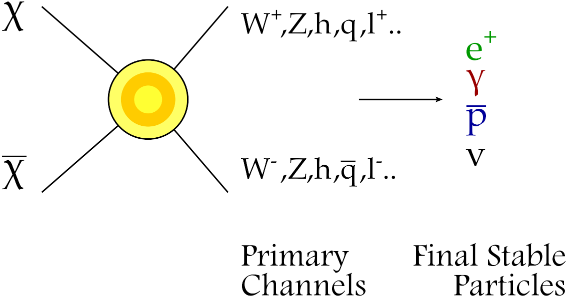
Electroweak Lights from Dark Matter Annihilation

Alfredo Urbano

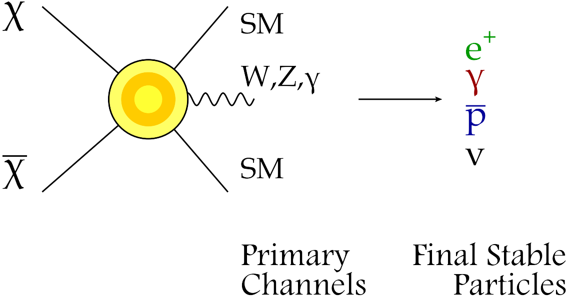
IFAE - Universitat Autònoma de Barcelona

PONT 2011, Avignon 21 April 2011

Stable Particles from DM annihilation



Stable Particles from DM annihilation



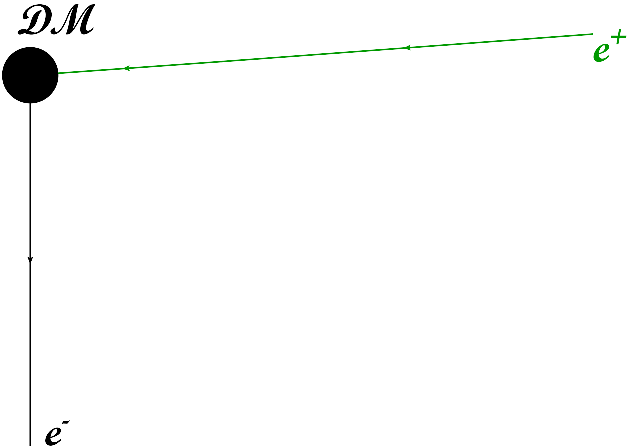
1st Scenario

P.Ciafaloni, D. Comelli, A. Riotto, F. Sala, A. Strumia, A.U.

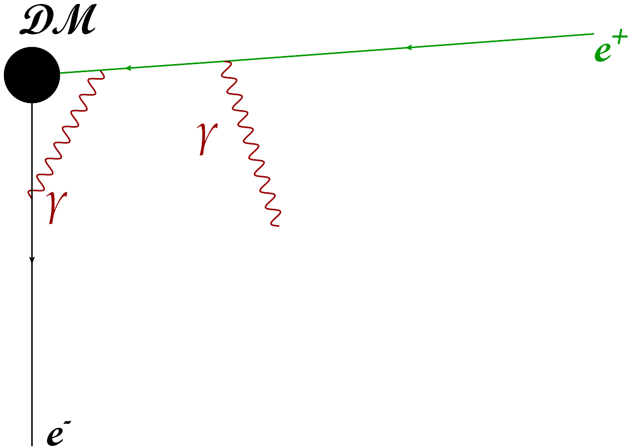
"Weak Corrections are Relevant in Dark Matter Indirect Detection",

JCAP 1103, 019 (2011).

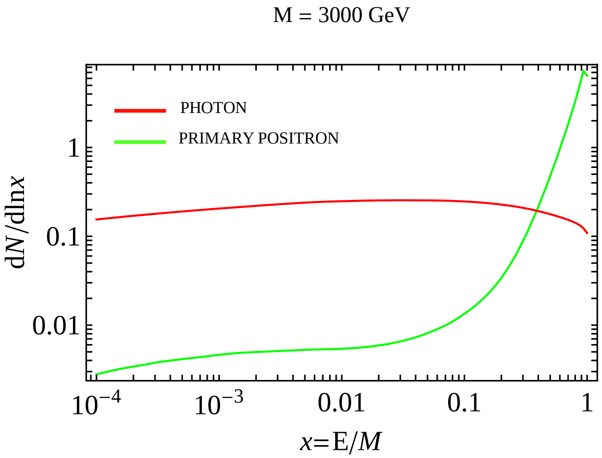
Electroweak Radiative Corrections



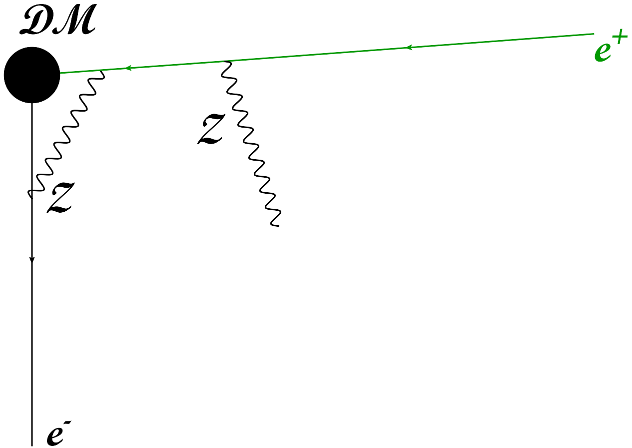
Electroweak Radiative Corrections



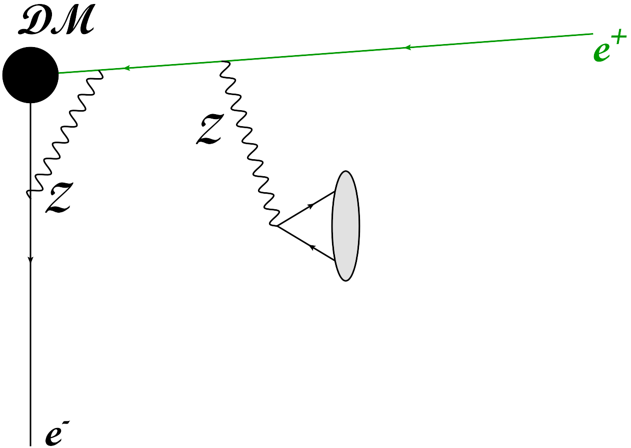
Electroweak Radiative Corrections



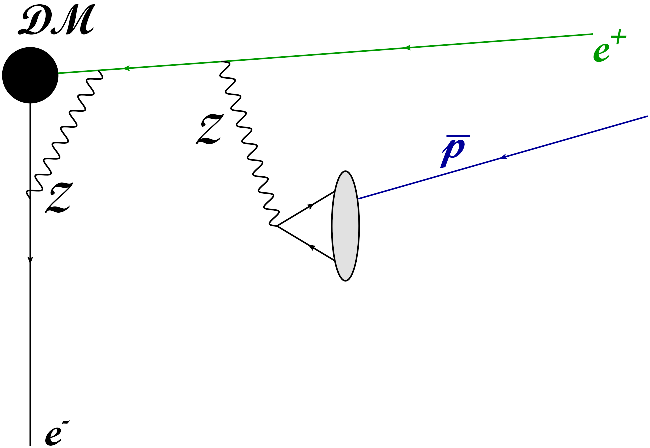
Electroweak Radiative Corrections



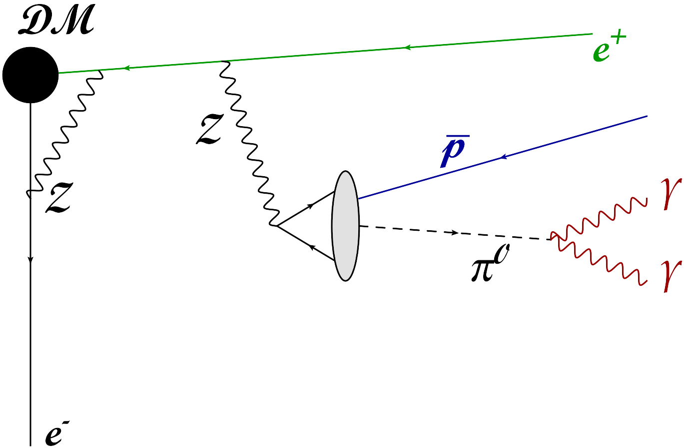
Electroweak Radiative Corrections



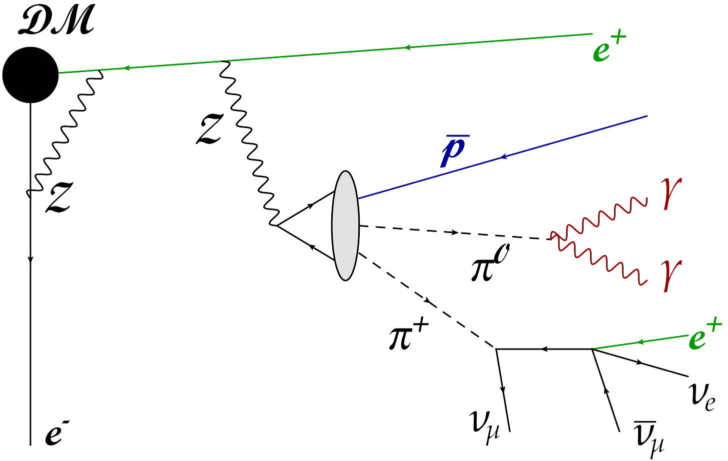
Electroweak Radiative Corrections



Electroweak Radiative Corrections



Electroweak Radiative Corrections



Key Point: log-enhanced terms

$$\frac{\Delta\sigma}{\sigma} = \alpha_W \left(\ln^2 \frac{M^2}{M_W^2} + \ln \frac{M^2}{M_W^2} \right)$$

Key Point: log-enhanced terms

$$\frac{\Delta\sigma}{\sigma} = \alpha_W \left(\ln^2 \frac{M^2}{M_W^2} + \ln \frac{M^2}{M_W^2} \right)$$

α_W → *0.03*

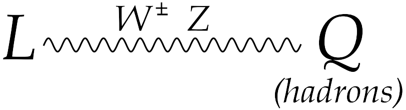
Key Point: log-enhanced terms

$$\frac{\Delta\sigma}{\sigma} = \alpha_W \left(\ln^2\frac{M^2}{M_W^2} + \ln\frac{M^2}{M_W^2} \right)$$

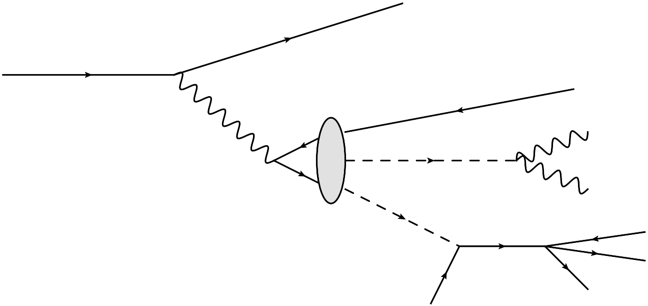
$\alpha_W \to$ *0.3*

$M \sim \mathrm{TeV}$

Key Point: $\mathrm{SU(2)_L \otimes U(1)_Y}$ q.n.

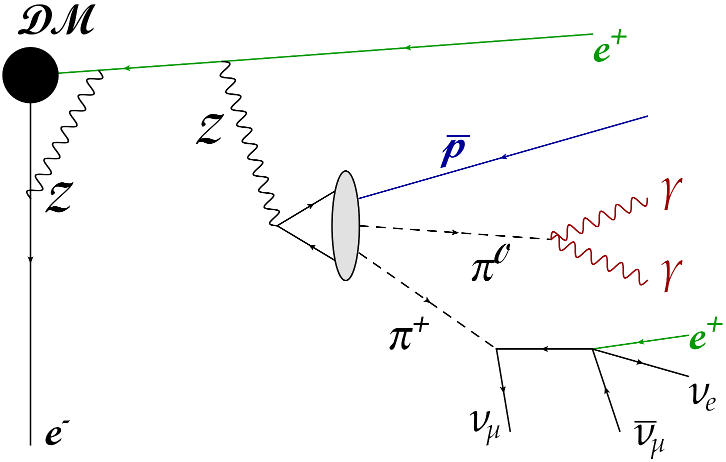


Key Point: Fragmentation of the Energy

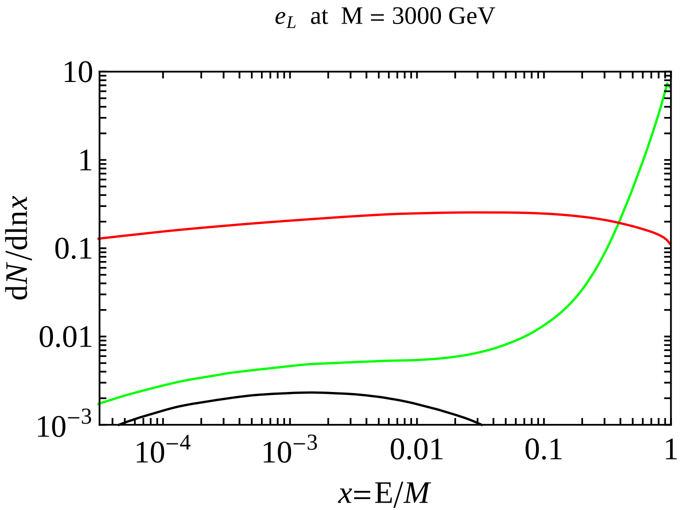


TeV scale *GeV scale*

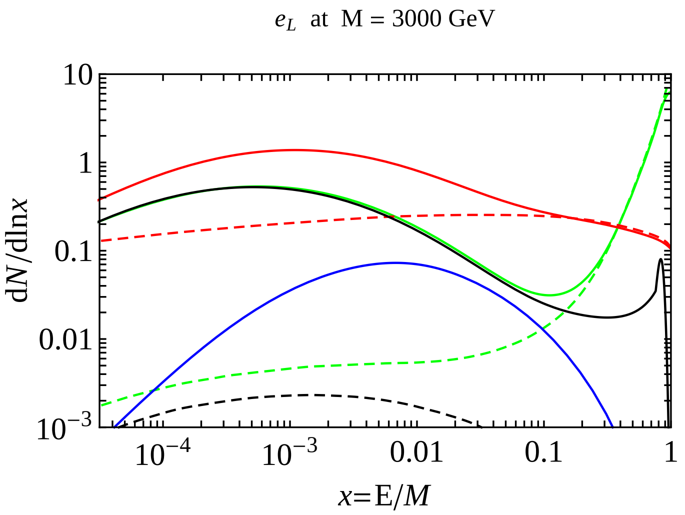
$\mathrm{DM\,DM} \to e^+_L e^-_L$



$\mathrm{DM\,DM} \to e_L^+ e_L^-$

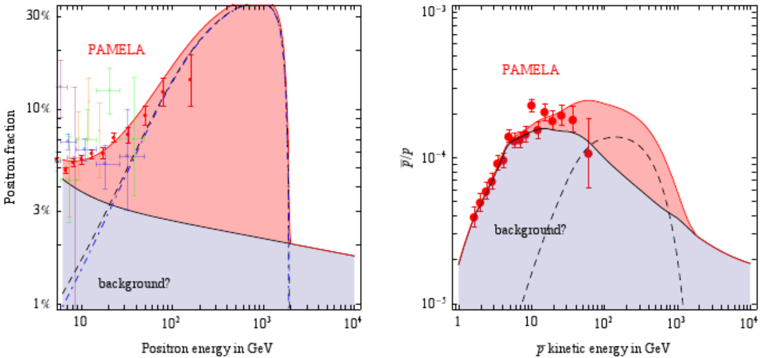


$\mathrm{DM\,DM} \to e_L^+ e_L^-$



PAMELA: $\mathrm{DM\,DM} \to \mu_L^+ \mu_L^-$

DM DM $\to \mu_L^+ \mu_L^-$ with $M = 2.$ TeV, MED, NFW



2^{nd} Scenario

P.Ciafaloni, M. Cirelli, D. Comelli, A. De Simone, A. Riotto, A.U.

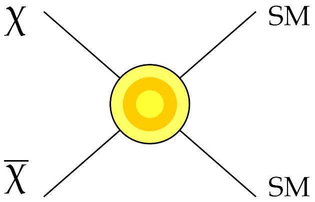
"On the Importance of Electroweak Corrections for Majorana Dark Matter Indirect Detection."

ArXiv:1104:2996

2^{nd} Scenario

$$v\sigma(2 \rightarrow 2) = a + bv^2$$

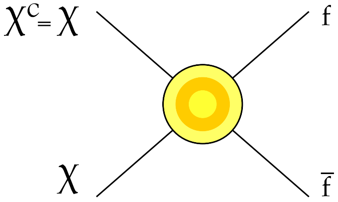
"s-wave" (→ a) "p-wave" (→ bv^2)



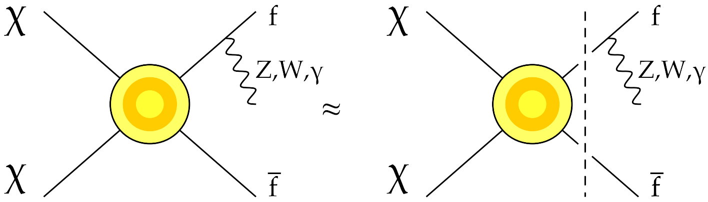
2^{nd} Scenario

$$v\sigma(2 \to 2) = \cancel{a} + bv^2$$

p-wave suppression
(remember $v = 10^{-3}$)



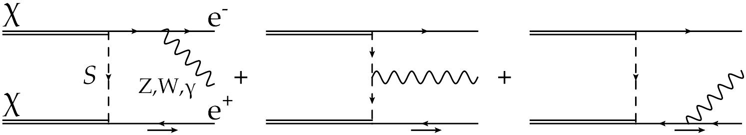
2^{nd} Scenario



$$v\sigma(2 \to 3) \approx v\sigma(2 \to 2) \cdot D^{EW}$$

still $a = 0$!

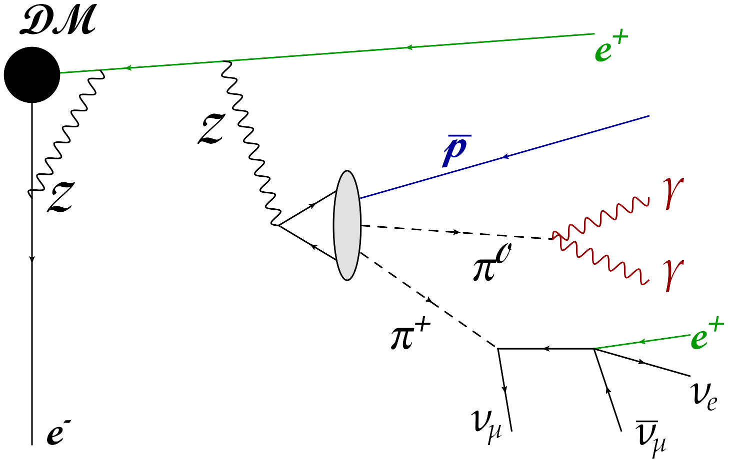
2nd Scenario



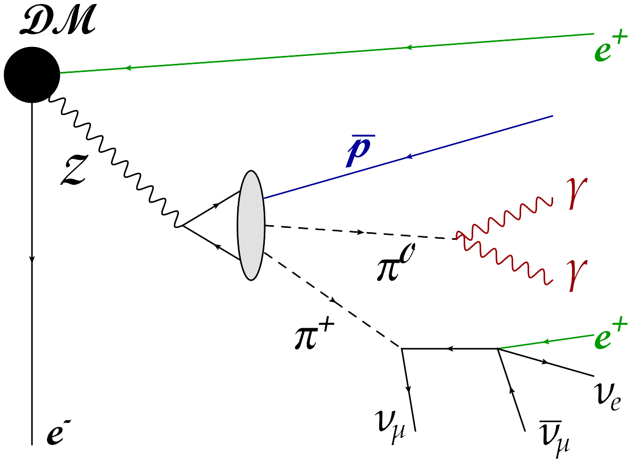
$$v\sigma(2\to 3) = a + bv^2$$

see L.Bergstrom, Phys. Lett. B225, 372 (1989) for γ

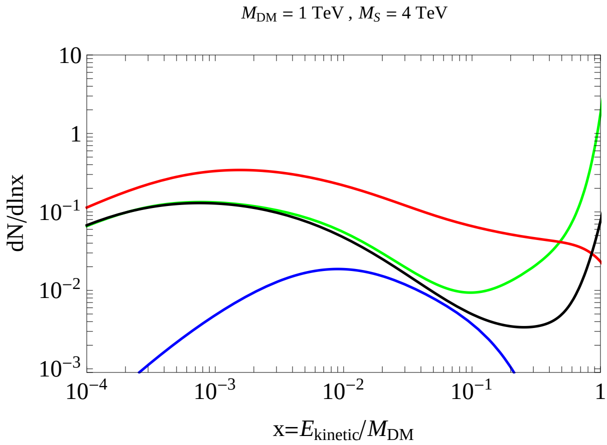
Electroweak Radiative Corrections



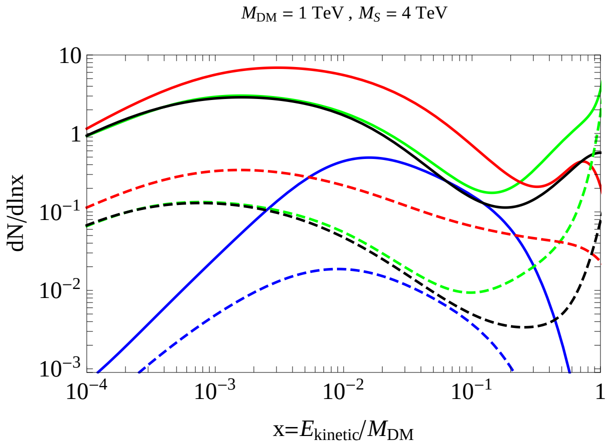
Electroweak Radiative Corrections



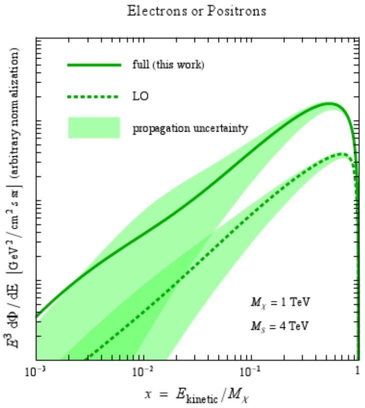
Energy Spectra Majorana DM

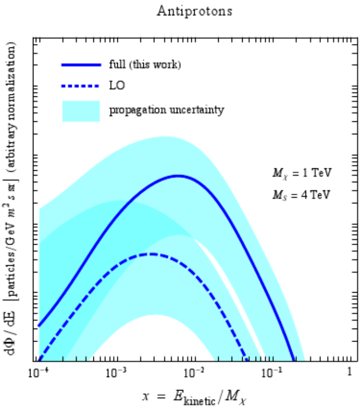


Energy Spectra Majorana DM



Energy Spectra after propagation



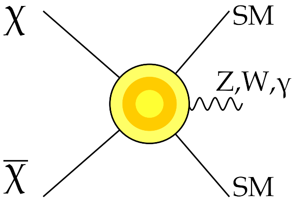


Conclusions

- Relevant for energy spectra when DM mass is much larger than EW scale
- Relevant when there is a suppression mechanism for the 2-body cross section
- All final stable particles are present
- The low energy part can be greatly enhanced

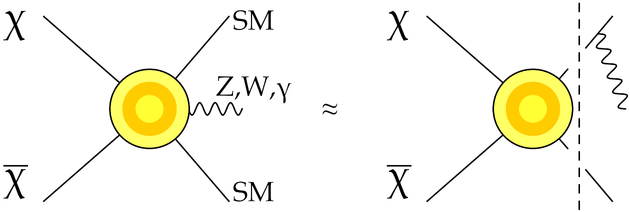
BACKUP ARGUMENTS

1^{st} Scenario



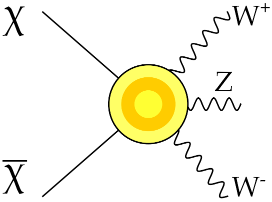
$v\sigma(2 \to 3)$

1^{st} Scenario

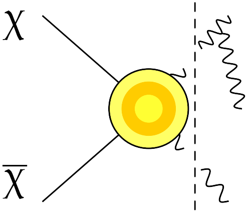


$$v\sigma(2 \to 3) \approx v\sigma(2 \to 2) \cdot D^{EW}$$

1^{st} Scenario

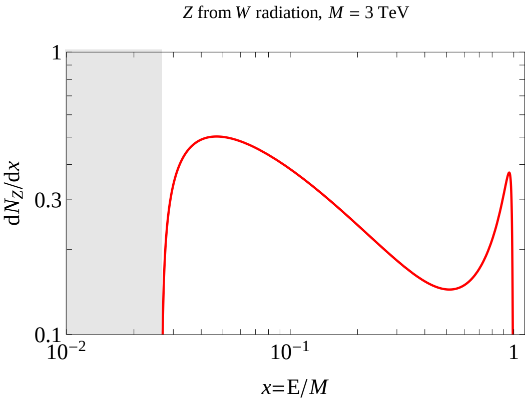


≈



$$v\sigma(2 \rightarrow 3) \approx v\sigma(2 \rightarrow 2) \cdot D^{EW}$$

1^{st} Scenario



1^{st} Scenario