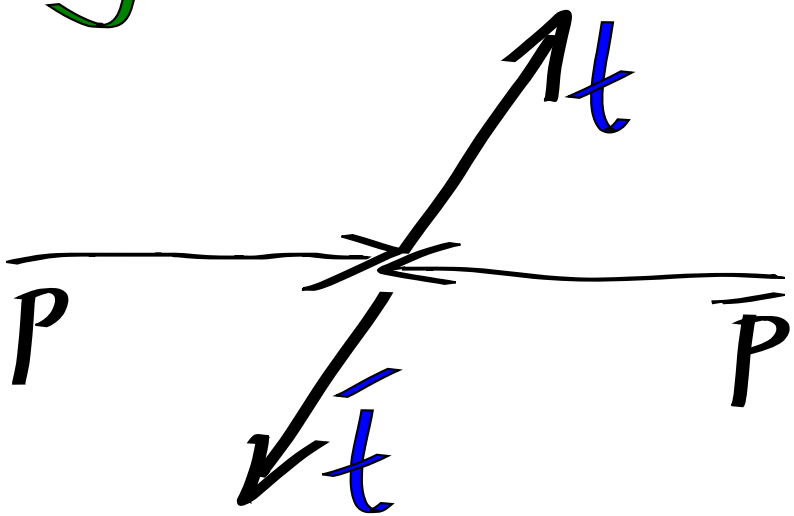
the $t\bar{t}$ asymmetry

ouch New Physics



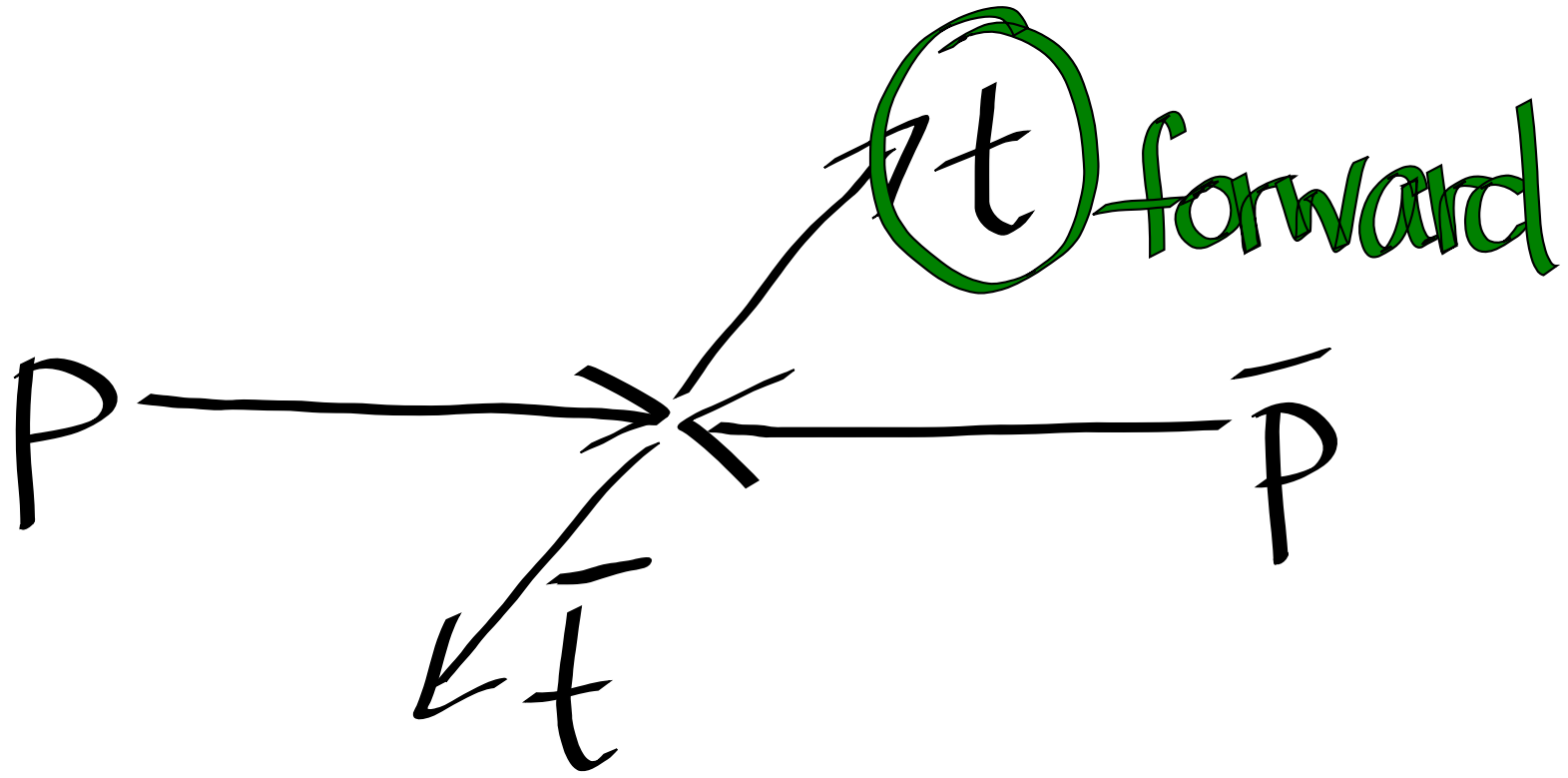
Outline

α. $t\bar{t}$ asymmetry

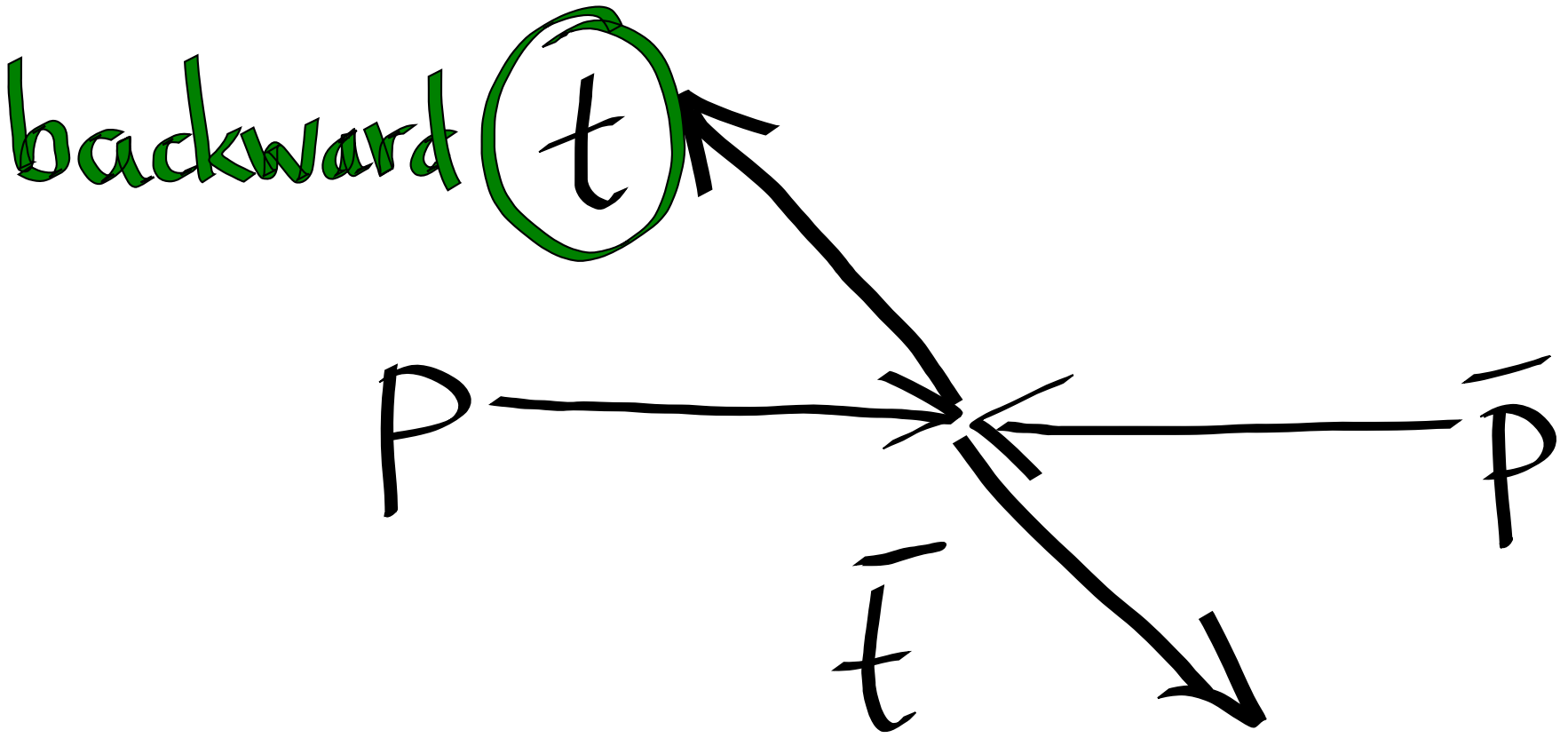
β. New physics explanations
$\Rightarrow$ light axigluon

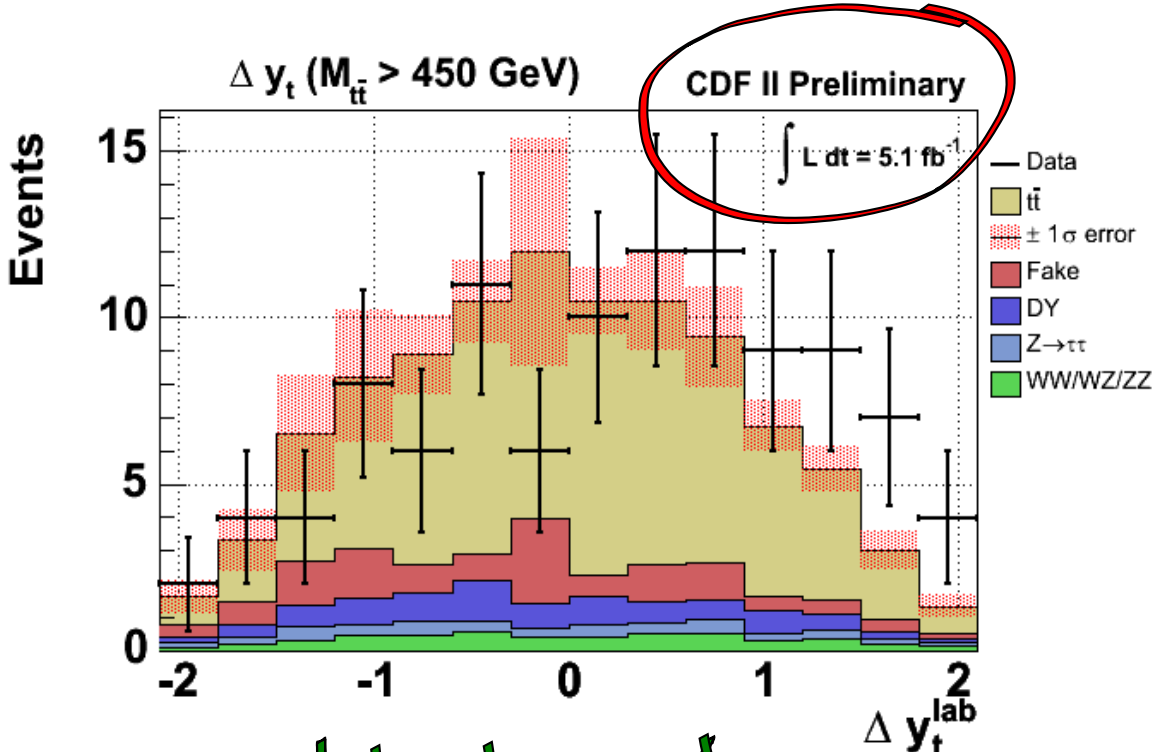
γ. A lepton charge asymmetry at the $t\bar{t}$ bar threshold

$t\bar{t}$ asymmetry

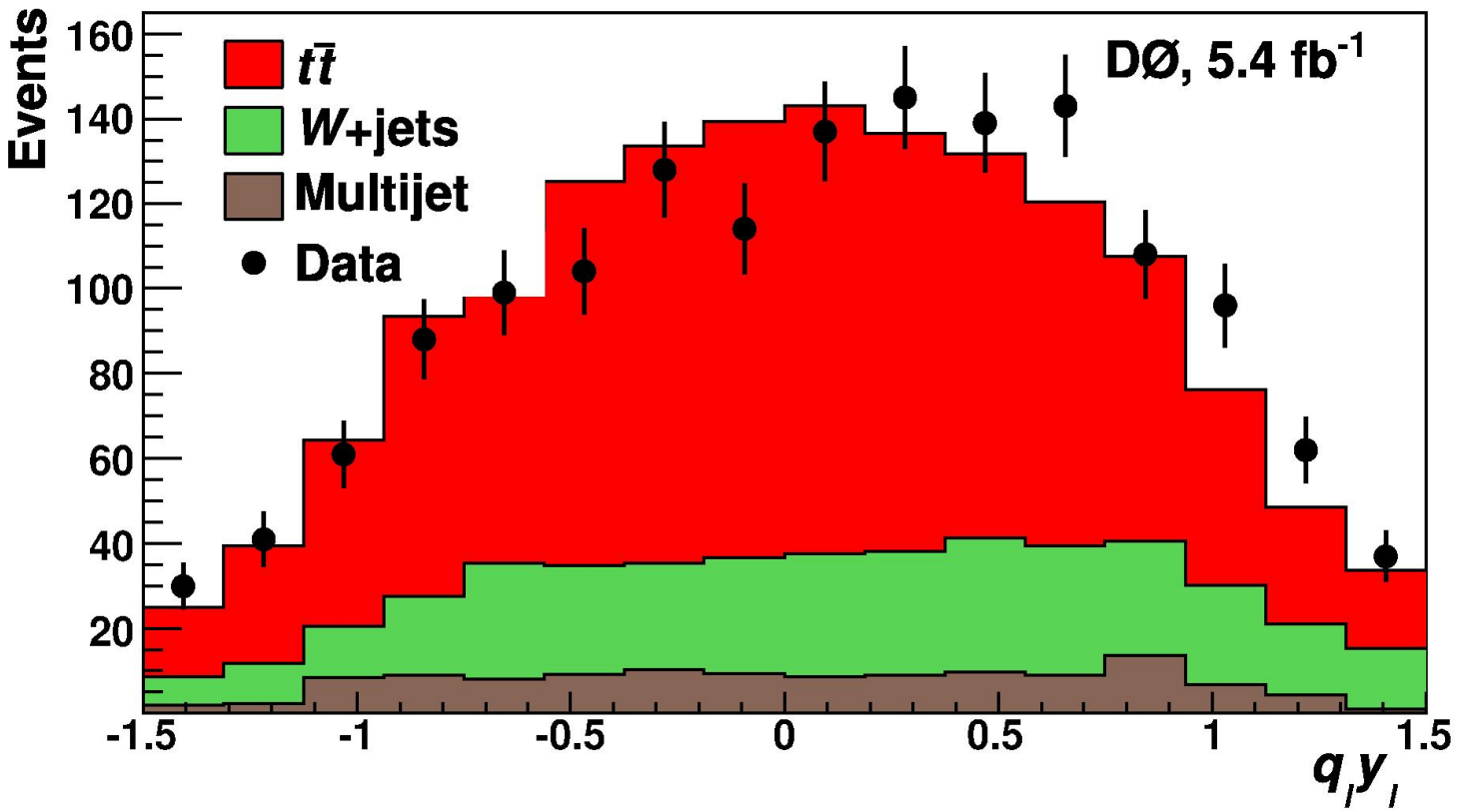


$t\bar{t}$ asymmetry



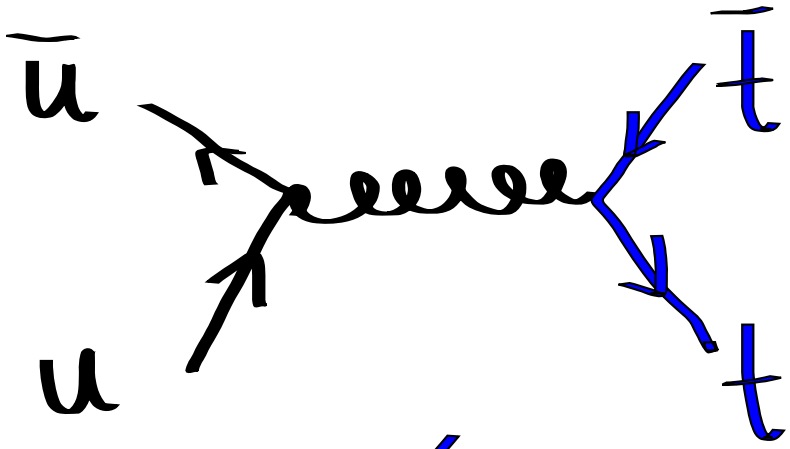


dilepton $A_{t\bar{t}} \sim 20\%$

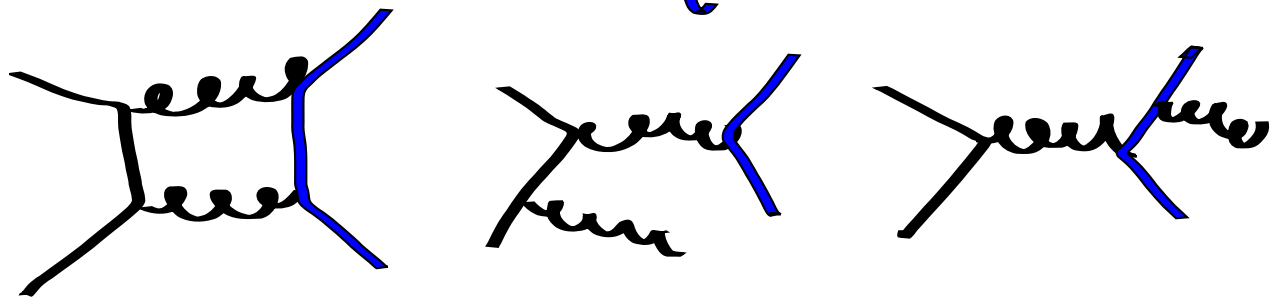

Events
160
140
120
100
80
60
40
20
$t\bar{t}$
W+jets
Multijet
Data
DØ, 5.4 fb^{-1}
-1.5
-1
-0.5
0
0.5
1
1.5
$q_l y_l$

and DØ ...

SM prediction

LO: 

$A_{t\bar{t}} = 0$

NLO: 

5-10%

NNLO: Not yet available

20 different measurements, most show the asymmetry

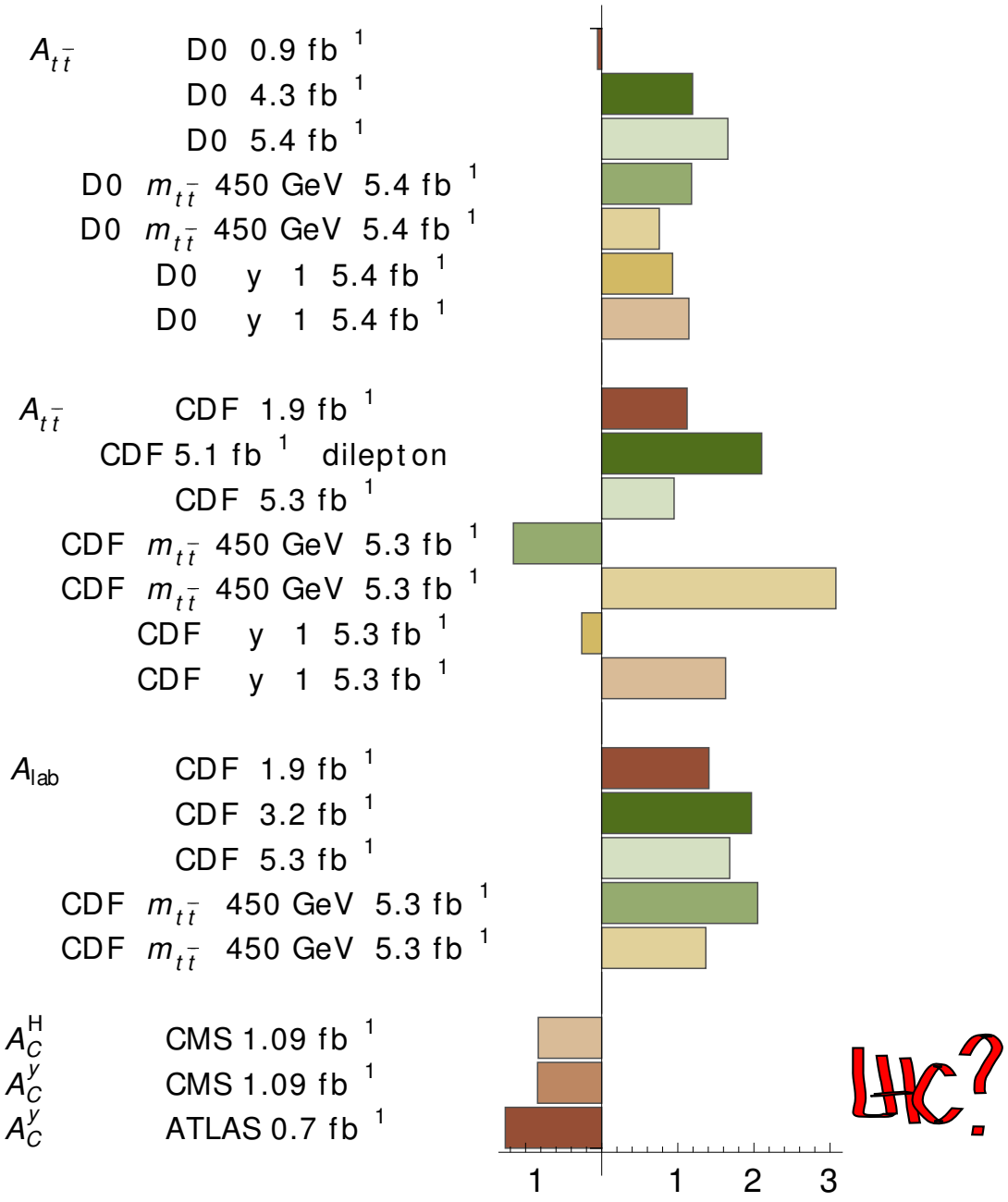
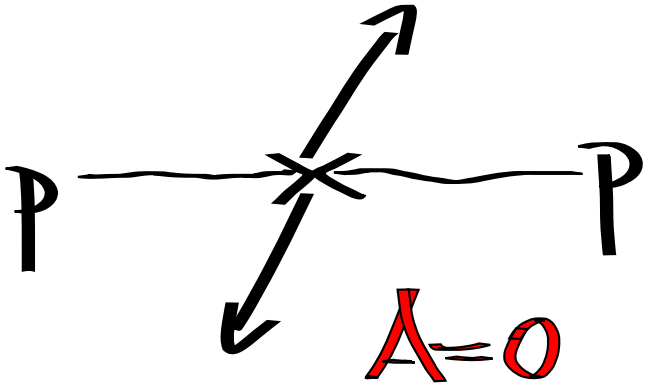
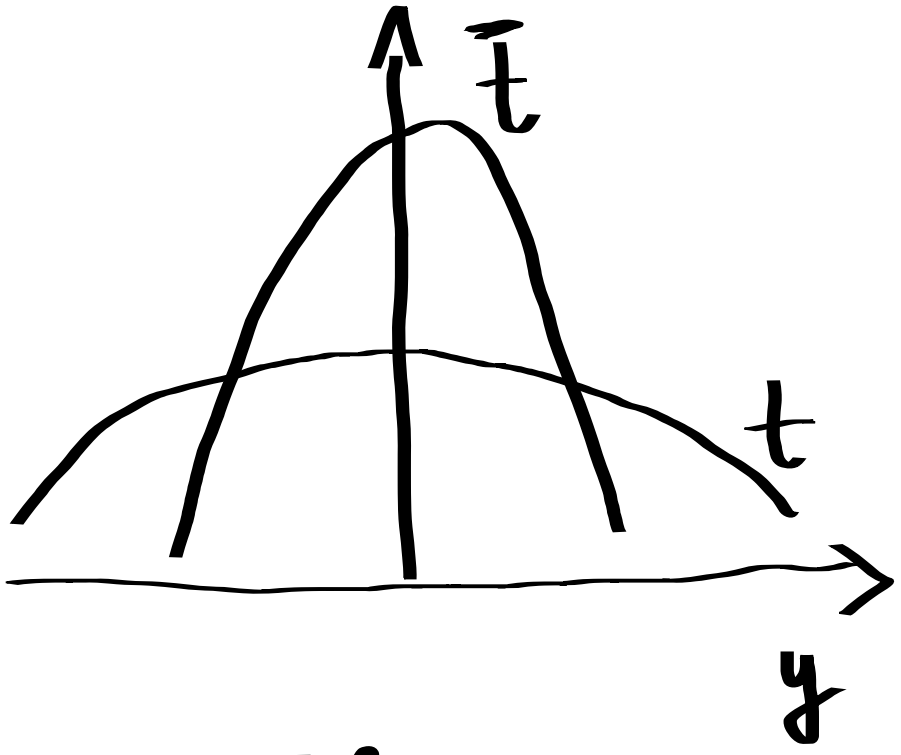
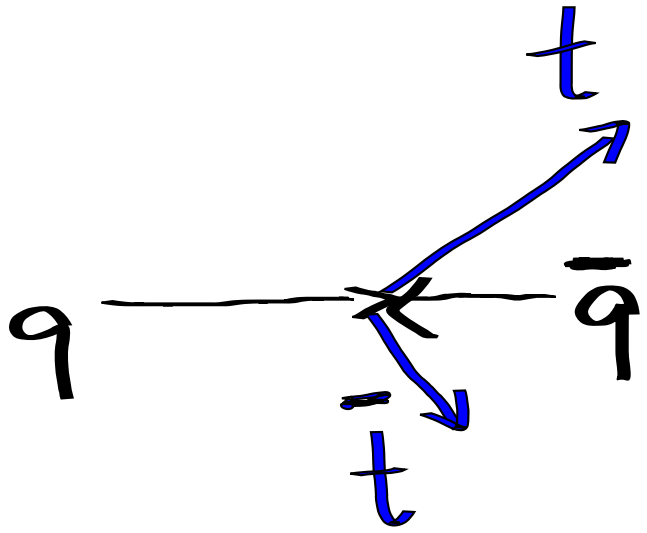


Figure 9: Summary of experimental measurments of the charge asymmetry in comparison with the SM theoretical predictions. The histogram represents the pull of the discrepancy for each measurement.

Asymmetry @ LHC ?!







$A_{SM} \sim 1\%$

$A_{CMS/ATLAS} = -2\% \pm 2\% \pm 2\% \quad (1\,fb^{-1})$

20 different measurements, most show the asymmetry

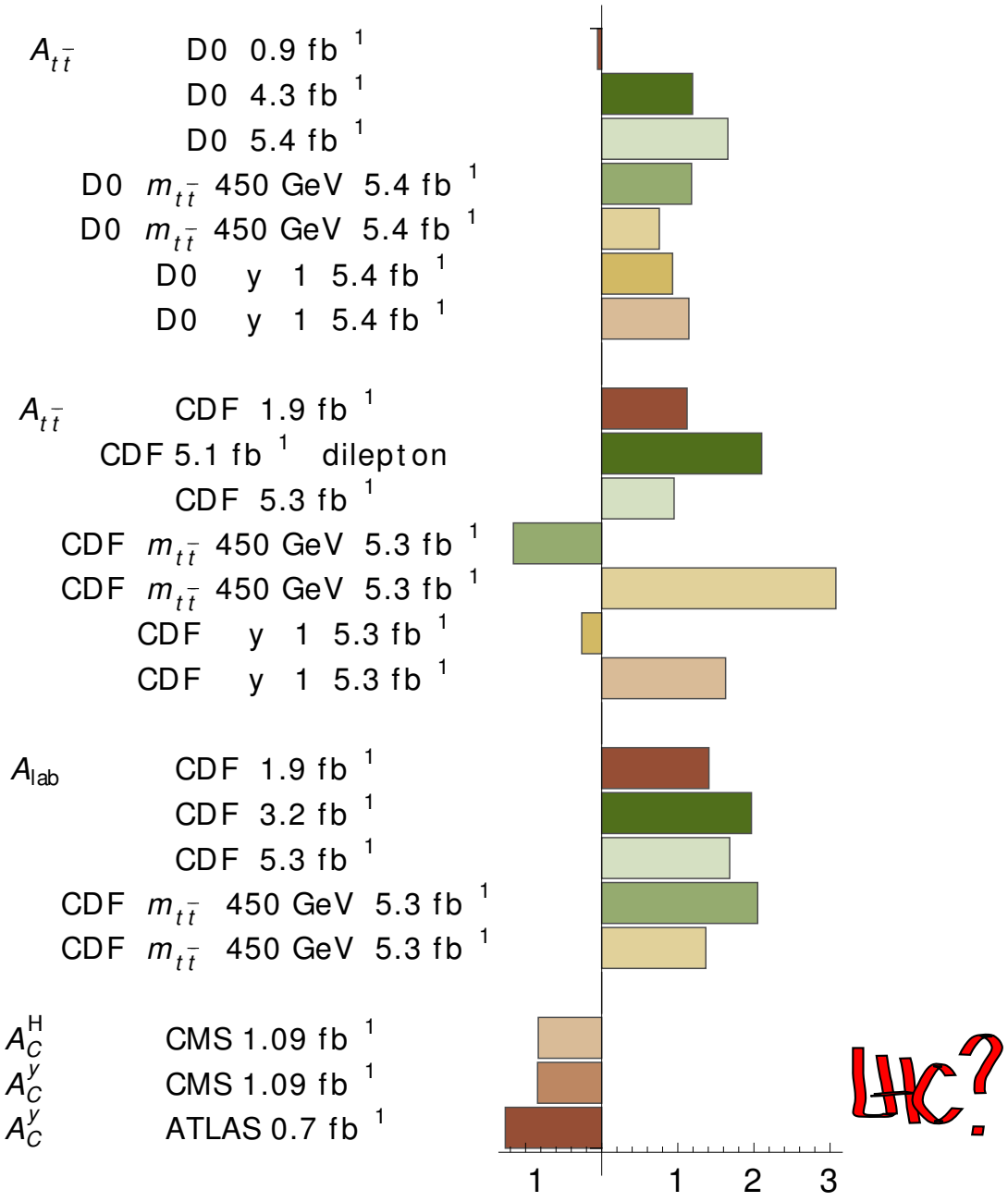
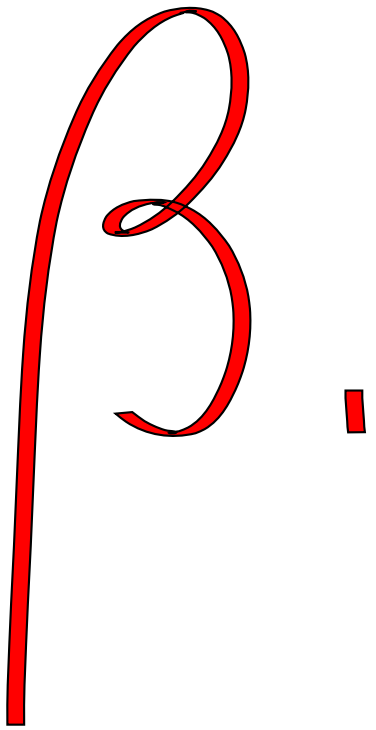


Figure 9: Summary of experimental measurments of the charge asymmetry in comparison with the SM theoretical predictions. The histogram represents the pull of the discrepancy for each measurement.



let's assume it's not

SM calculation error

or exp. error.

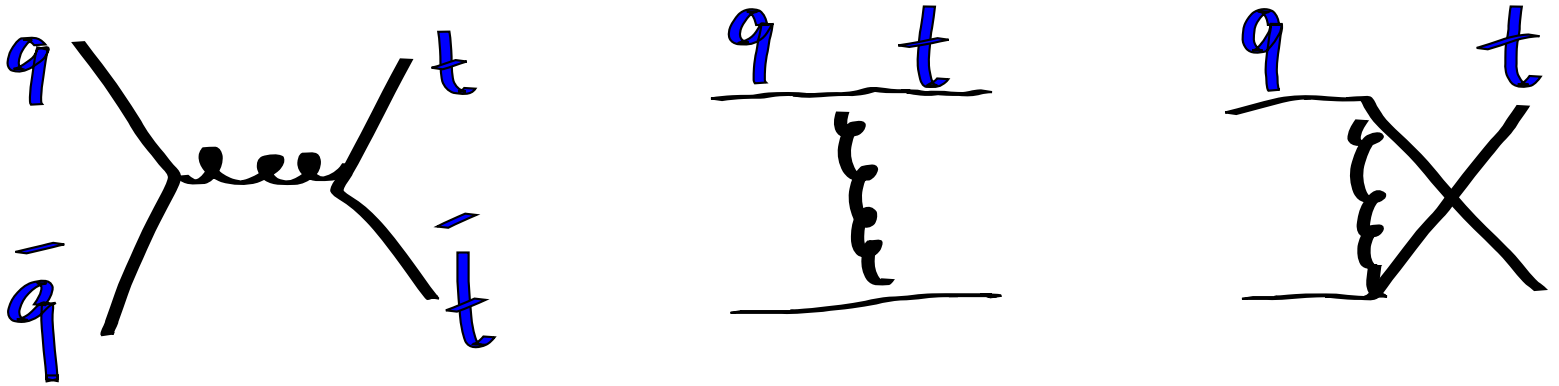
Can we explain it with

New Physics?

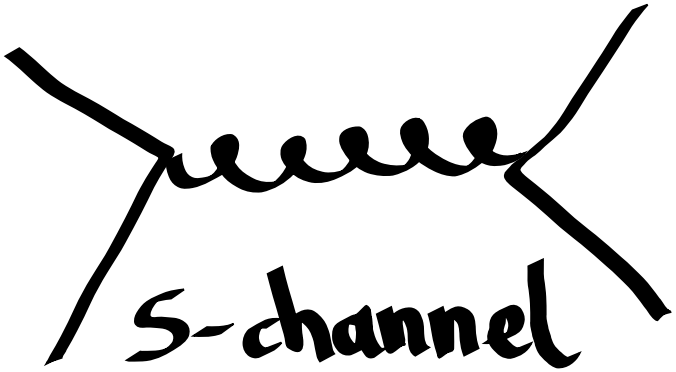
Need an order 1 fraction

of $t\bar{t}$ pairs from NP

$\Rightarrow$ tree level



New physics

1. 

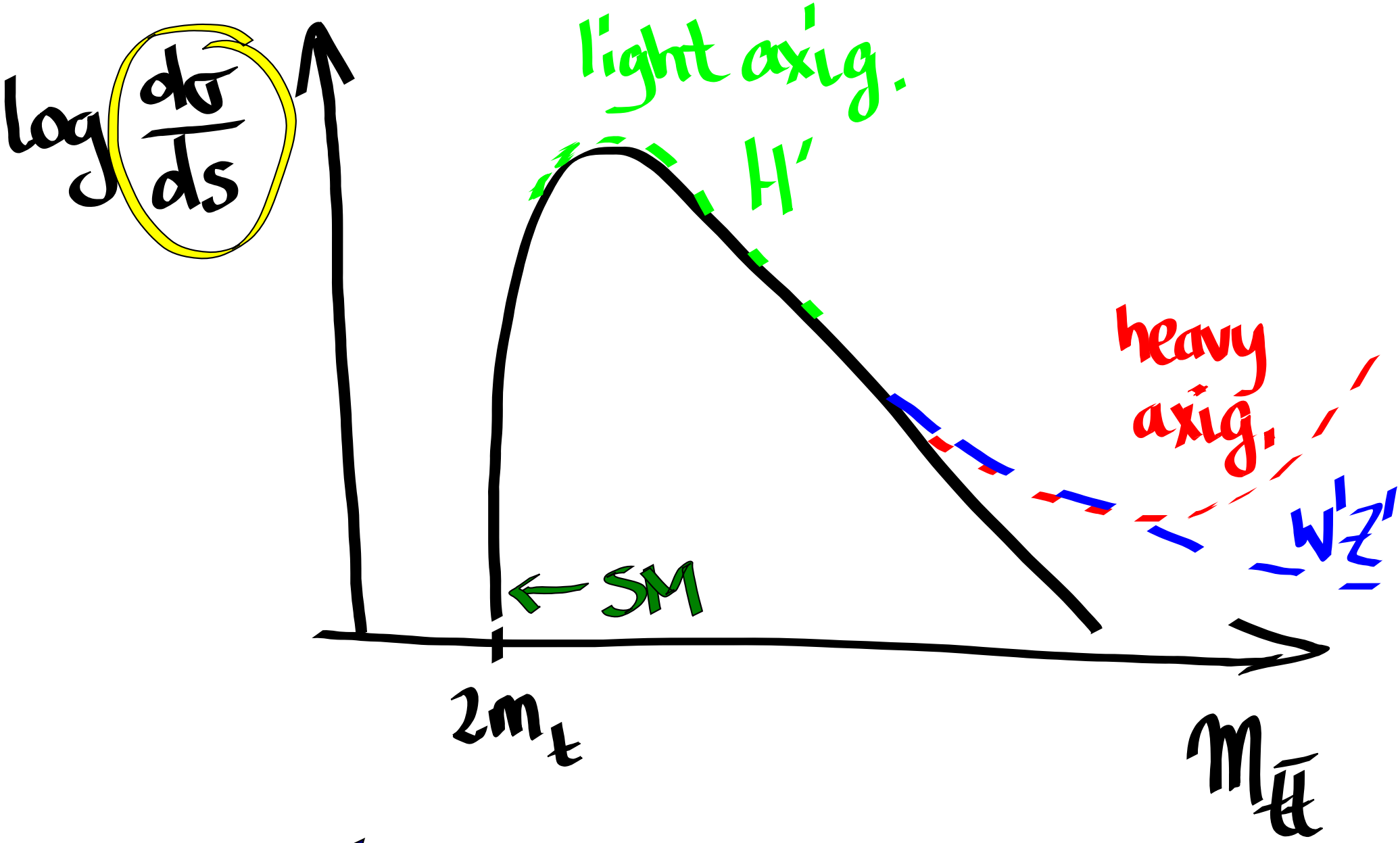
axigluon $\nearrow \lesssim 2m_t$

axigluon $\searrow \gg 2m_t$

2. 

Z', W', H'

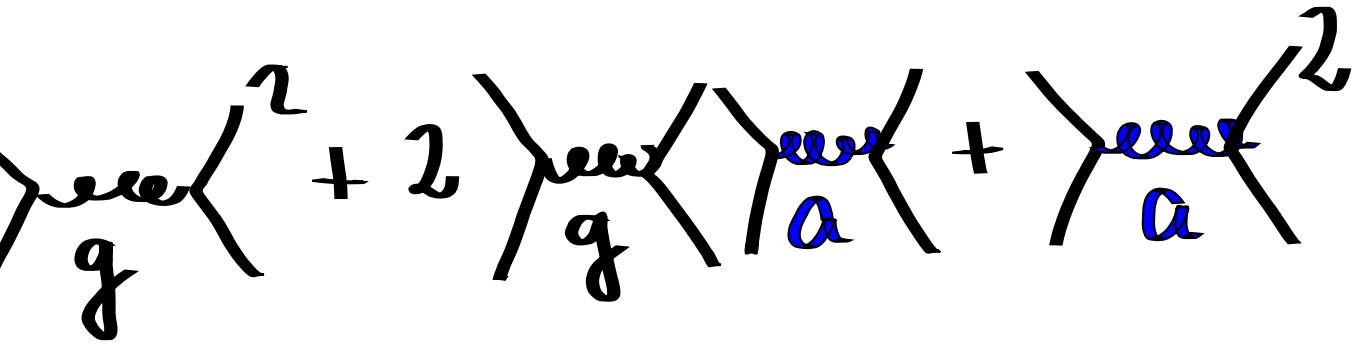
all fit "reasonably" well: $A_{t\bar{t}}, \sigma_{t\bar{t}}$



ATLAS/CMS: "soon"

Axigluon mediated $t\bar{t}$ production

$$\frac{d\sigma}{d\cos\theta} \sim$$



$$\alpha_s^2 \frac{u^2+t^2}{s^2} + 2\alpha_s\alpha_a \frac{s(u-t)}{s(s-M^2)} + \alpha_a^2 \frac{u^2+t^2}{(s-M^2)^2}$$

width

QCD

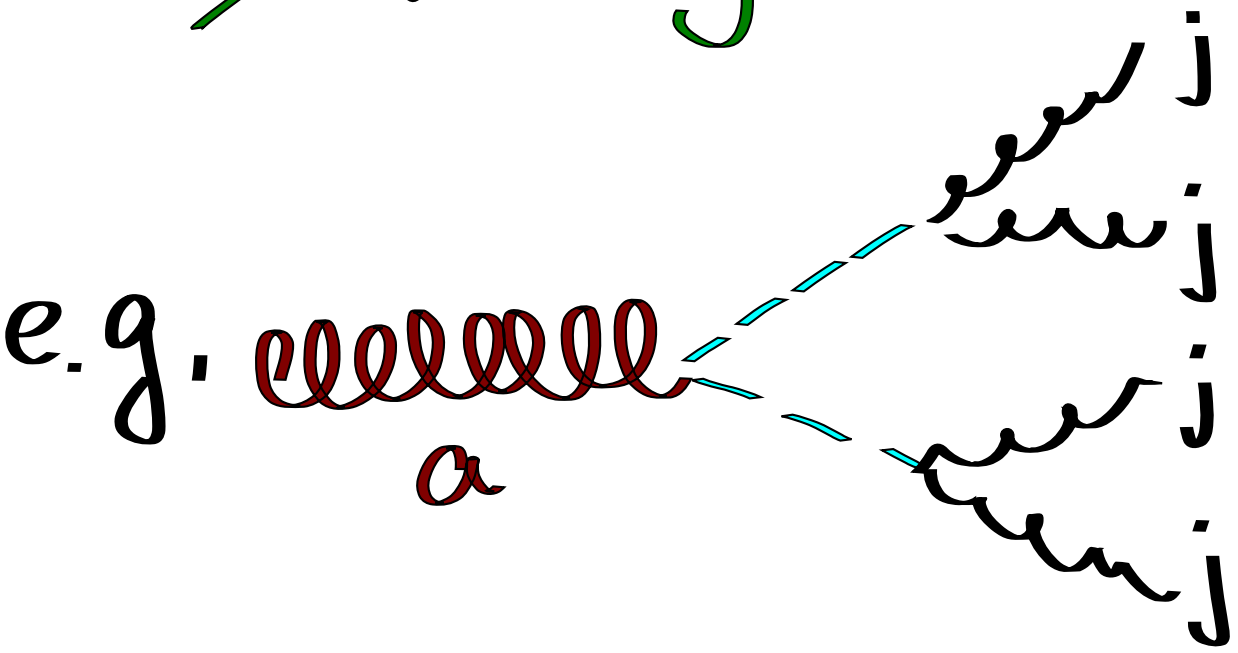
0.3

asymmetric

0.09

Axigluon must have small (0.3) coupling to quarks, large width

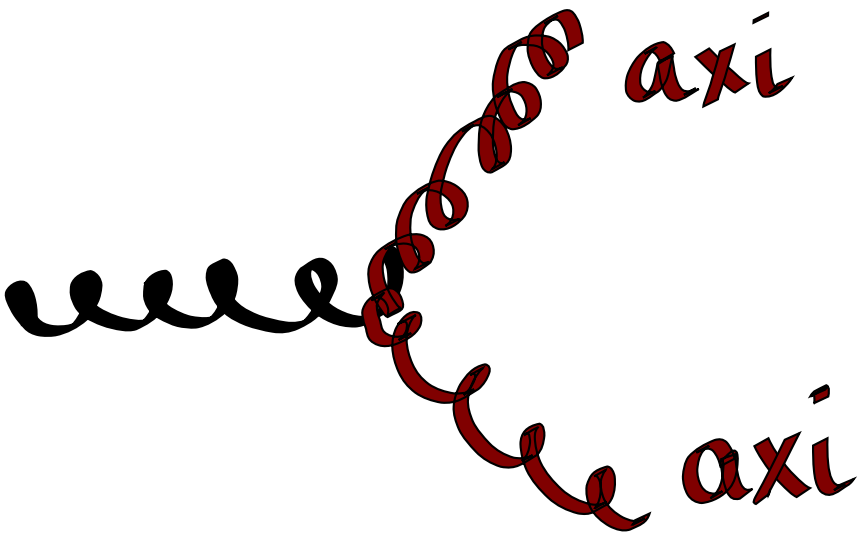
$\Longrightarrow$ it decays into something else



w. Marques-Tavares
Gross, Spethmann

Light axigluon production @ LHC

100 – 450 GeV



$\sigma_{450} \sim 20\,\text{pb}$

what is the signature ?

axigluon pair decay

reconstruct { 4 jets, 6 jets

ATLAS prelim. $36\ pb^{-1}$

$m \gtrsim 200\ GeV$

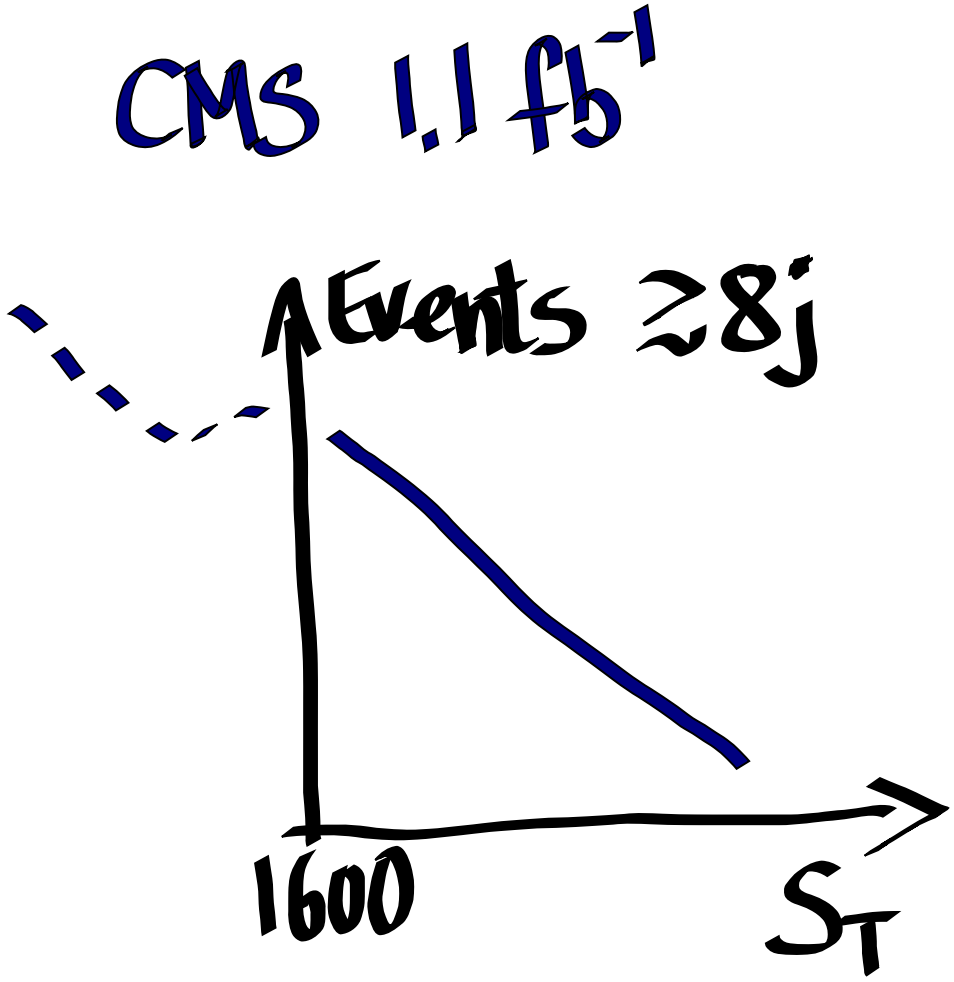
CMS $35\ pb^{-1}$

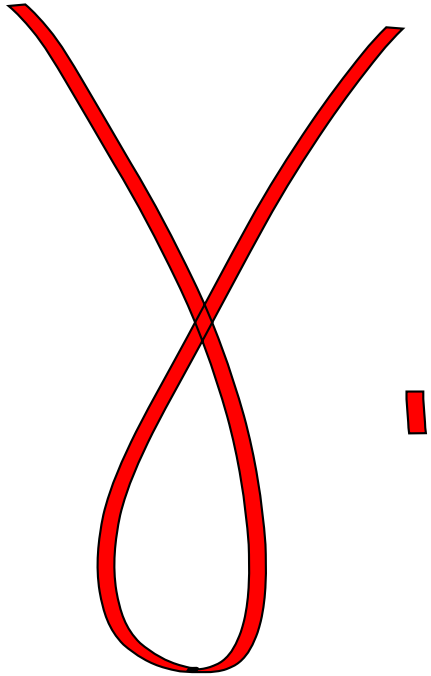
$180 < m < 280\ GeV$

($>2\sigma$ excess @ 380 GeV)

axigluon pair decay

"black holes" { 8 jets / 12 jets





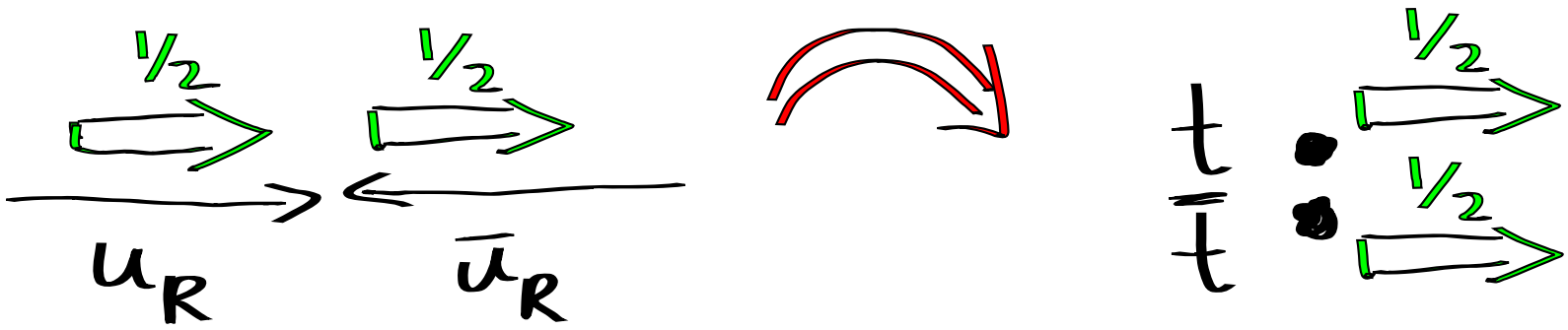
top threshold spin asymmetry

(w. Falkowski, Perez)

all models which explain the $t\bar{t}$ asymmetry have chiral couplings to quarks i.e. $g_L \neq g_R$

$\Rightarrow$ tops are produced from initial chiral quarks with different rates

R chirality initial quarks



$S_z = +1$

$L_z = 0$

$J_z = +1$

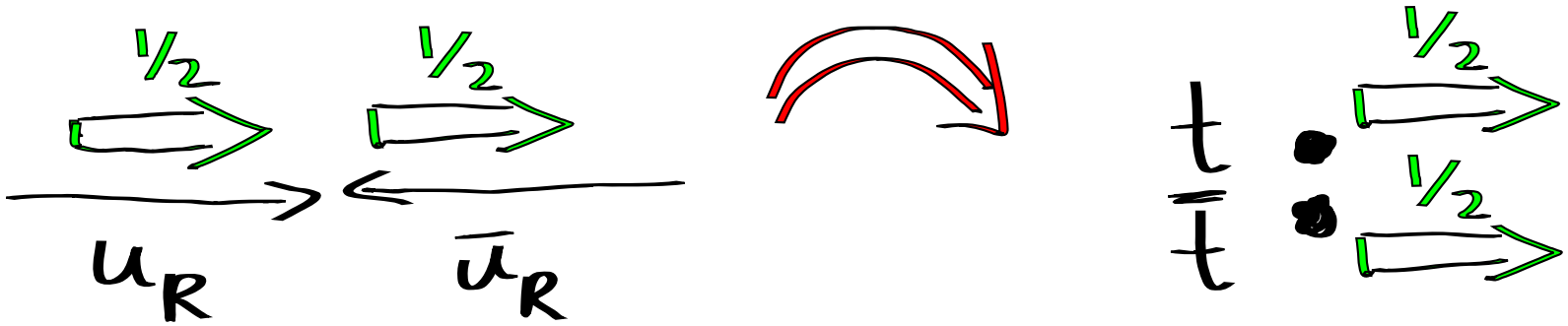
$S_z = +1$

$L_z = 0$

$J_z = +1$

R chirality initial quarks

L chirality : all spins reversed



$S_z = +1$

$L_z = 0$

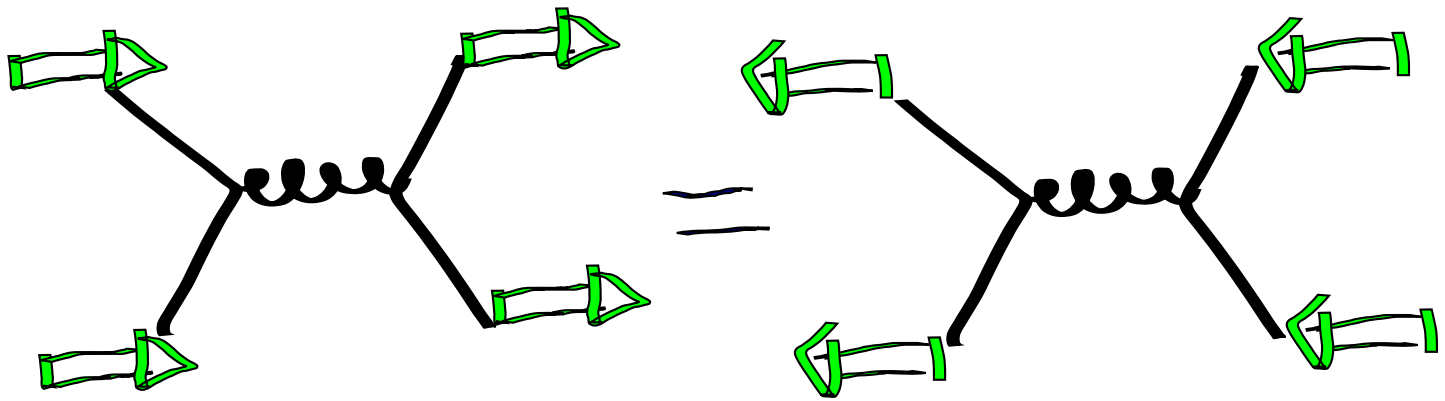
$J_z = +1$

$S_z = +1$

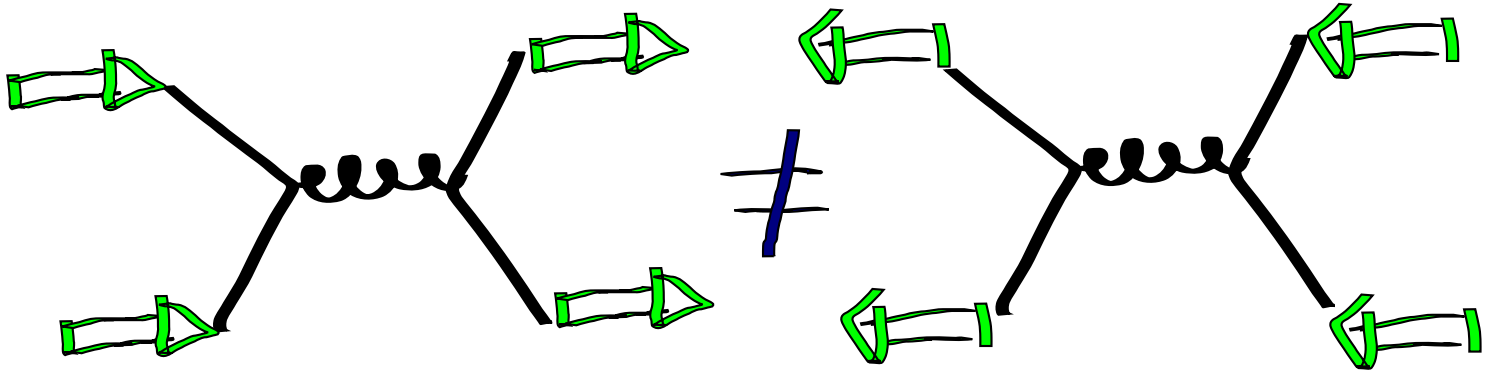
$L_z = 0$

$J_z = +1$

SM

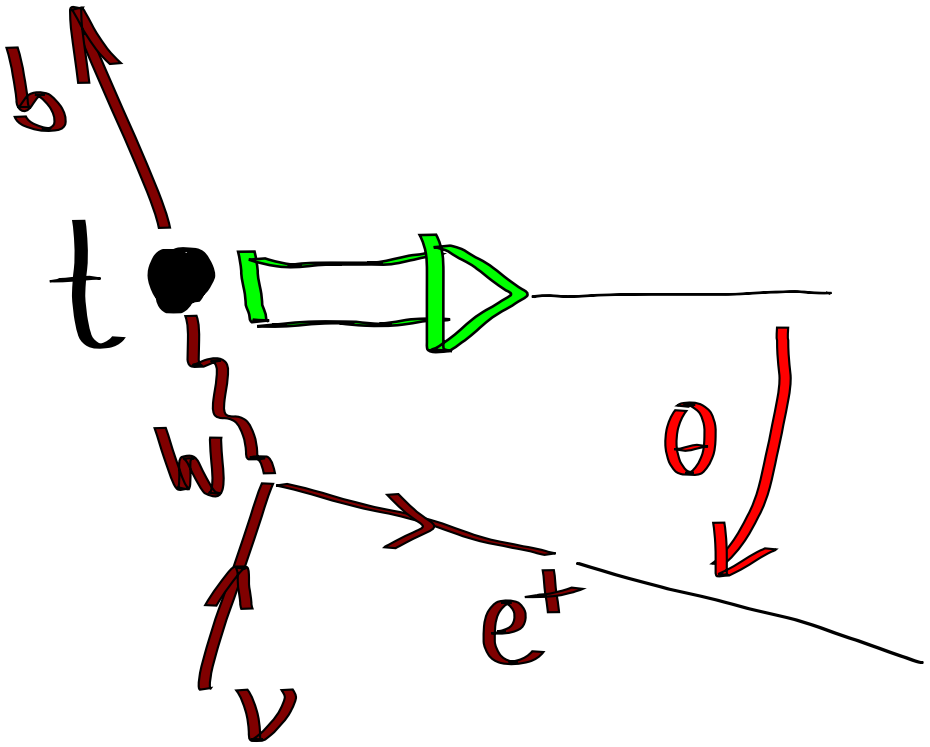


NP

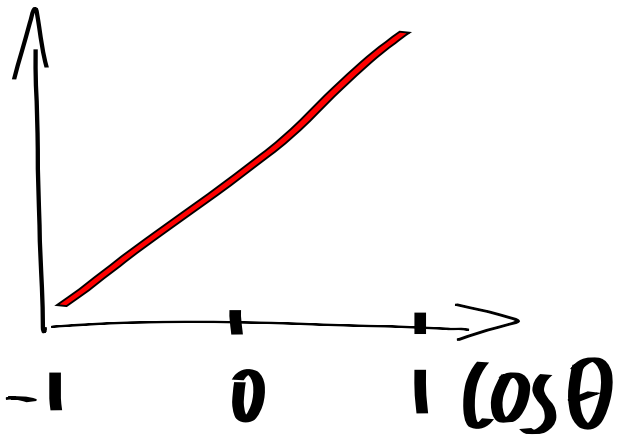


$\Rightarrow$ spin asymmetry of top quarks

are top spins measurable? Yes!



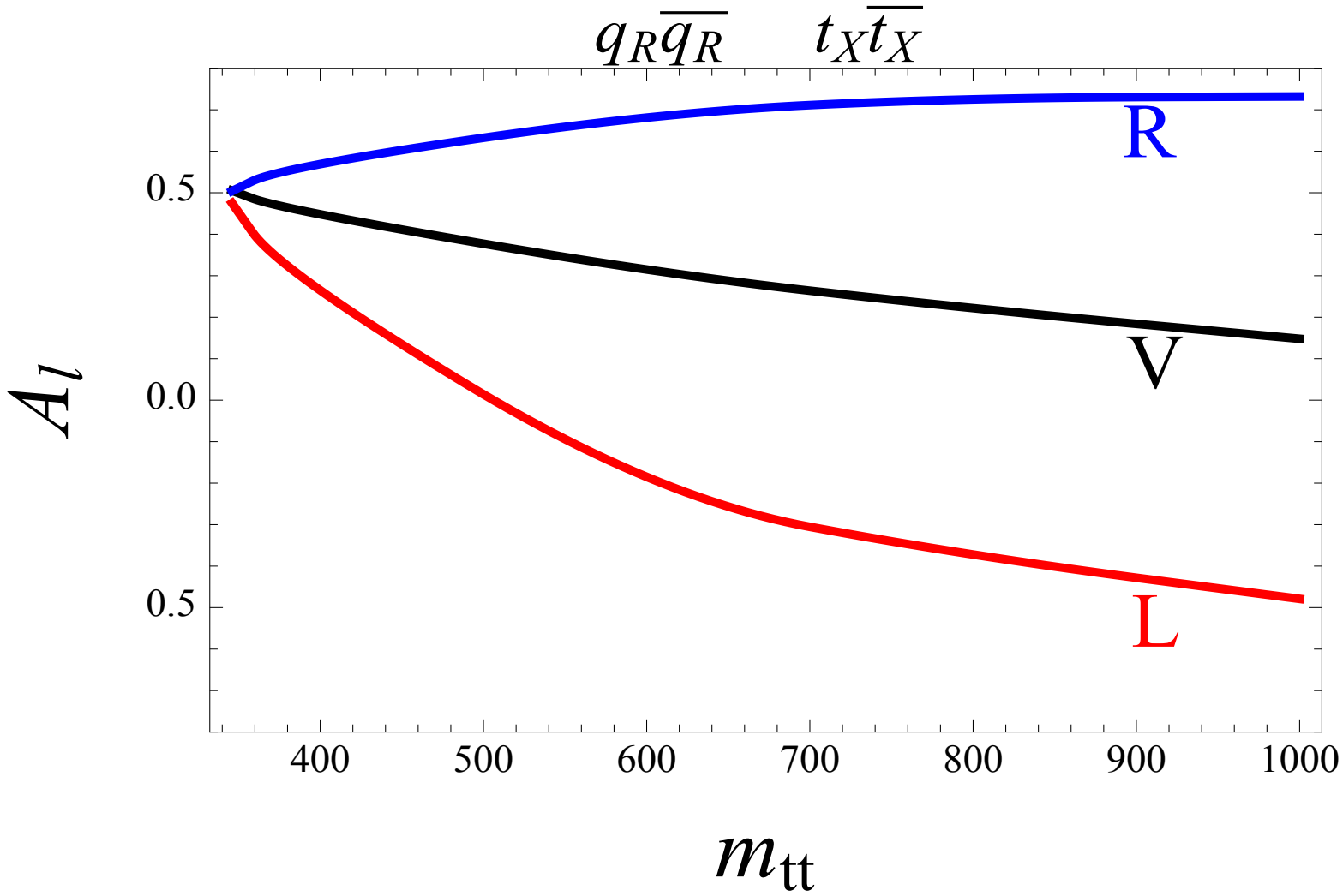
$$\frac{d\Gamma}{d(\cos\theta)} \sim 1 + \cos\theta$$



- thus models with chiral couplings to light quarks predict lepton asymmetry
- The lepton asymmetry is independent of the $t\bar{t}$ asymmetry
- A_e can overwhelm $A_{t\bar{t}}$

$\Longrightarrow$ not completely clear what exp's have measured

Example: $g_R^q = 1$, $g_L^q = 0$, g_x^t varied

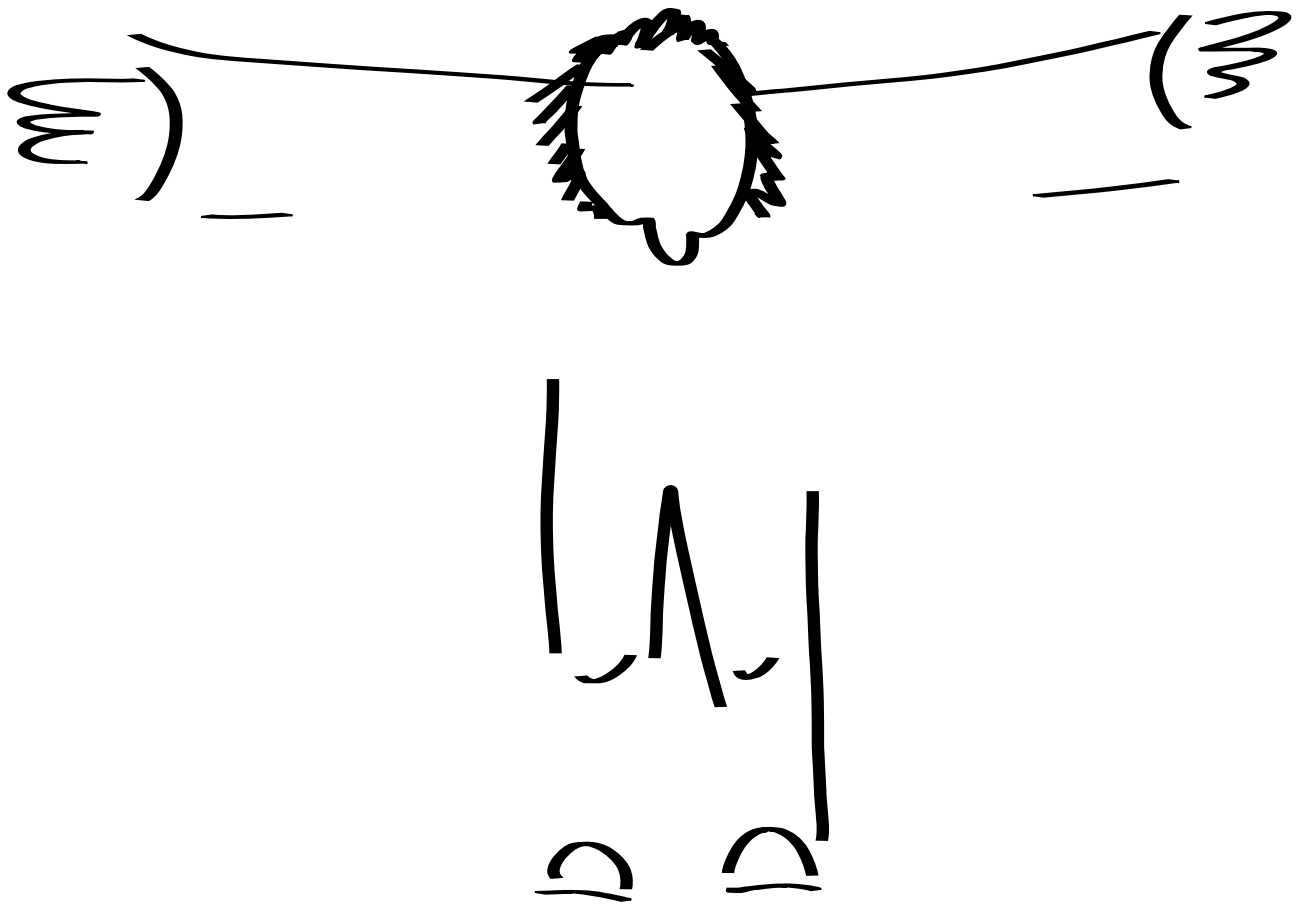


α. The jury is still out on $A_{t\bar{t}}$

- exp. issue / LHC ched
- SM calc.
- New physics

β. Light axigluons should be seen in multi-jets

γ. The lepton asymmetry may be (partially) responsible for the Tevatron results



thanks ...