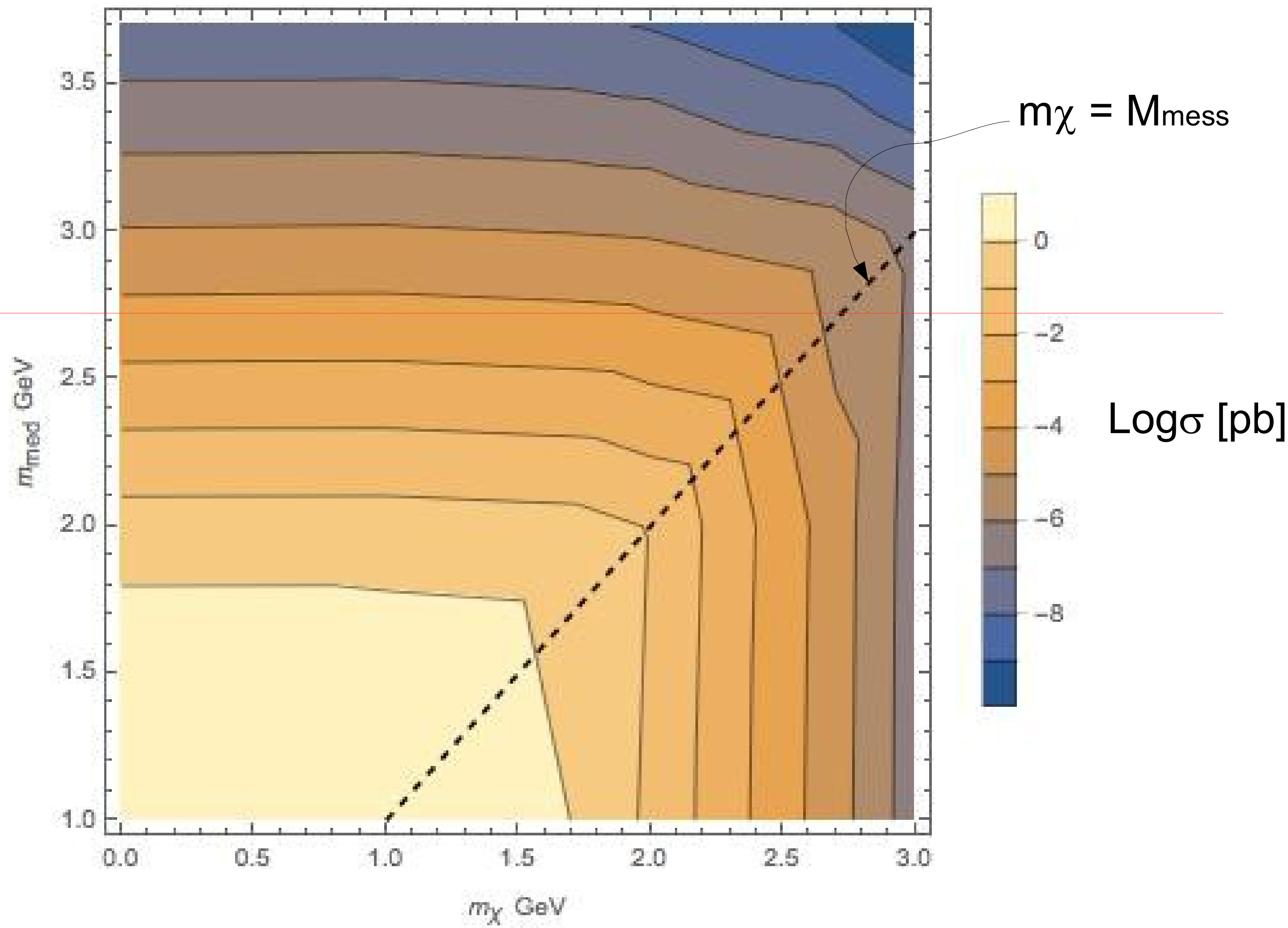
$$: (s \gtrsim 4m^2)$$

$$\frac{\lambda y}{16\pi^2}\left[\sqrt{1-\frac{4m^2}{s}}\ln\left(\frac{\sqrt{s}+\sqrt{s-4m^2}}{\sqrt{s}-\sqrt{s-4m^2}}\right)+\ln\left(\frac{m^2}{\Lambda^2}\right)-1+i\pi\sqrt{1-\frac{4m^2}{s}}\right]$$

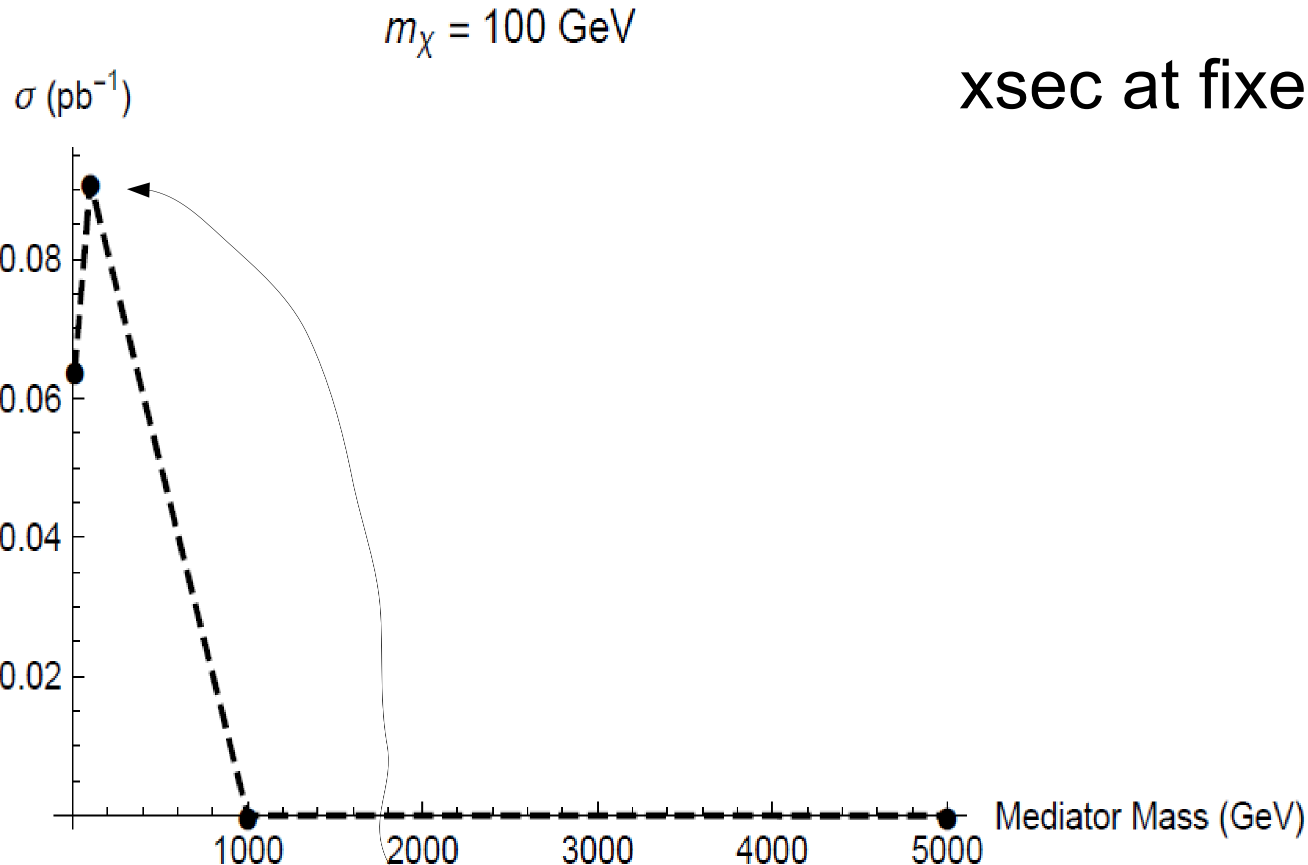
Resonance effect mediators go on shell

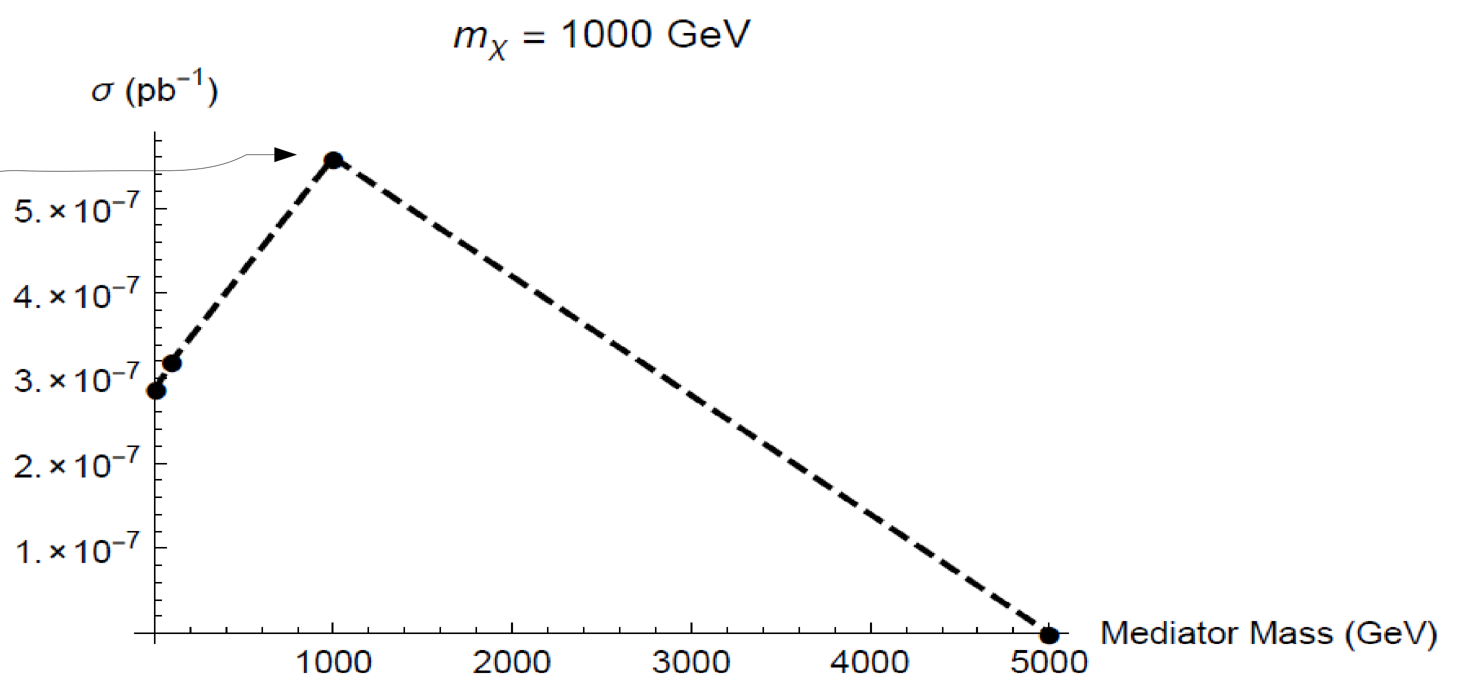
Process p p > j χ

Scan over DM and Messenger Mass with λ =1 for 13 TeV c.o.m Energy



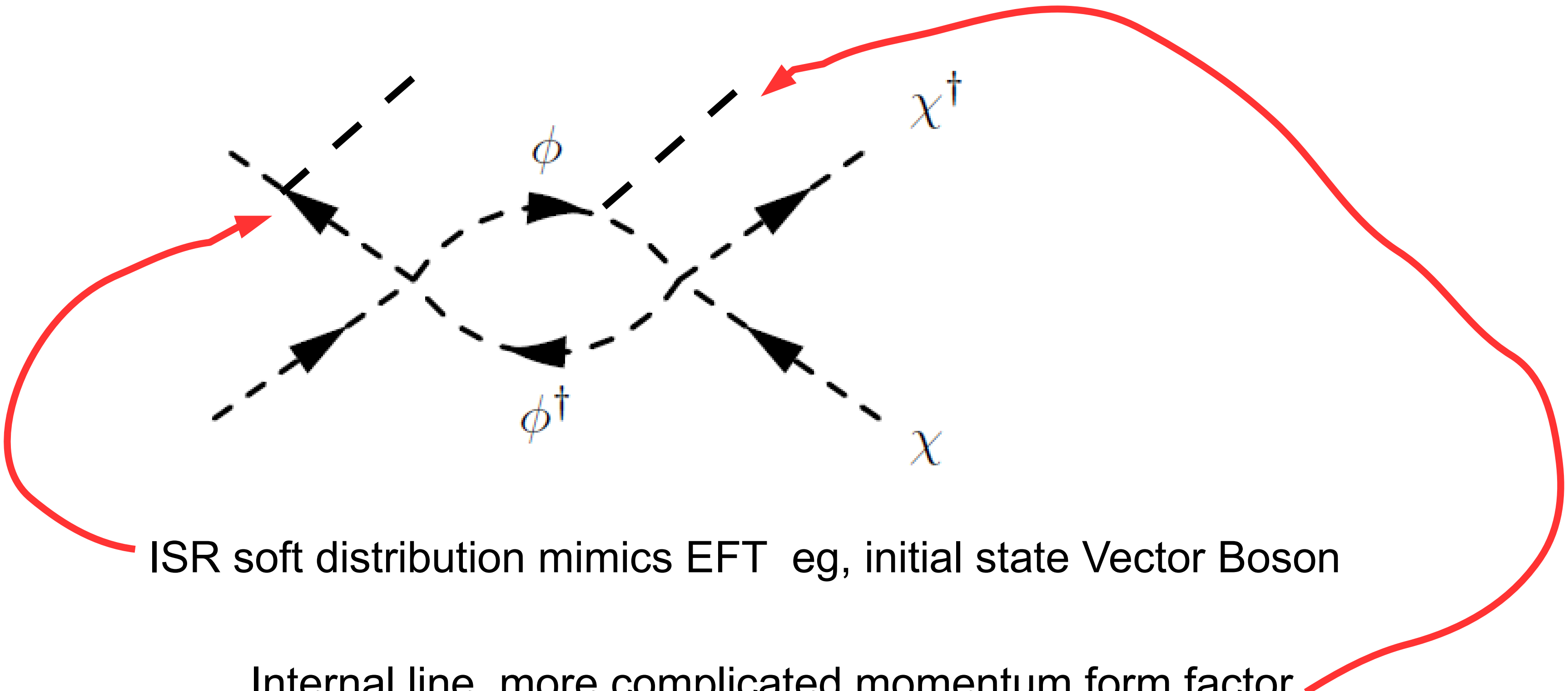
xsec at fixed DM masses





peak

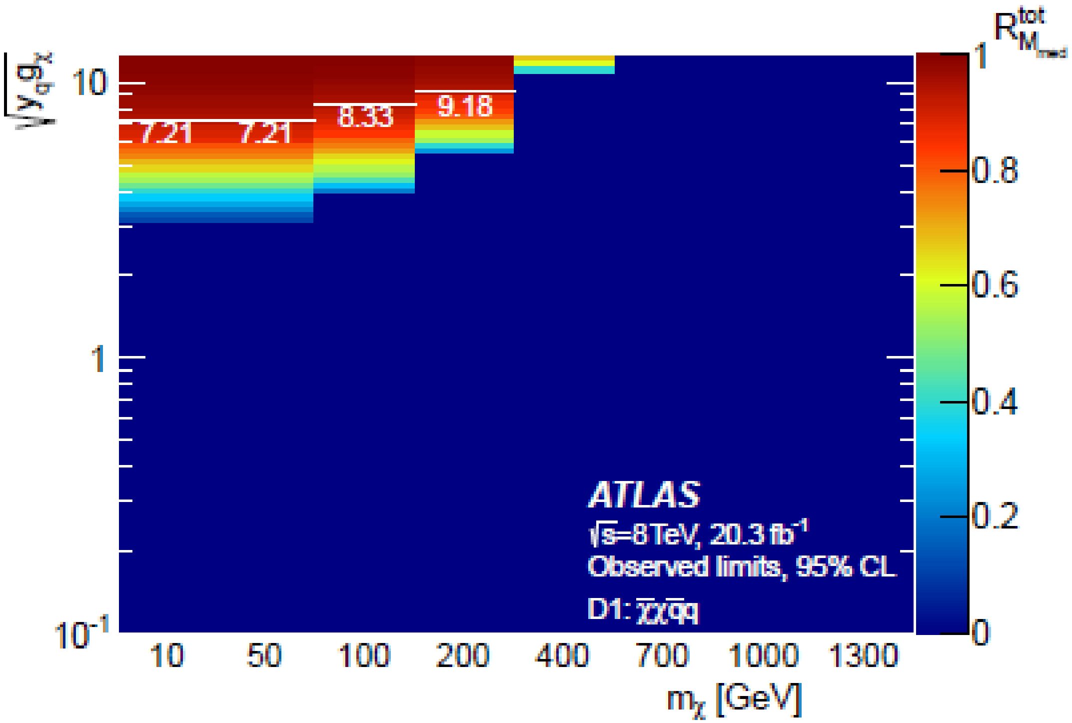
Where is the radiation coming from?



ISR soft distribution mimics EFT eg, initial state Vector Boson

Internal line, more complicated momentum form factor

Extra Slides ATLAS truncation



D11

$$\frac{\alpha_s}{4M_\star^3} = \frac{\alpha_s g_\chi}{M_{\text{med}}^2 \Lambda_s}$$

$$M_{\text{med}} = \sqrt[3]{\frac{4g_\chi}{b}}\, M_\star$$

Let $a = 4b^{-1}$

$$M_{\text{med}}^{\text{D11}} = \sqrt[3]{a g_\chi}\, M_\star$$

$$0 < \sqrt[3]{a g_\chi} < \sqrt[3]{16\pi}$$

1. The starting point is the nominal expected limit on $M_\star$ assuming 100% validity, named $M_\star^{\text{exp}}$. $M_\star^{\text{exp}}$ is set to $M_\star^{\text{in}}$ before executing step 2 for the first time.
2. For each step i, obtain the relative fraction of valid events $R^{\text{i}}_{M_{\text{med}}}$ satisfying $Q_{\text{tr}} < M^{\text{in}}_{\text{med}}$, where $M^{\text{in}}_{\text{med}}$ is the mediator mass limit obtained in the previous step (depending on $M_\star^{\text{in}}$).
3. Truncate $M_\star$ following Ref. [43]: $M_\star^{\text{out}} = \left[R^i_{M_{\text{med}}}\right]^{1/2(d-4)} M_\star^{\text{in}}$, noting that D1 and D11 are dimension $d = 7$ operators, while D5, D8, D9, C1, and C5 are dimension $d = 6$.
4. Go to step 2, using the current $M_\star^{\text{out}}$ as the new $M_\star^{\text{in}}$, repeating until the fraction of valid events at a given step $R^{\text{i}}_{M_{\text{med}}}$ reaches 0 or 1.
5. Calculate the total validity fraction $R^{\text{tot}}_{M_{\text{med}}} = \prod_i R^{\text{i}}_{M_{\text{med}}}$ and the truncated limit on the suppression scale

$$M_\star^{\text{valid}} = \left[R^{\text{tot}}_{M_{\text{med}}}\right]^{1/2(d-4)} M_\star^{\text{exp}}.$$