

A vibrant underwater scene from the movie Finding Nemo. In the foreground, Dory, a blue tang with a yellow tail, is smiling and looking towards the right. Next to her are Nemo, an orange clownfish with white stripes, and his father Marlin, also an orange clownfish with white stripes. In the background, there are several other fish, including a yellow tang, a purple tang, and a black and white striped tang. A pink starfish with a face is in the upper right corner. The bottom of the image shows purple coral and a small yellow seahorse. The title 'FINDING SUSY' is written in large, white, bold letters across the middle of the image.

FINDING SUSY

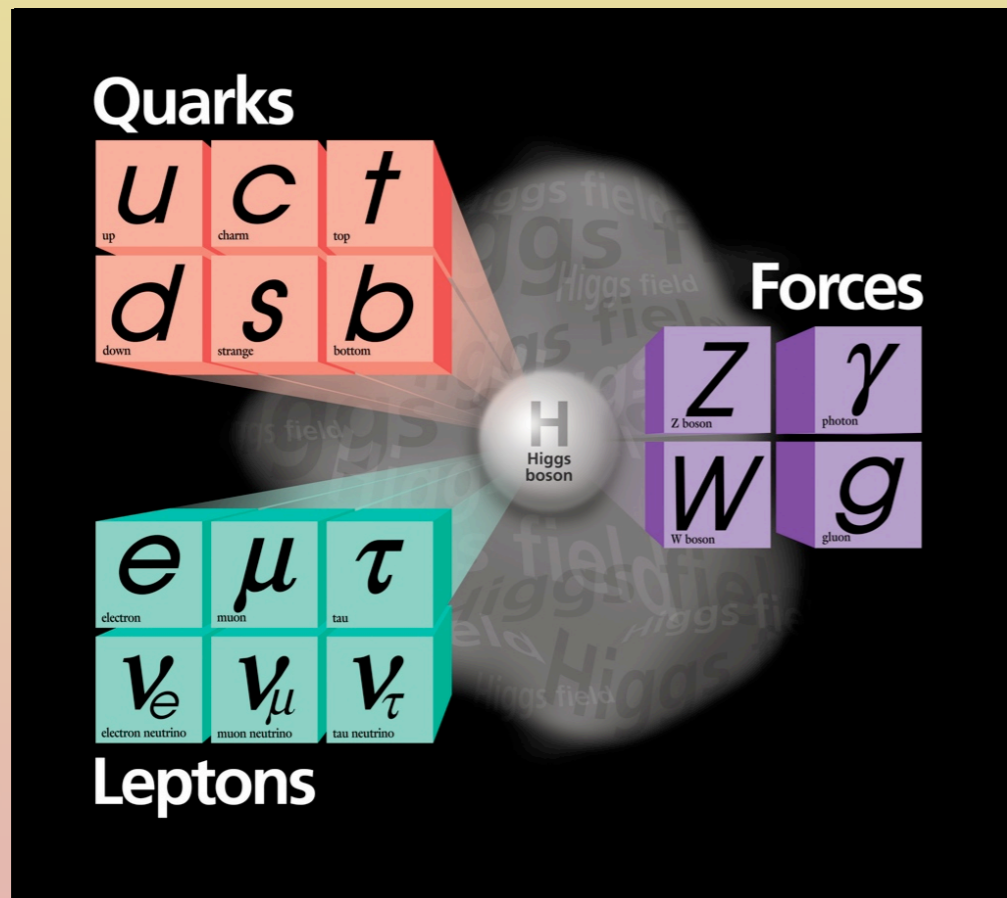
**With: W. Beenakker, S. Brensing,
M. Krämer, A Kulesza, E. Laenen
and I. Niessen**

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Supersymmetry

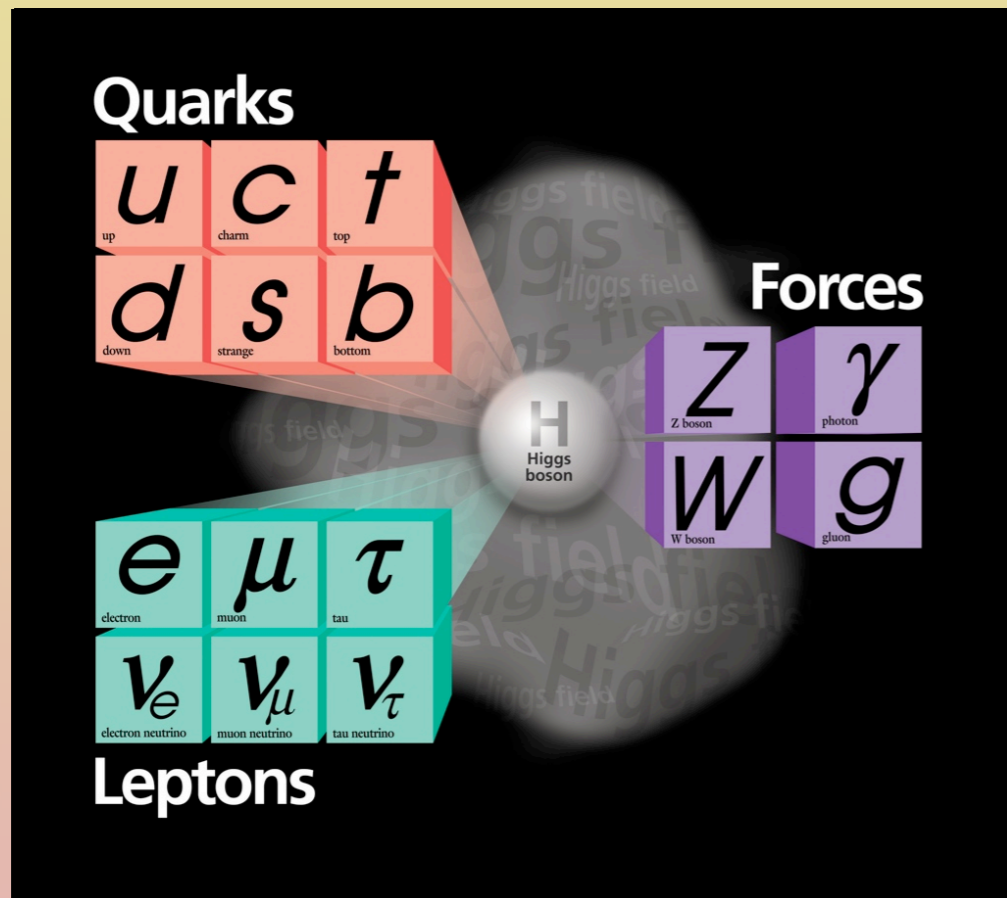


The Standard Model

Supersymmetry

Gauge coupling unification?

Dark Matter?



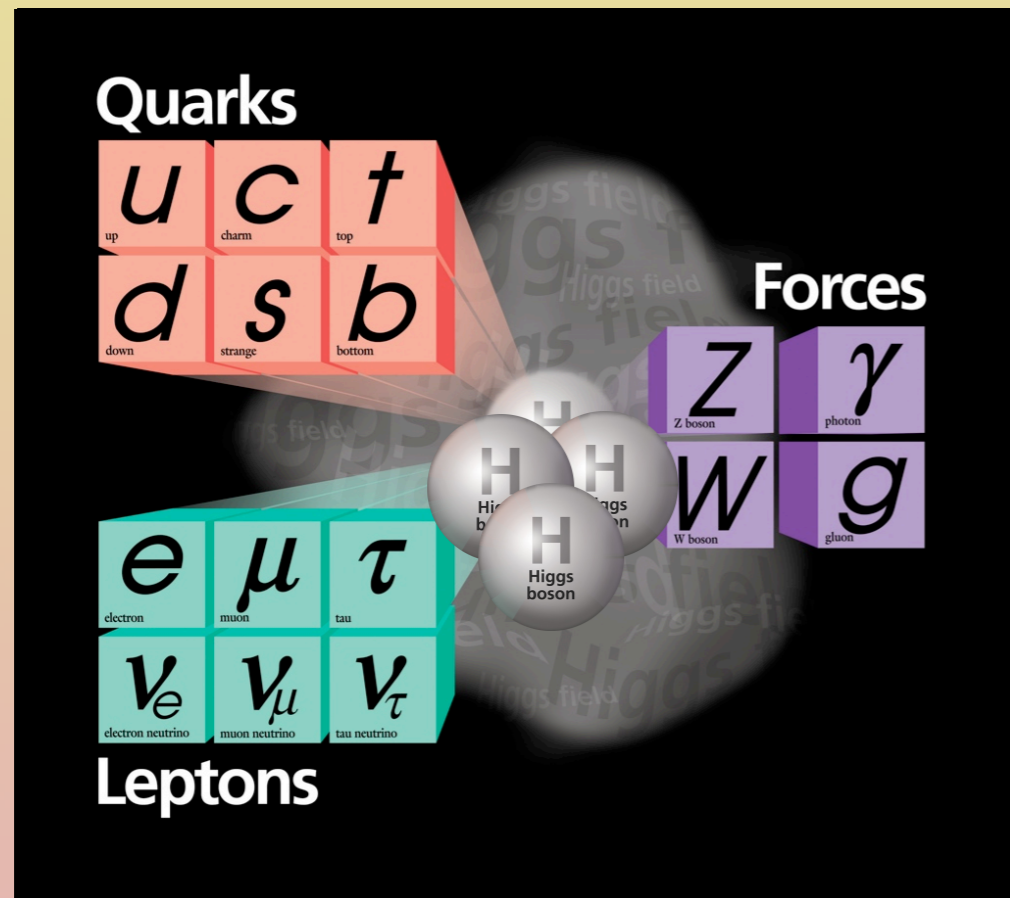
The Standard Model

Hierarchy problem?

Supersymmetry

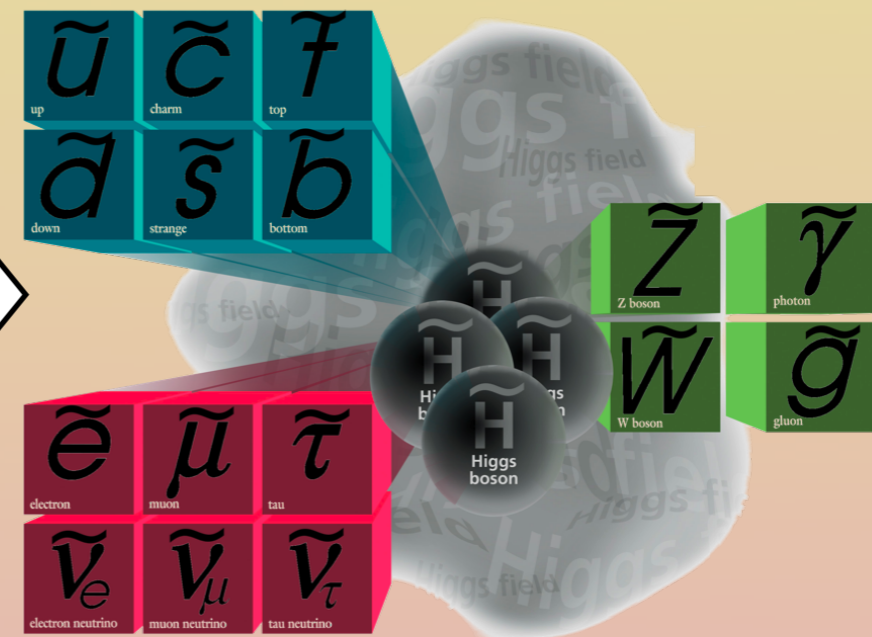
Gauge coupling unification?

Dark Matter?



The Standard Model

SUSY

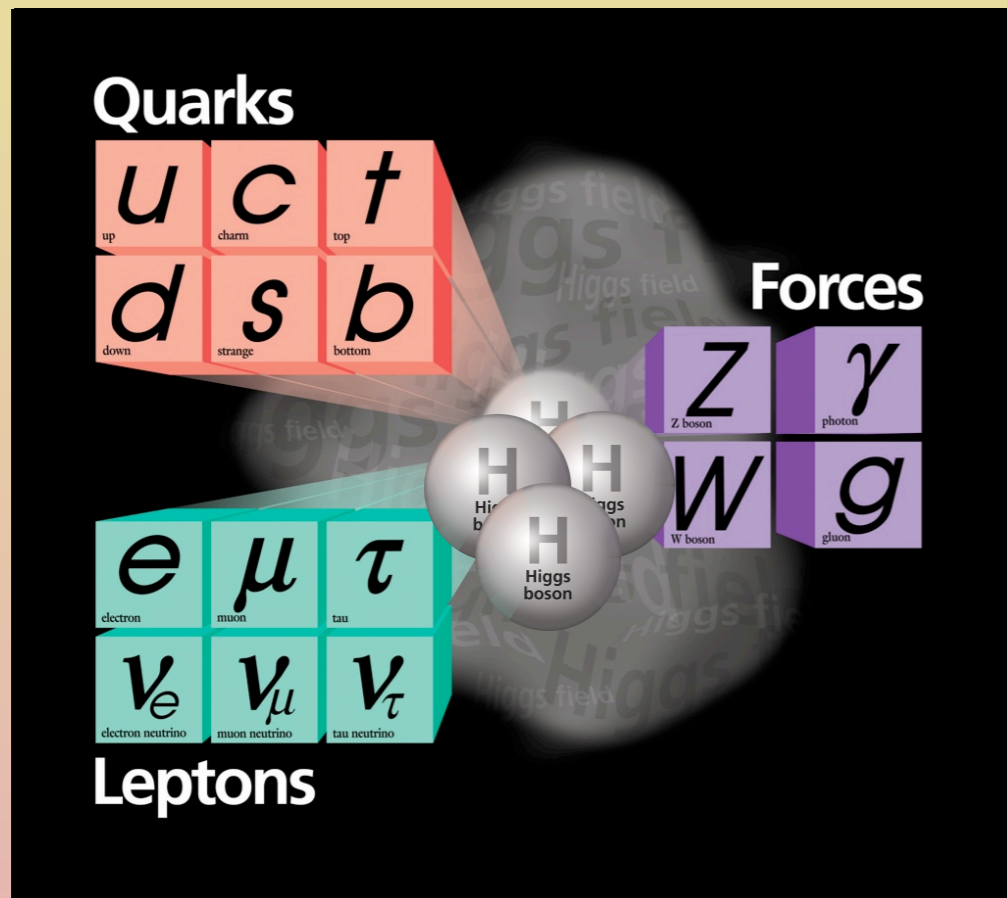


Hierarchy problem?

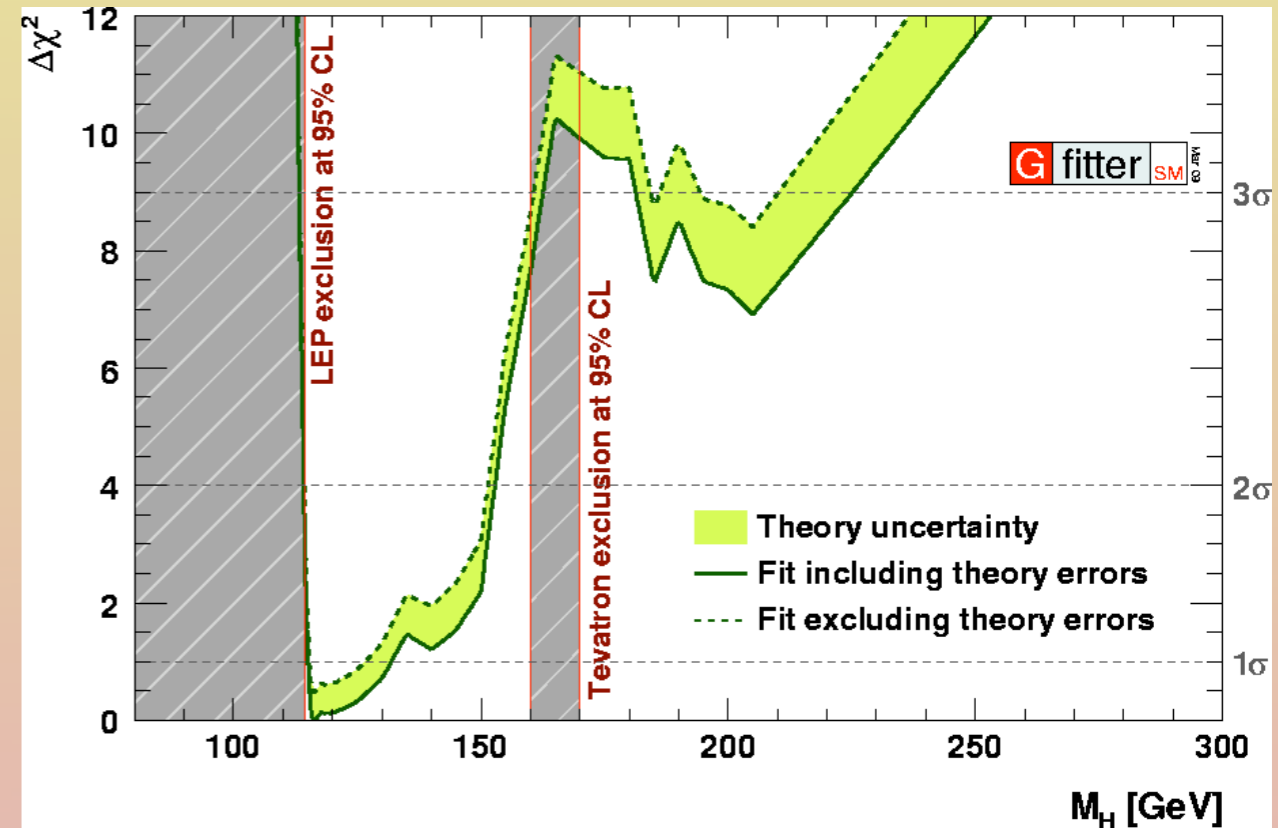
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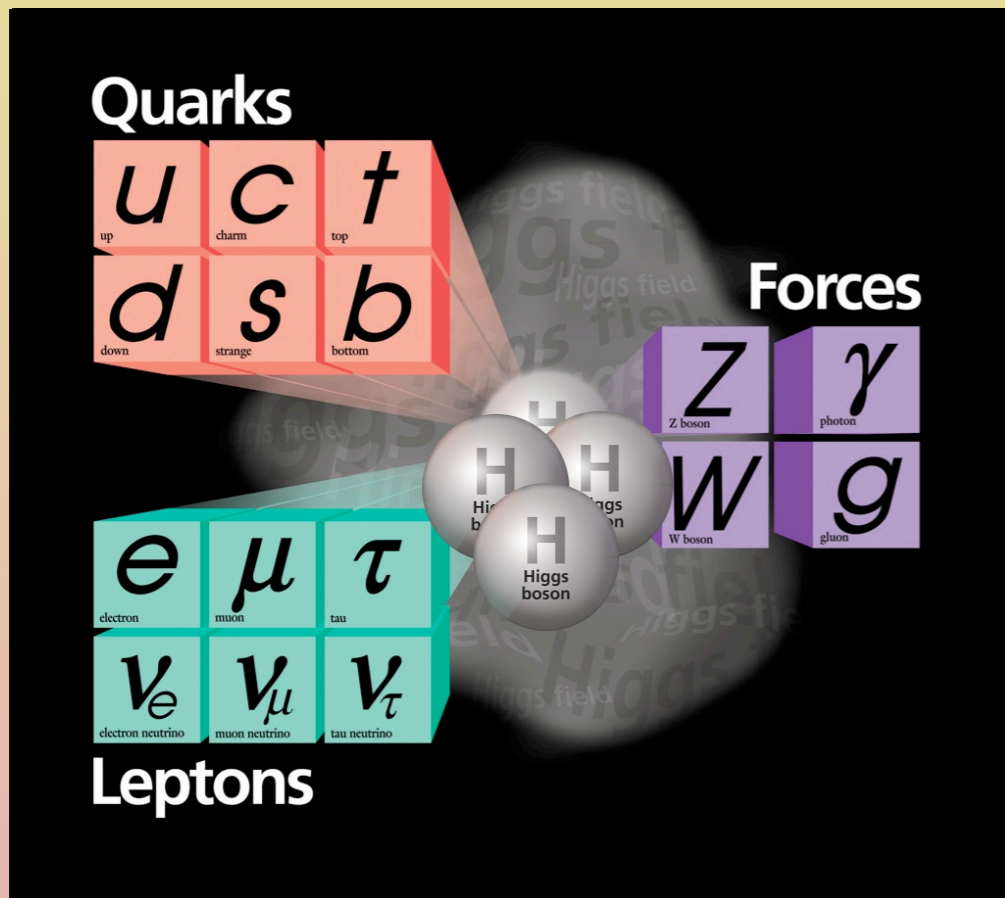


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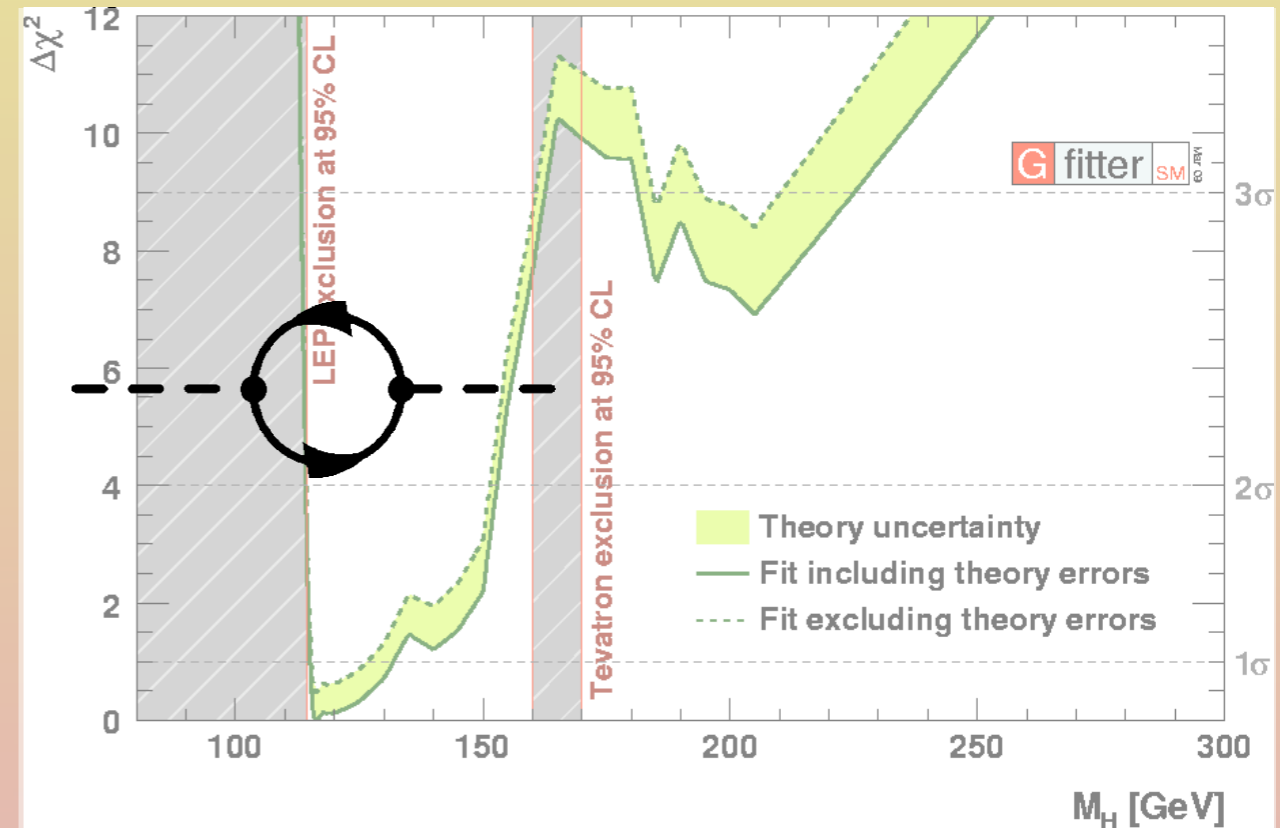
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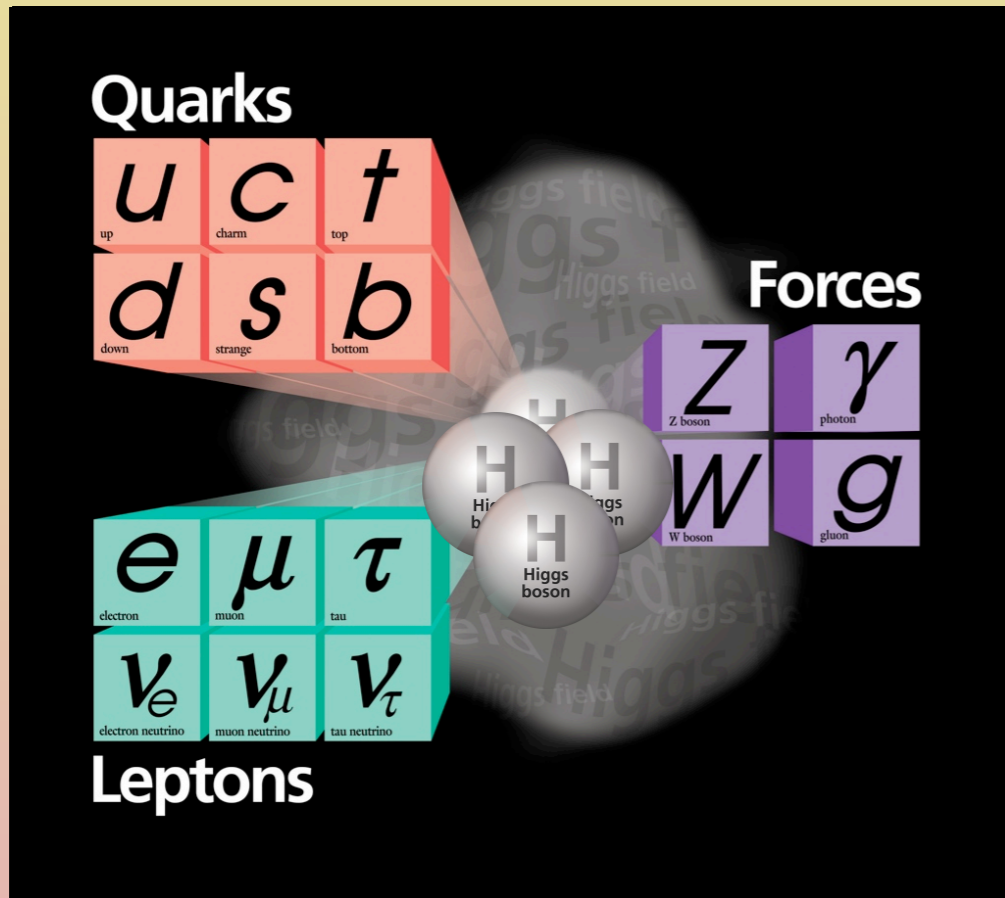


Hierarchy problem?

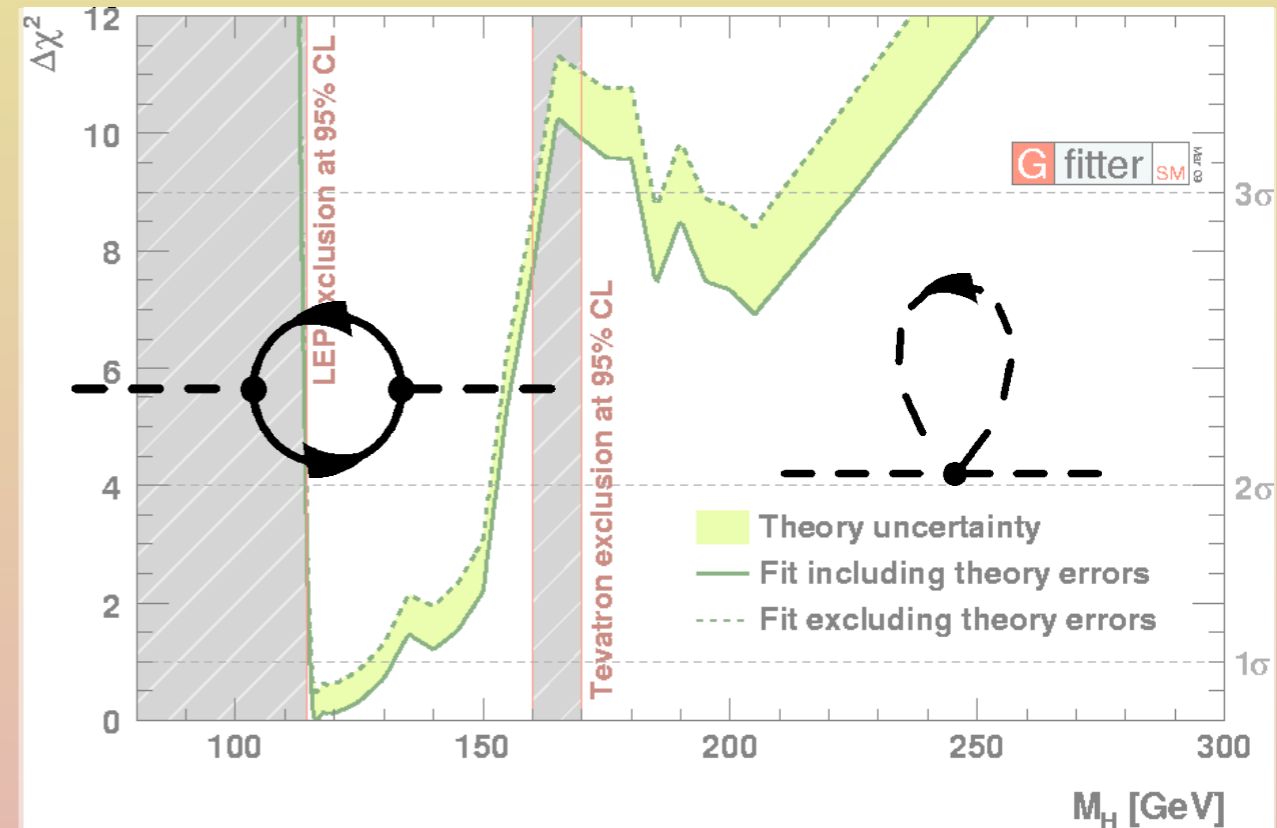
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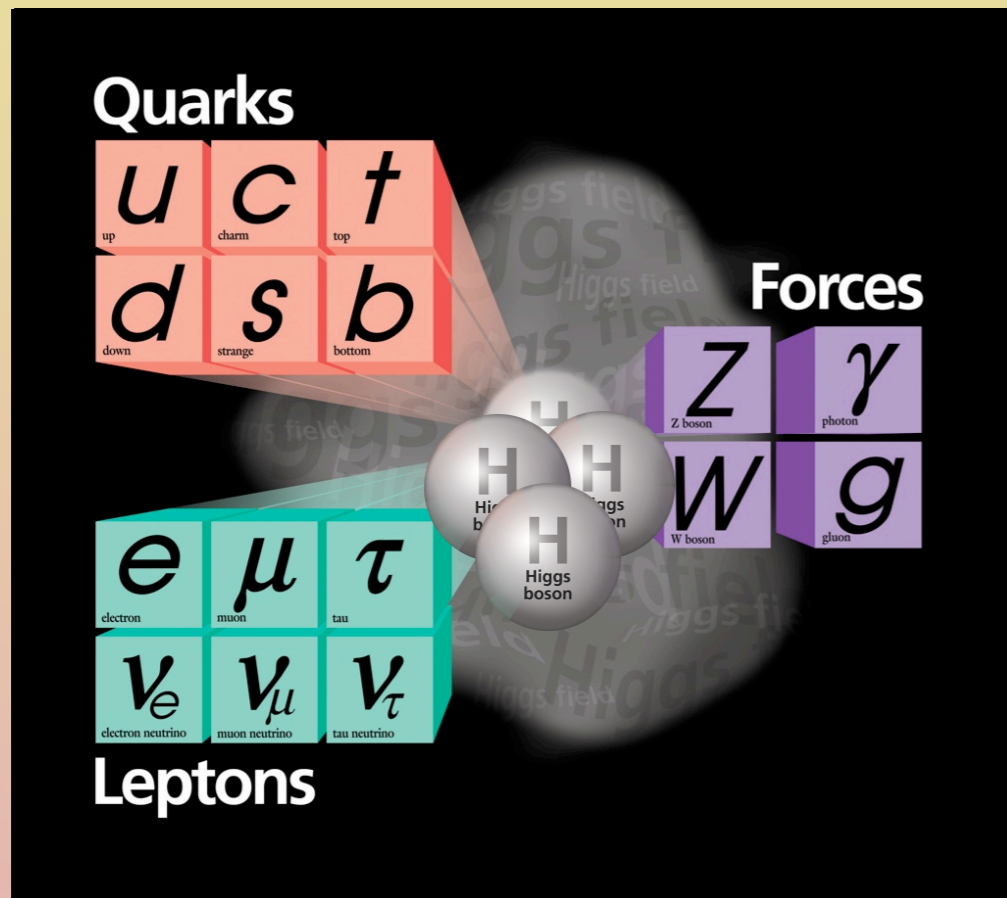


Hierarchy problem!

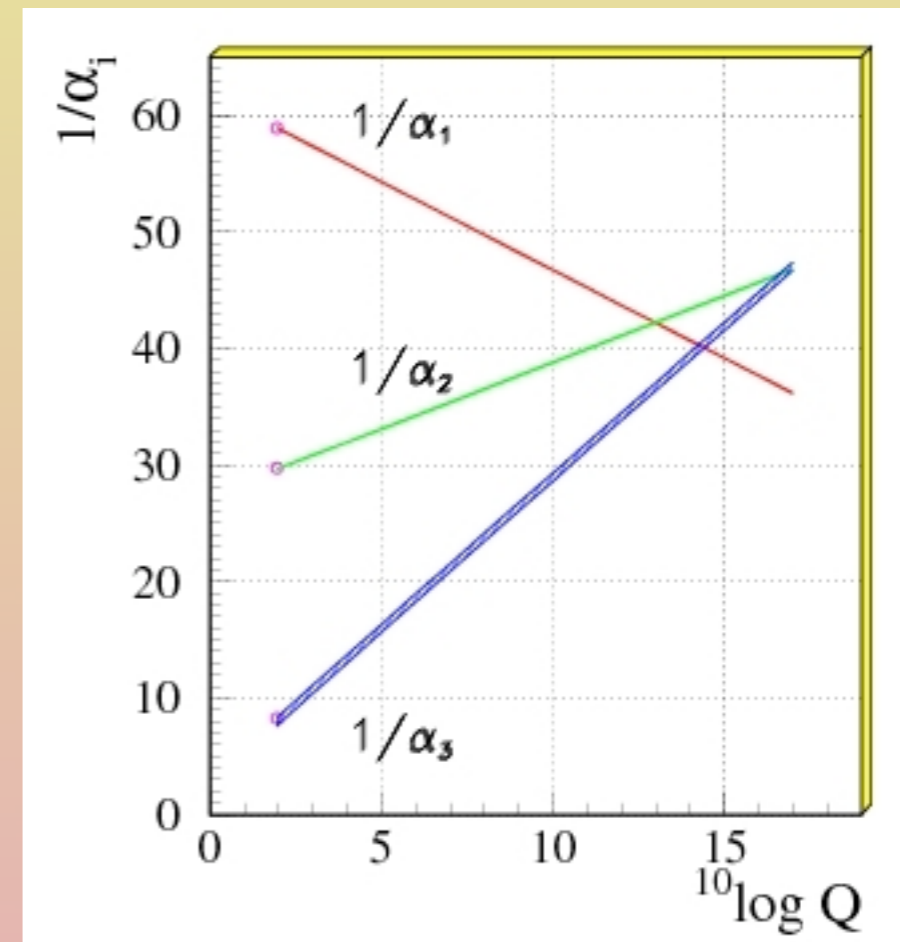
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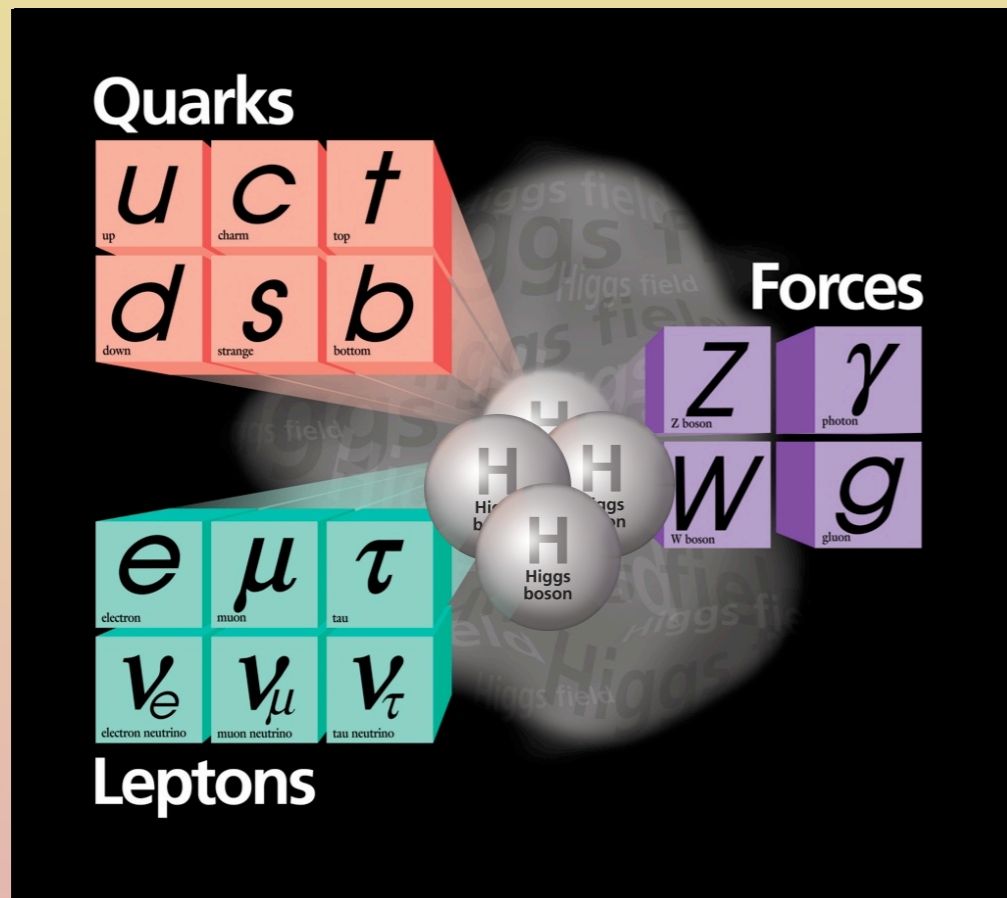


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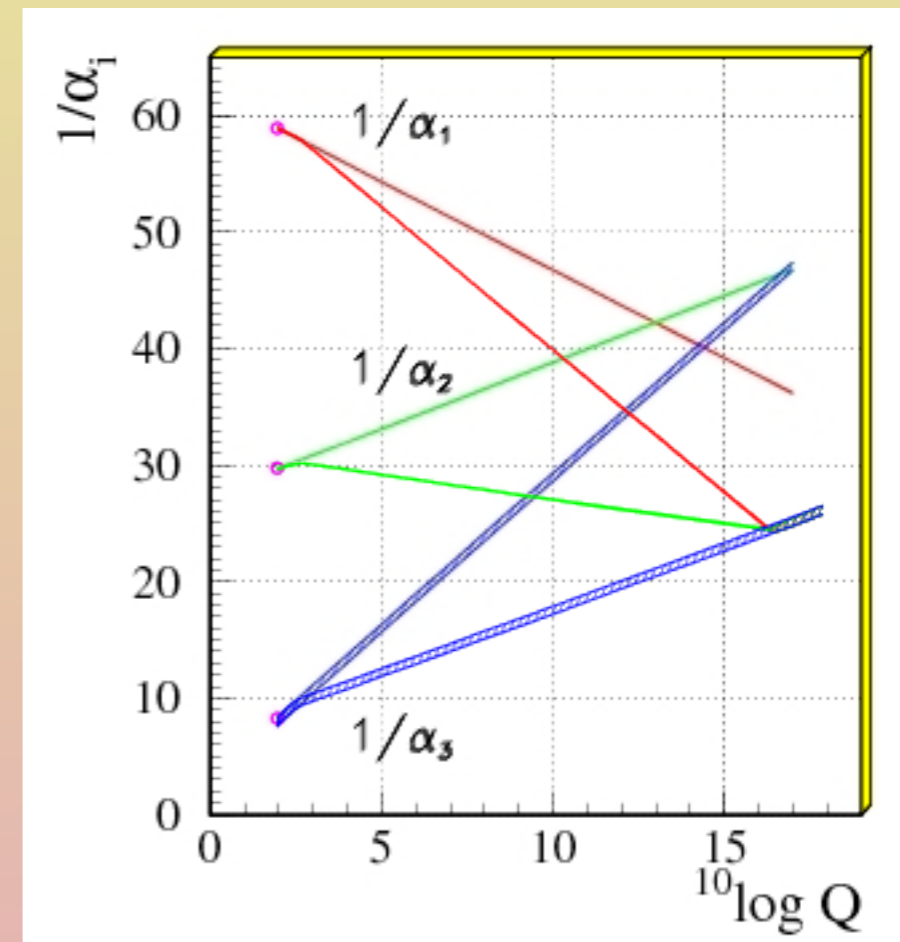
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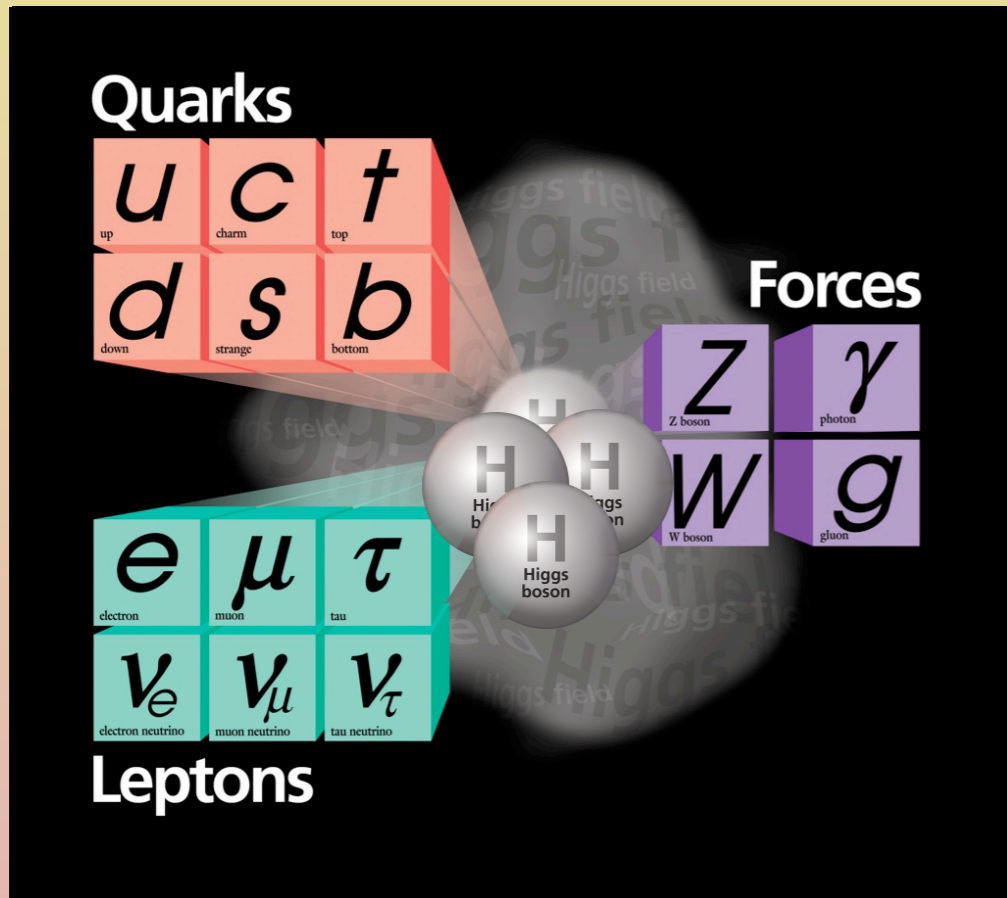


Hierarchy problem!

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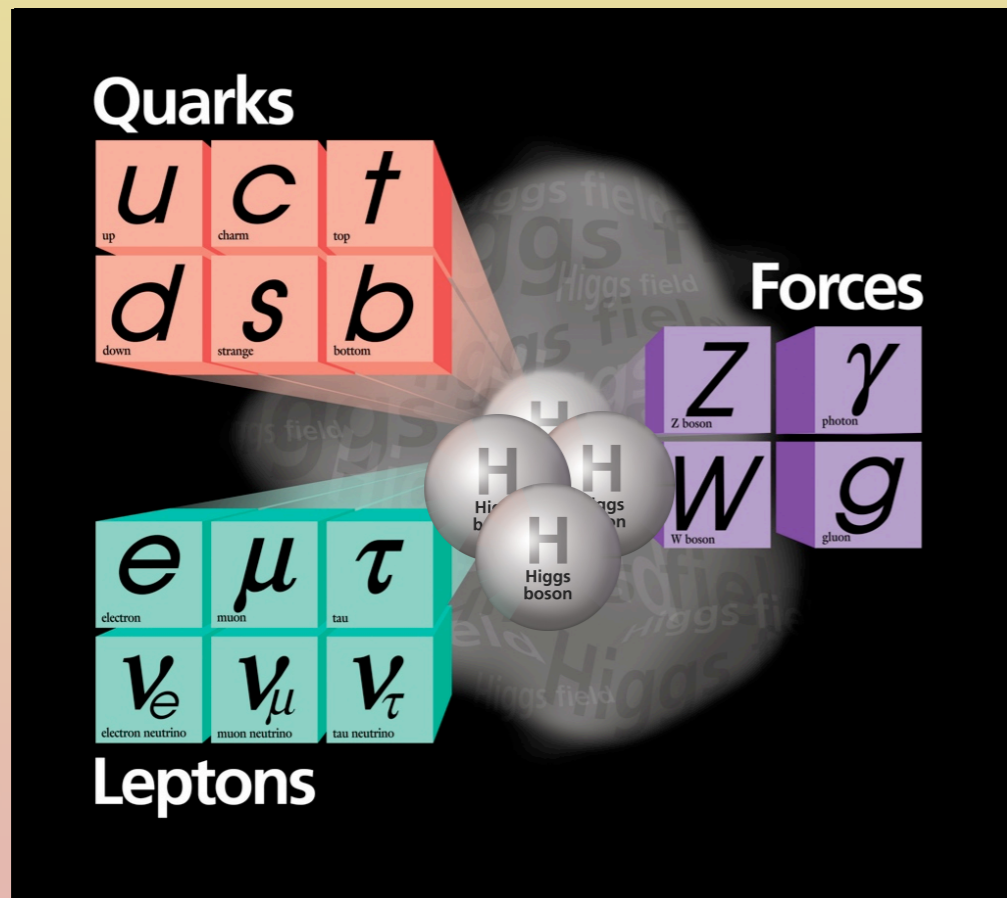


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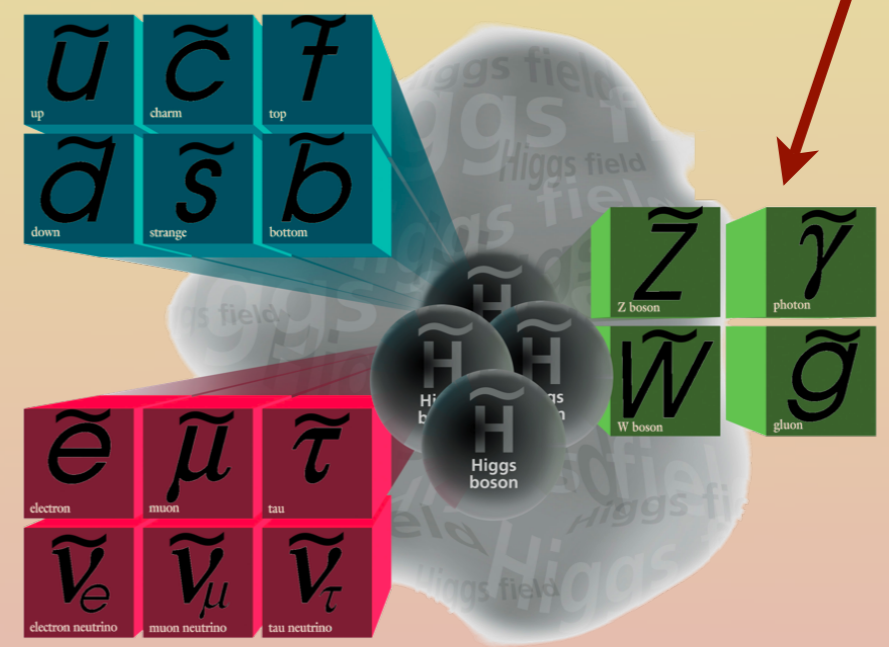
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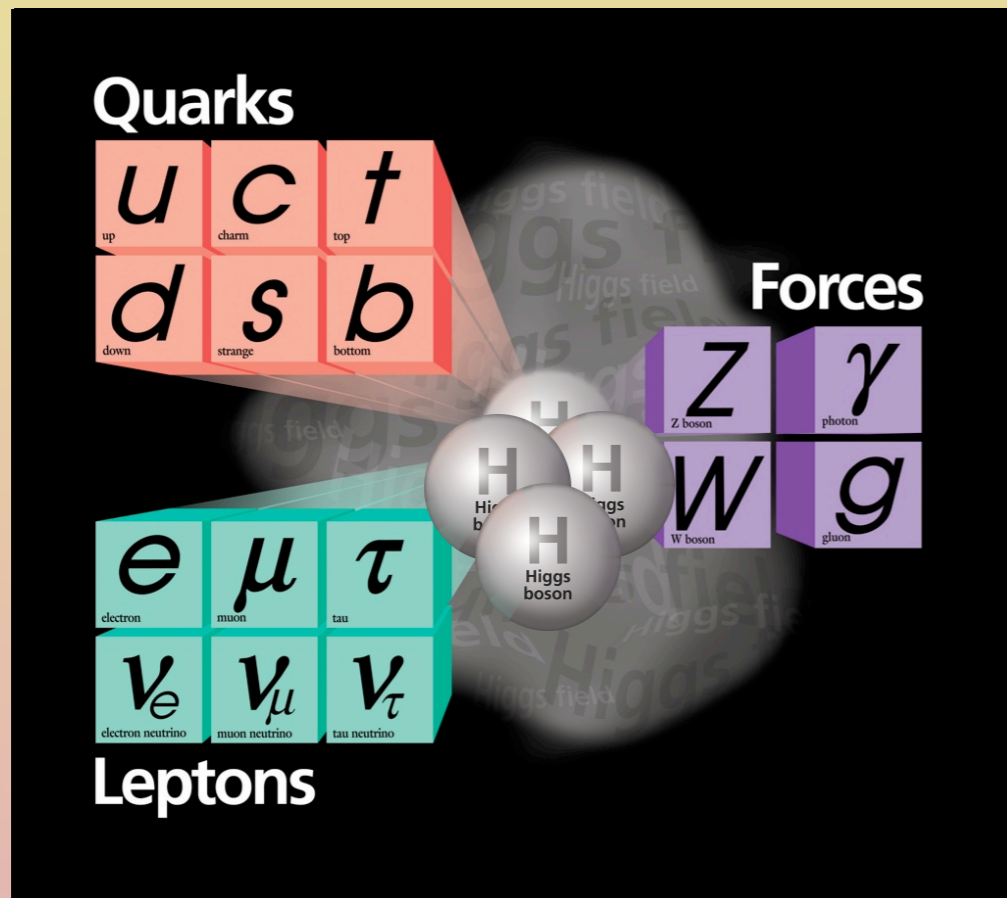


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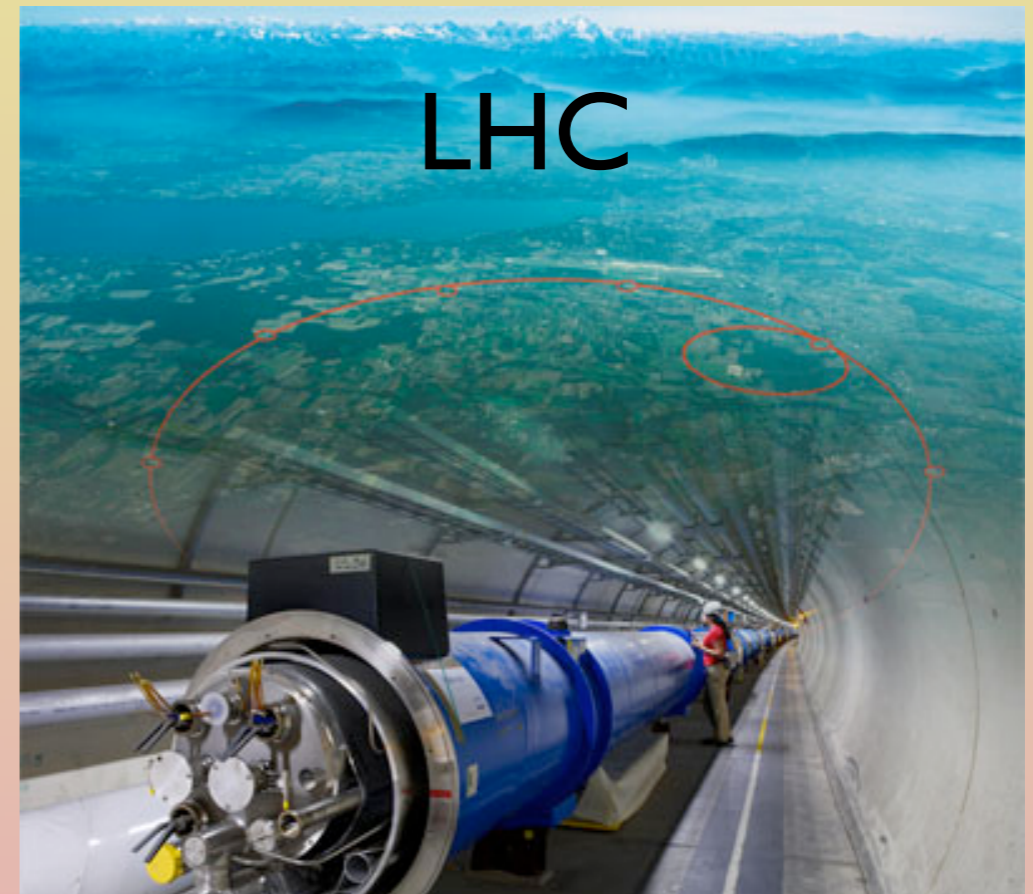
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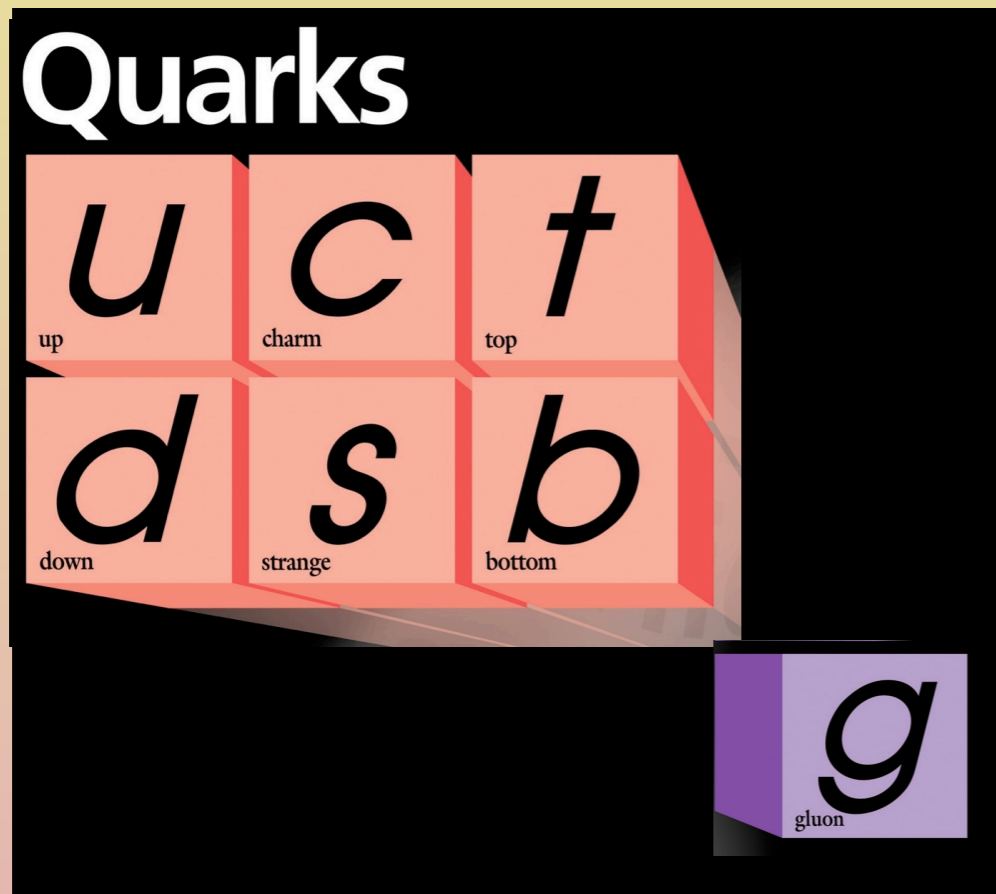


Hierarchy problem!

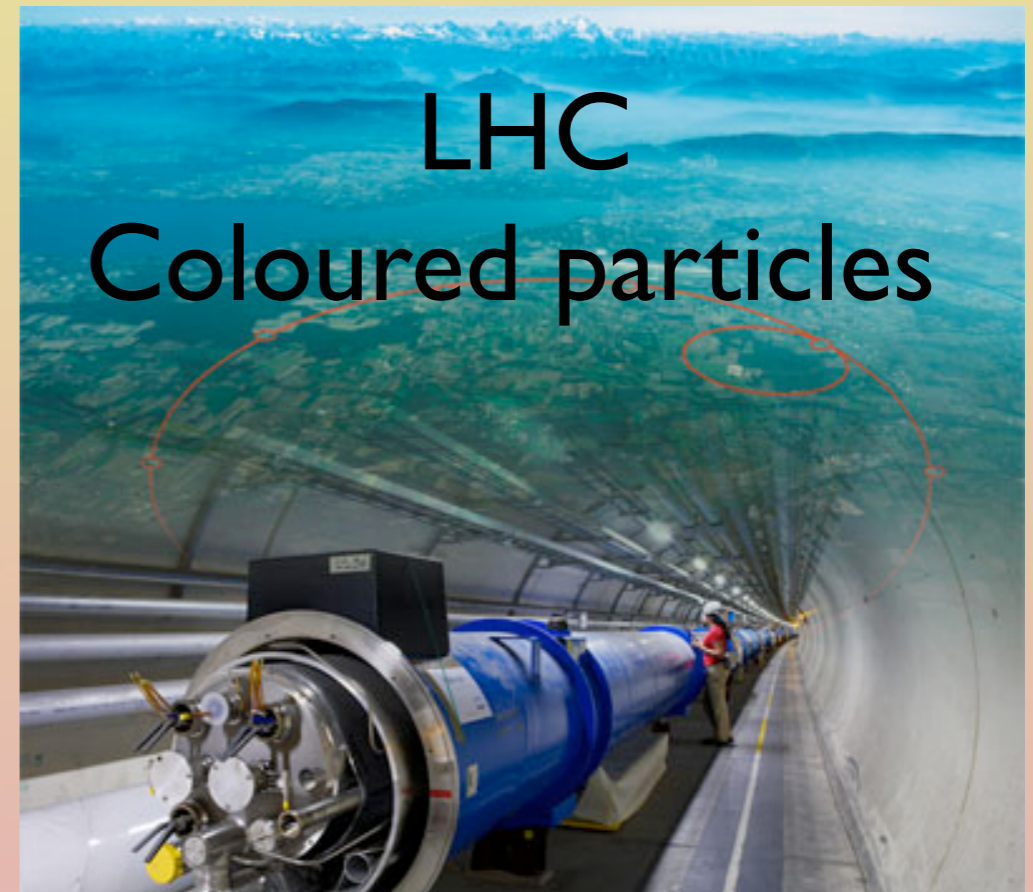
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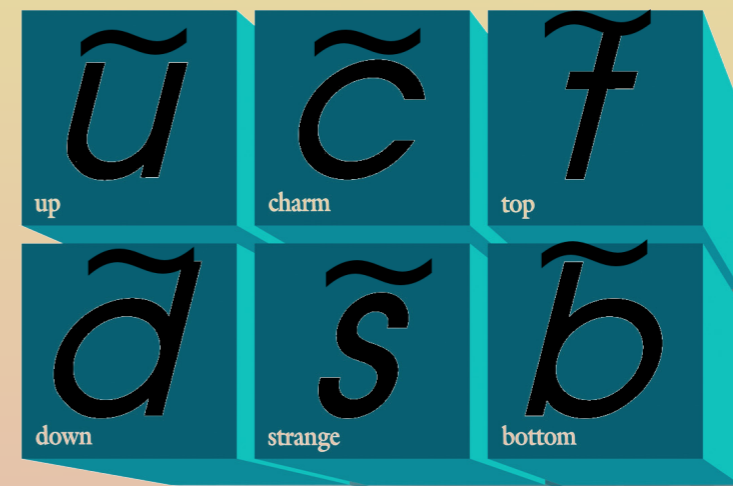
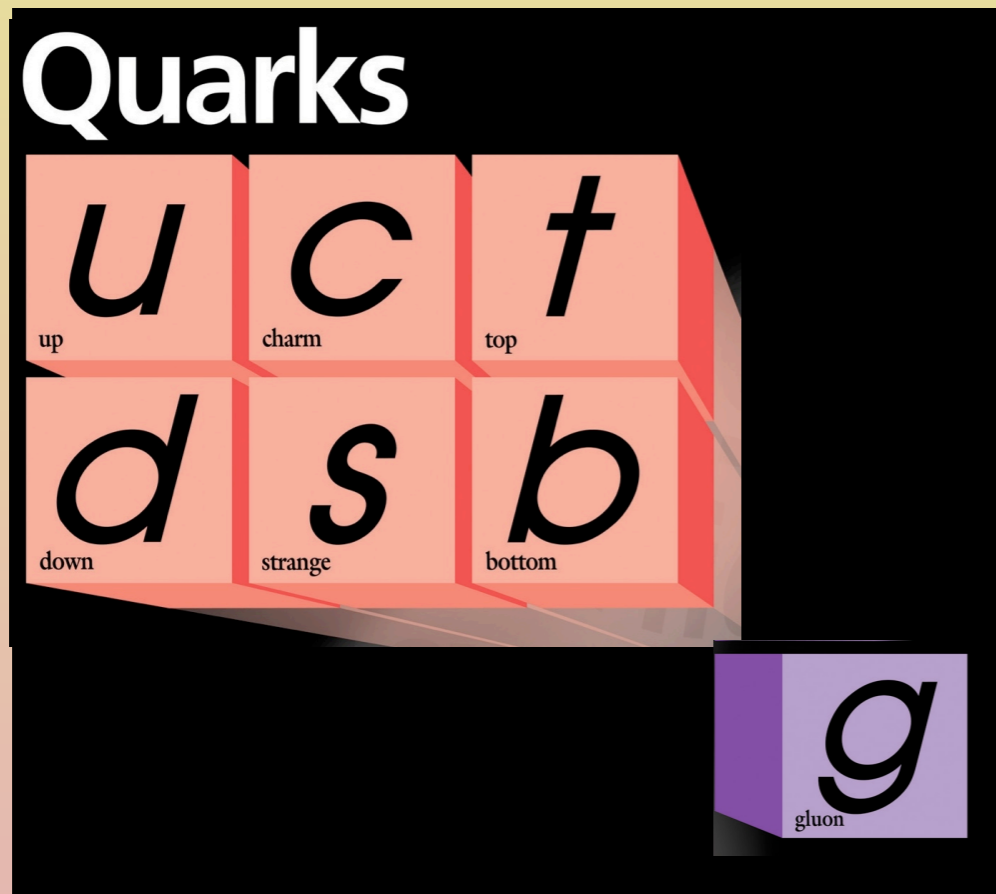


Hierarchy problem!

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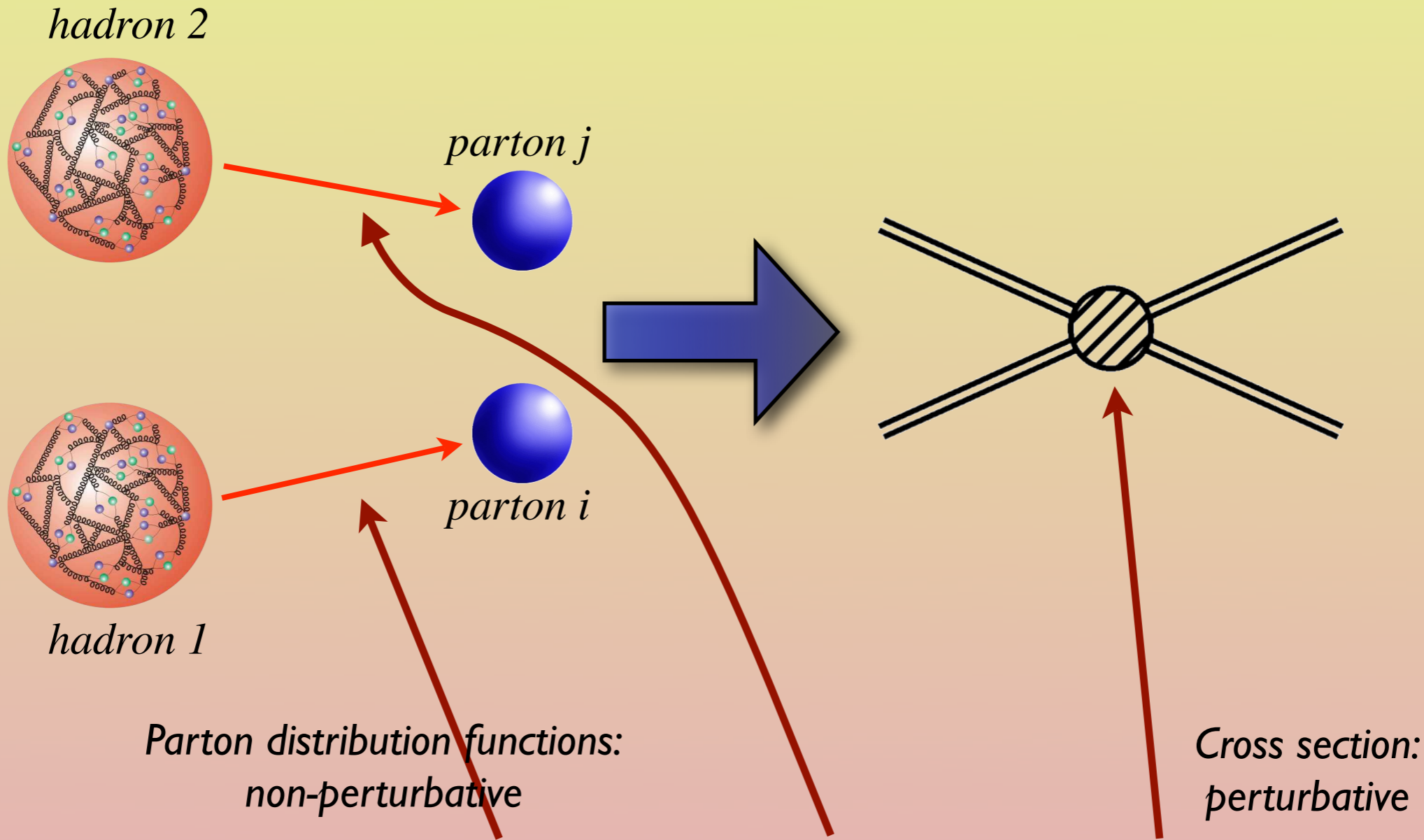


Coloured SUSY particles produced abundantly, so look at squark and gluino production



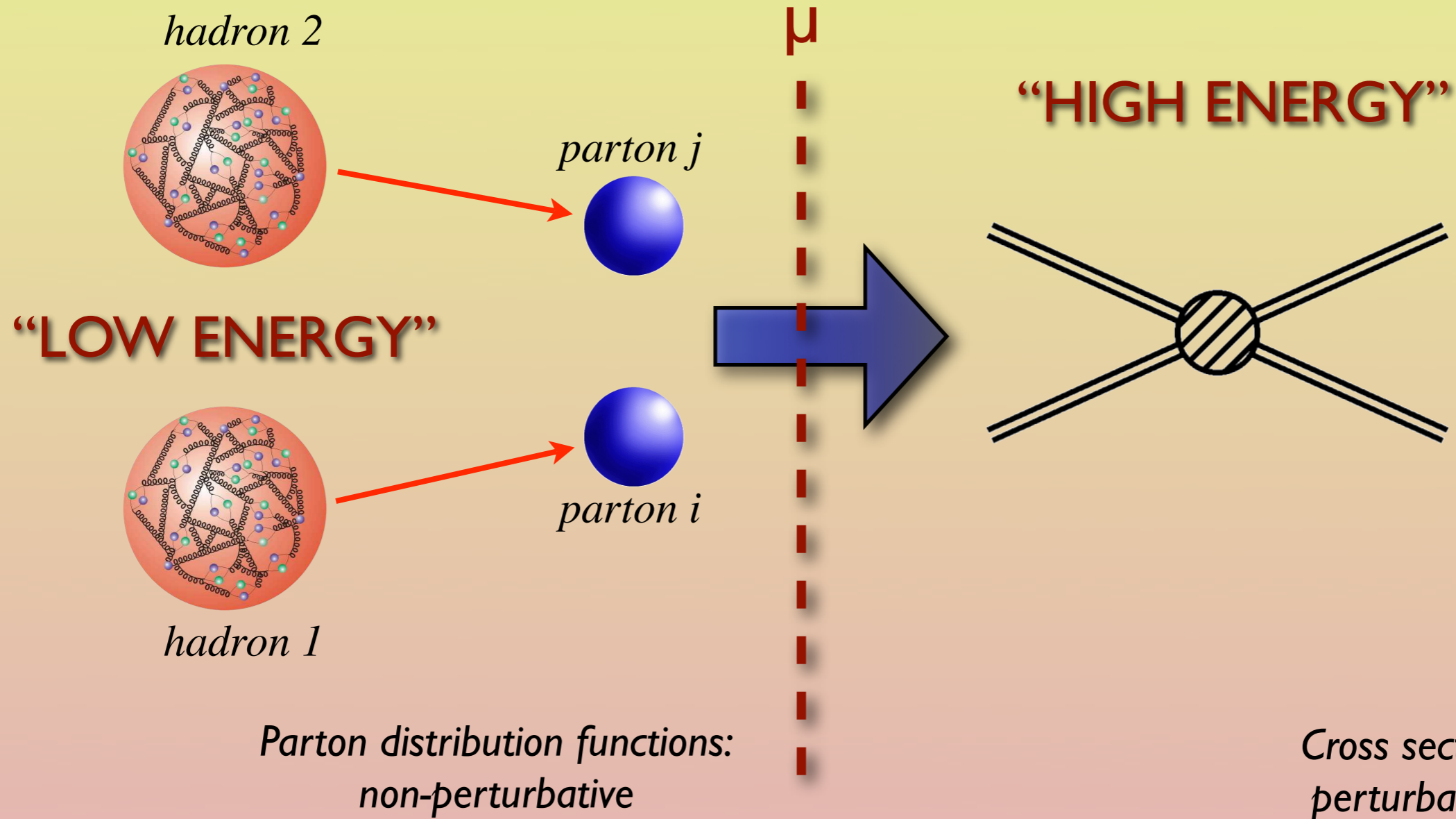
Hierarchy problem!

Colliding protons



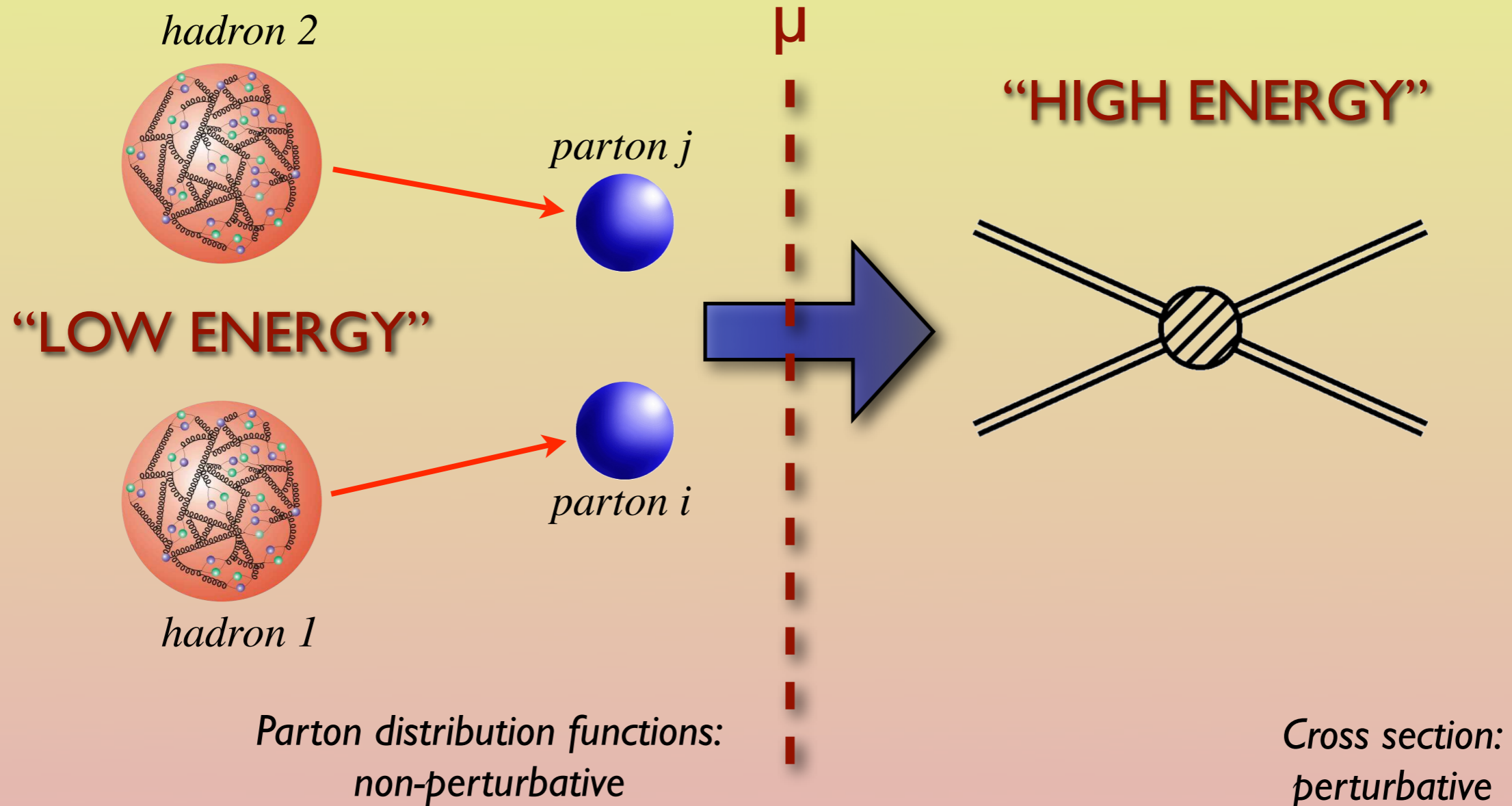
$$\sigma_{h_1 h_2 \rightarrow kl}(\{m^2\}) = \iint \sum_{i,j} f_{i/h_1}(x_1, \mu) f_{j/h_2}(x_2, \mu) \sigma_{ij \rightarrow kl}(\{m^2\}, \mu^2) dx_1 dx_2$$

Colliding protons



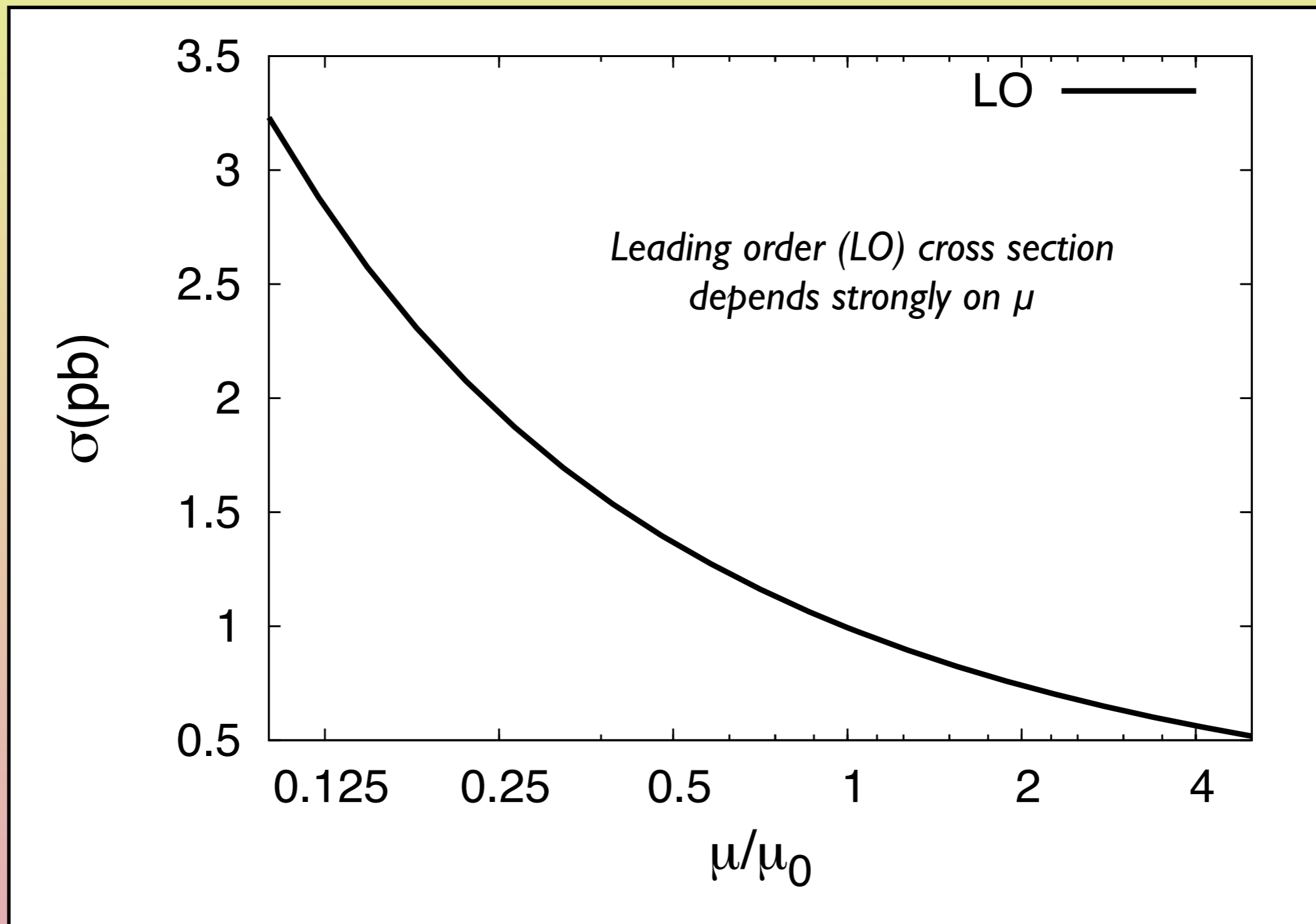
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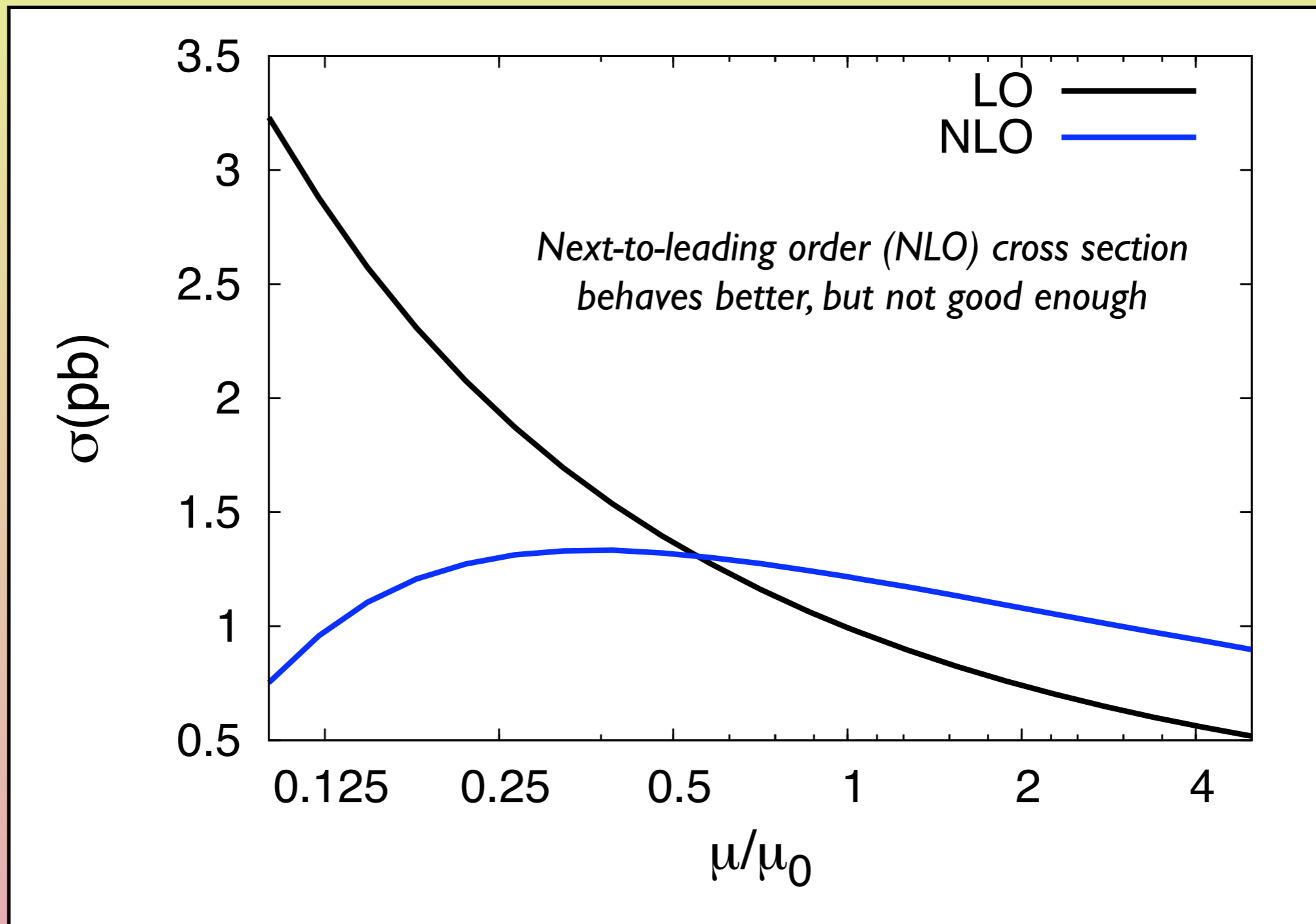


Match perturbative to non-perturbative regime at energy scale μ
This energy scale is a choice, so physics should not depend on it!

Scale dependence

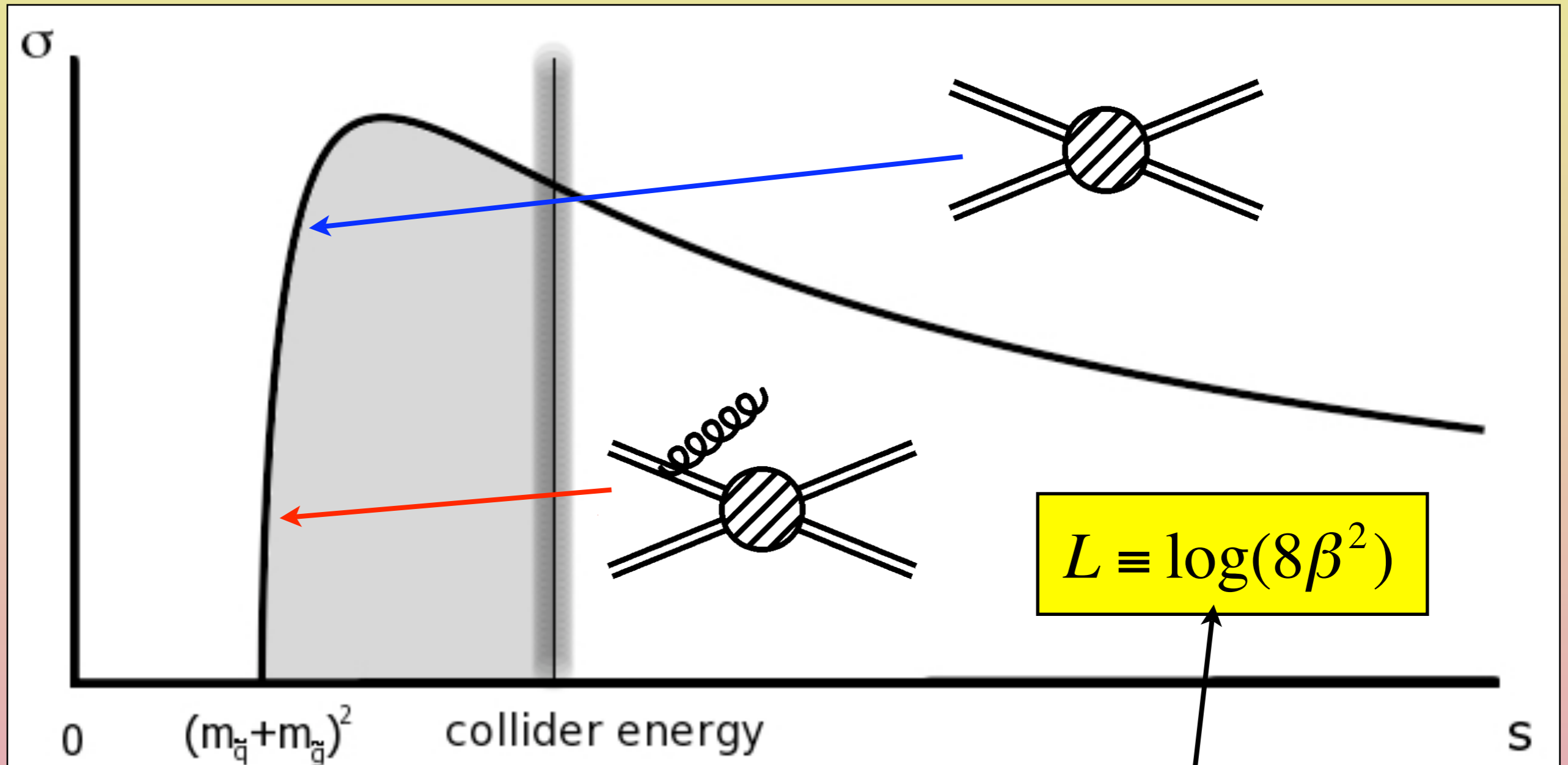


Scale dependence



Threshold

Near the production threshold even a gluon with very little energy can have a huge effect:



Corrections go as logarithms of β with β going to 0.

Logarithms

Structure of logarithmic terms in perturbative expansion:

LO:	1					$L \equiv \log(8\beta^2)$
NLO:	$\alpha_s L^2$	$\alpha_s L$	α_s			
NNLO:	$\alpha_s^2 L^4$	$\alpha_s^2 L^3$	$\alpha_s^2 L^2$	$\alpha_s^2 L$	α_s^2	
.....					

Good news: we can sum them to all orders in
perturbation theory!

Logarithms

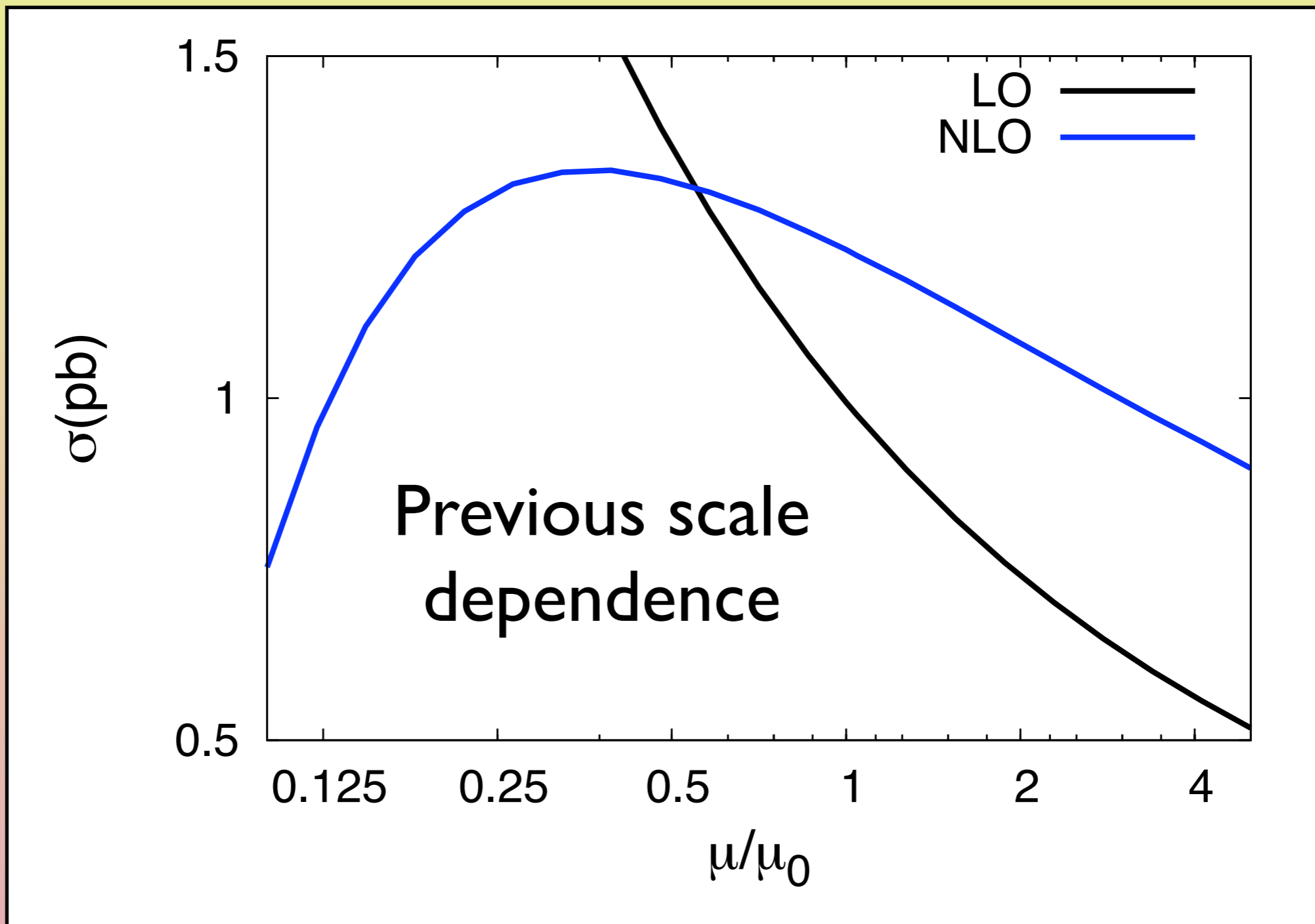
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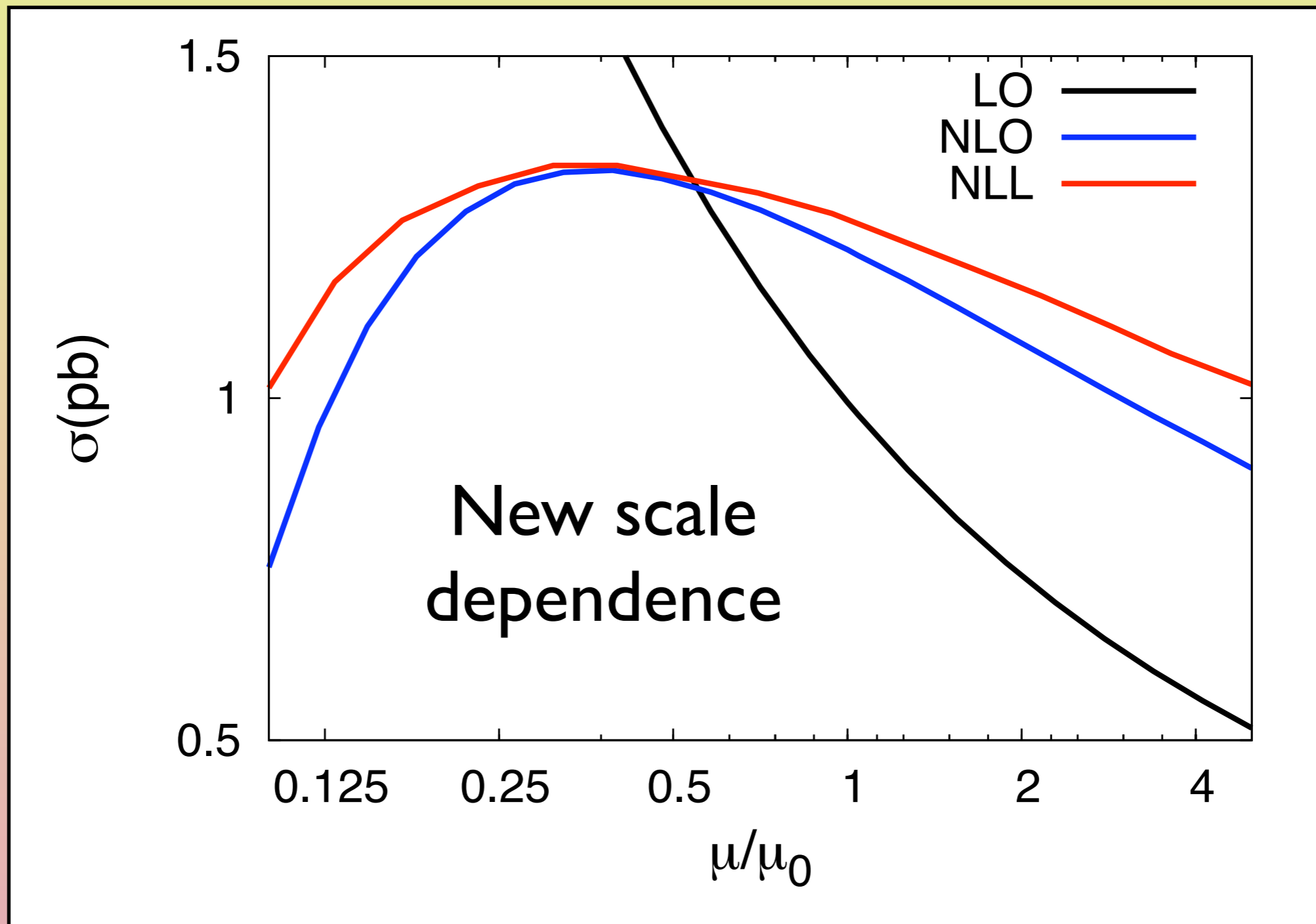
$$e^{LP_1(\alpha_s L)} e^{P_2(\alpha_s L)} \dots$$

Next-to-Leading
Logarithmic term (NLL)

Scale dependence

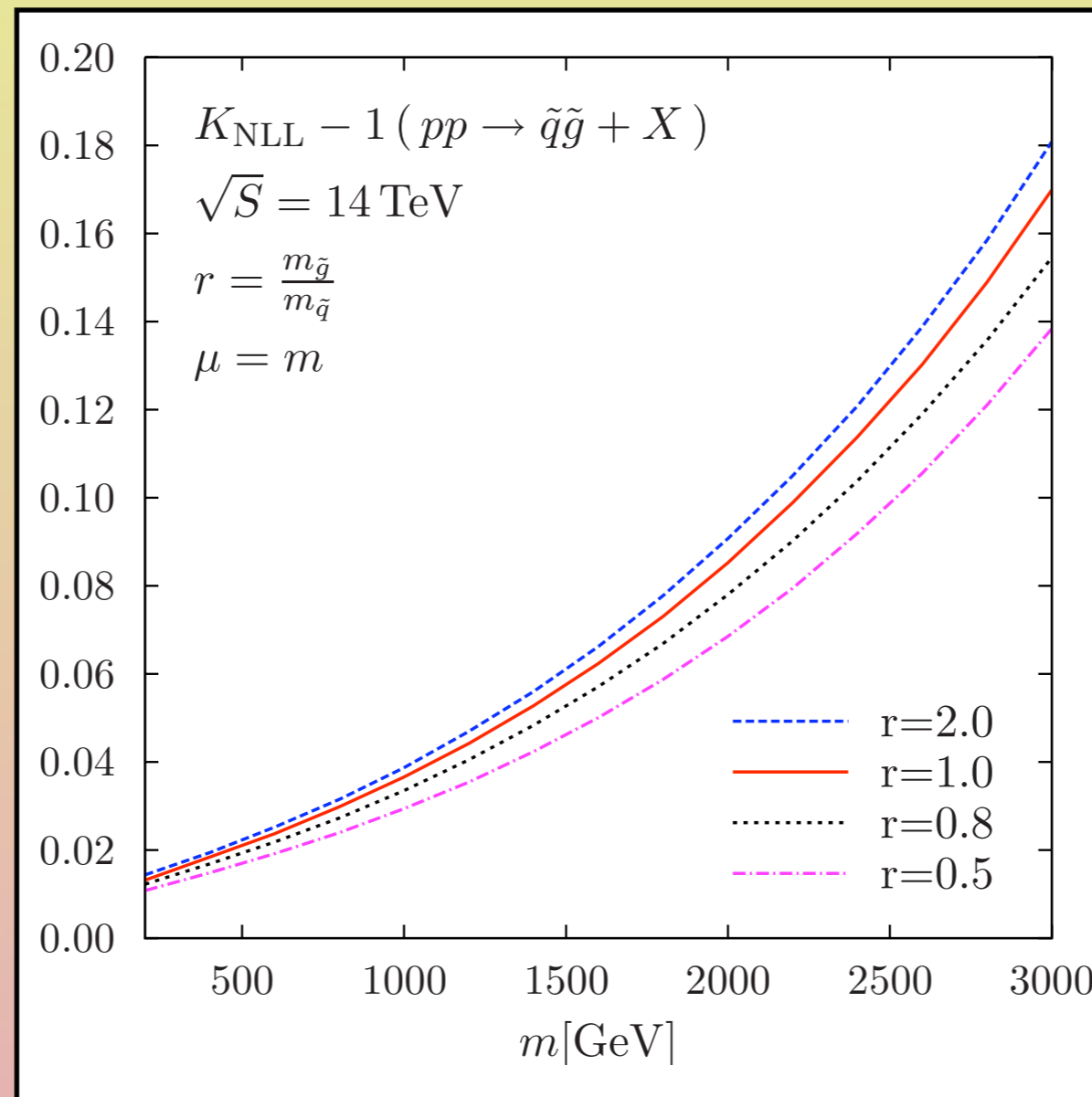


Scale dependence



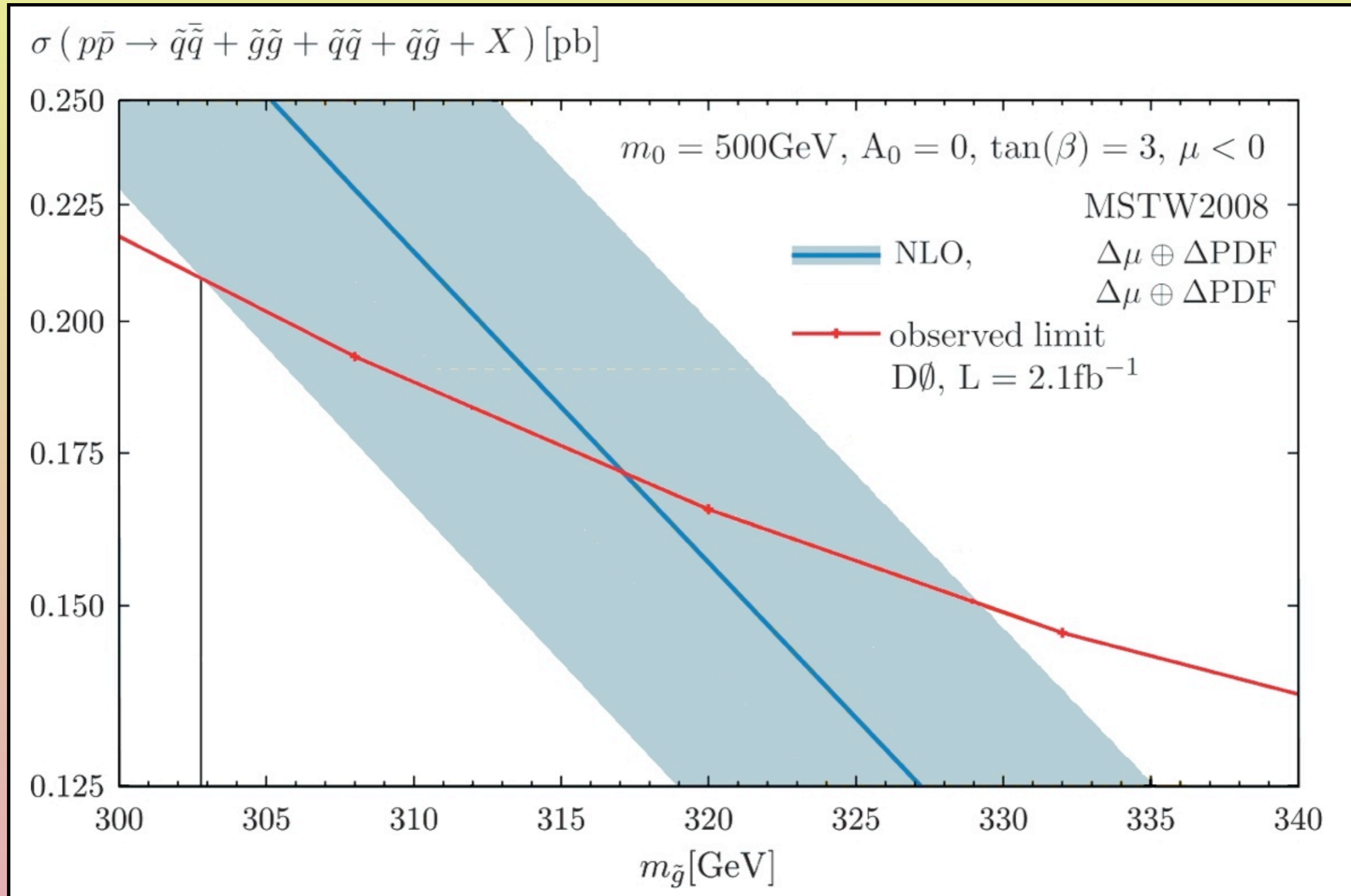
Larger cross section

Not only is the scale dependence reduced, the cross section increases as well.



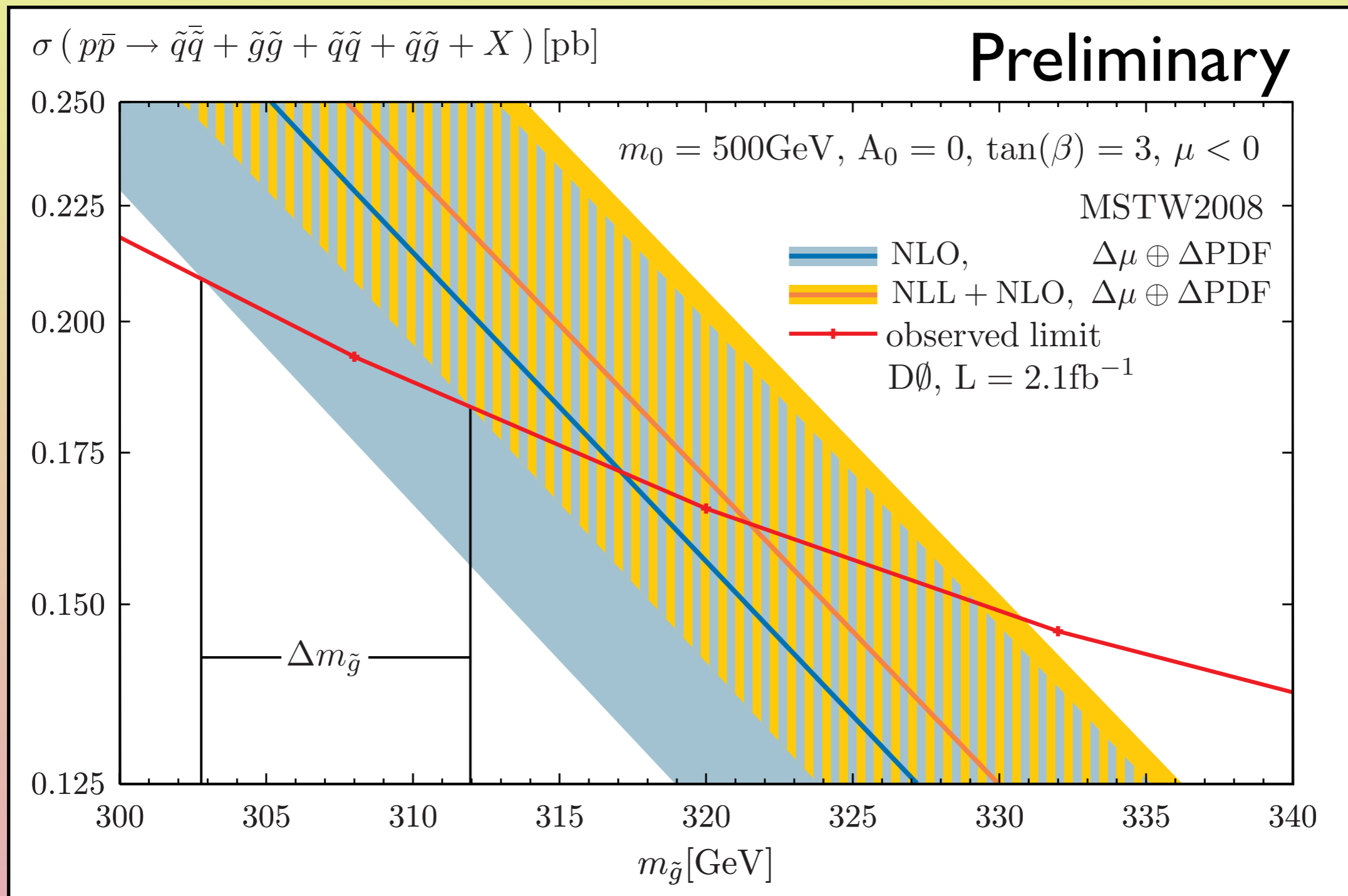
The increase of the squark-gluino cross section with respect to the NLO result.

Better exclusion limit



Exclusion limit at 303 GeV

Better exclusion limit



New exclusion almost 10 GeV higher

CONCLUSIONS

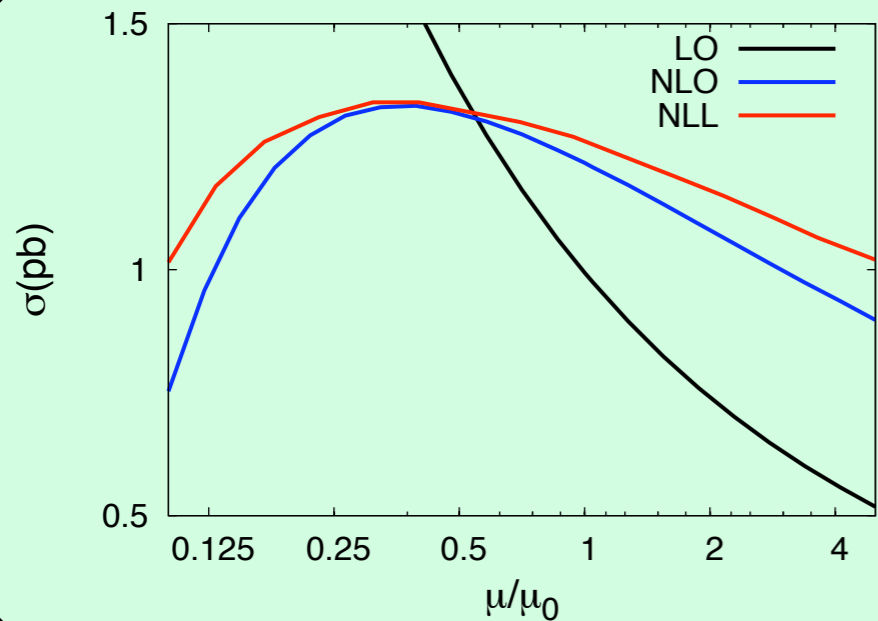


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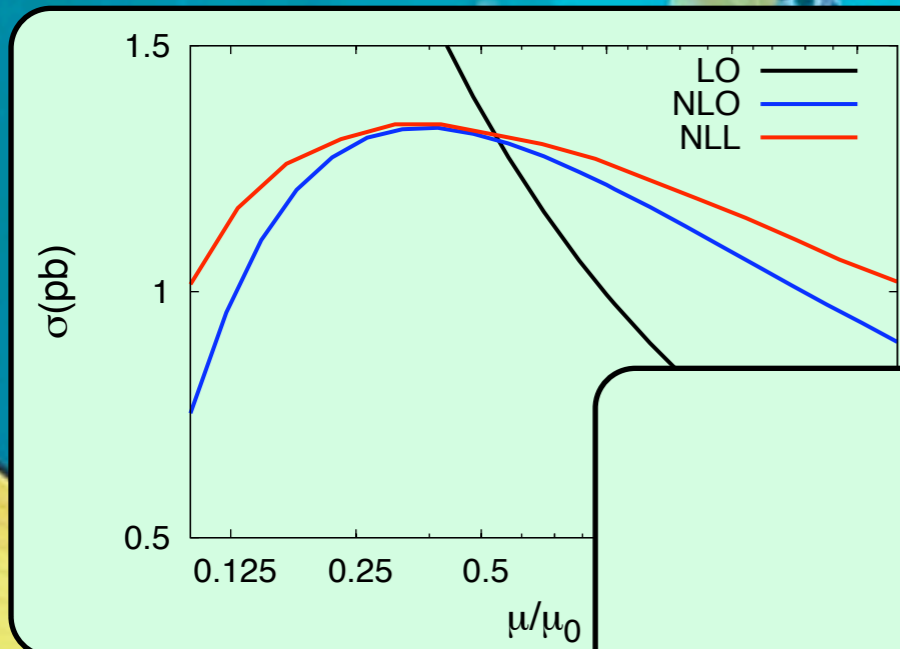
© Disney/Pixar

CONCLUSIONS



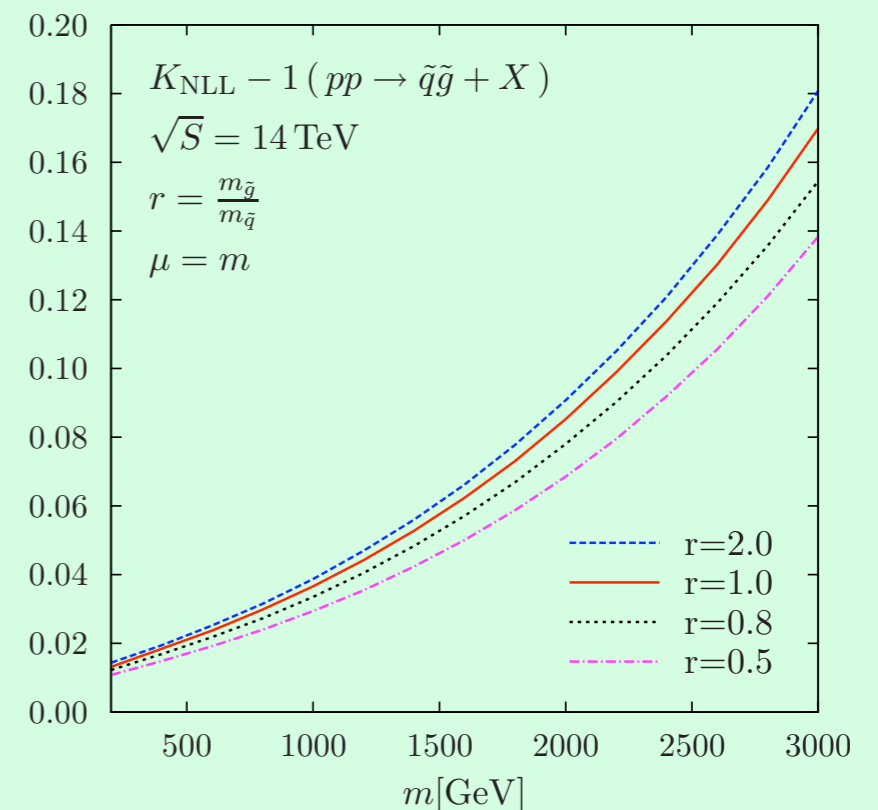
Less scale dependence

CONCLUSIONS

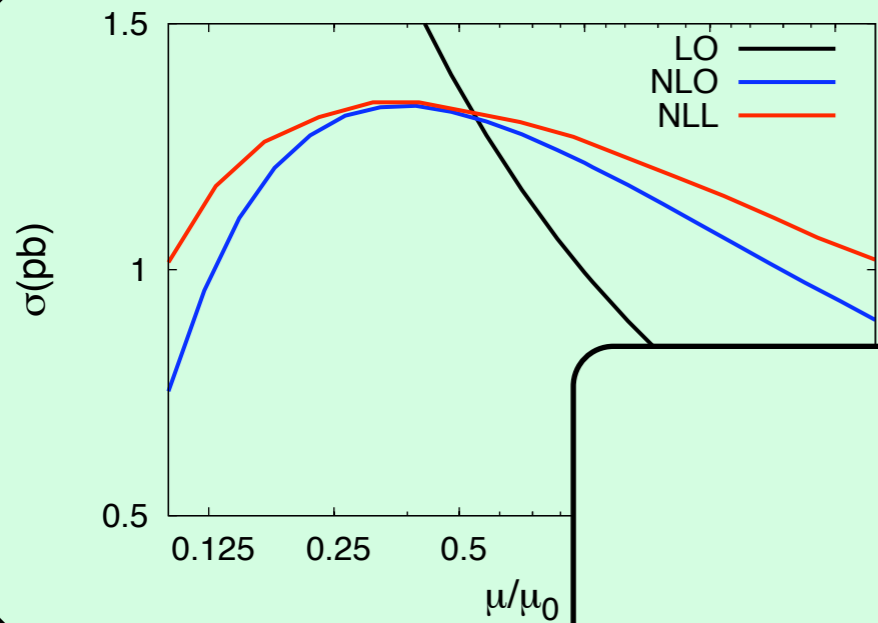


Less scale dependence

Higher cross section

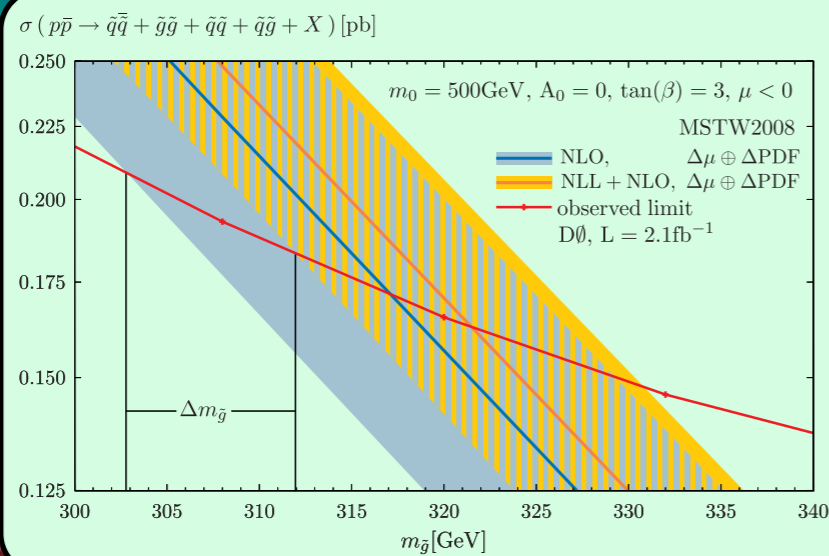
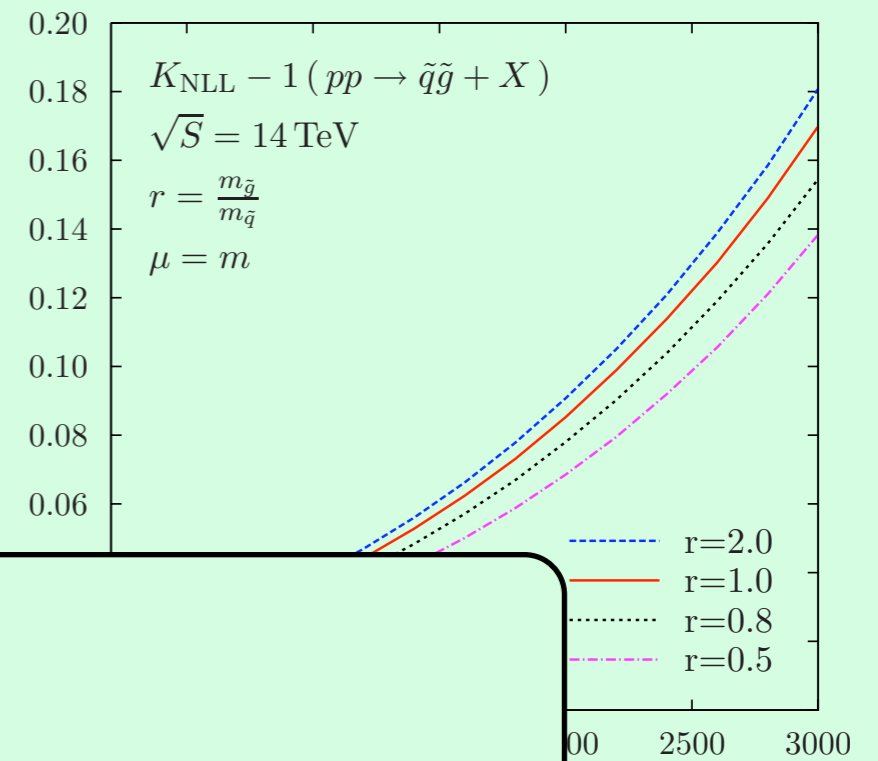


CONCLUSIONS



Less scale dependence

Higher cross section



Better exclusion limits



More information

JHEP 0912:041,2009 (arXiv:0909.4418)

PoS RADCOR2009:010,2010 (arXiv:1001.3123)

JHEP 1008:098,2010 (arXiv:1006.4771)

arXiv:1105.1110