Thoughts and Perspective

Tim M.P. Tait
University of California, Irvine

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Despite Appearances...

Canadians are not actually interchangeable...

Graham set the tone of these final thoughts, I provided the color scheme, and you are VERY lucky to have him (instead of me) there to flesh out the ideas!

The LHC Checklist

- [x] Discover the Higgs (or Whatever)
- [ ] Discover Supersymmetry
- [ ] Produce Dark Matter
- [ ] Understand flavor
- [ ] ...

The LHC Checklist

- ? Discover the Higgs (or Whatever)
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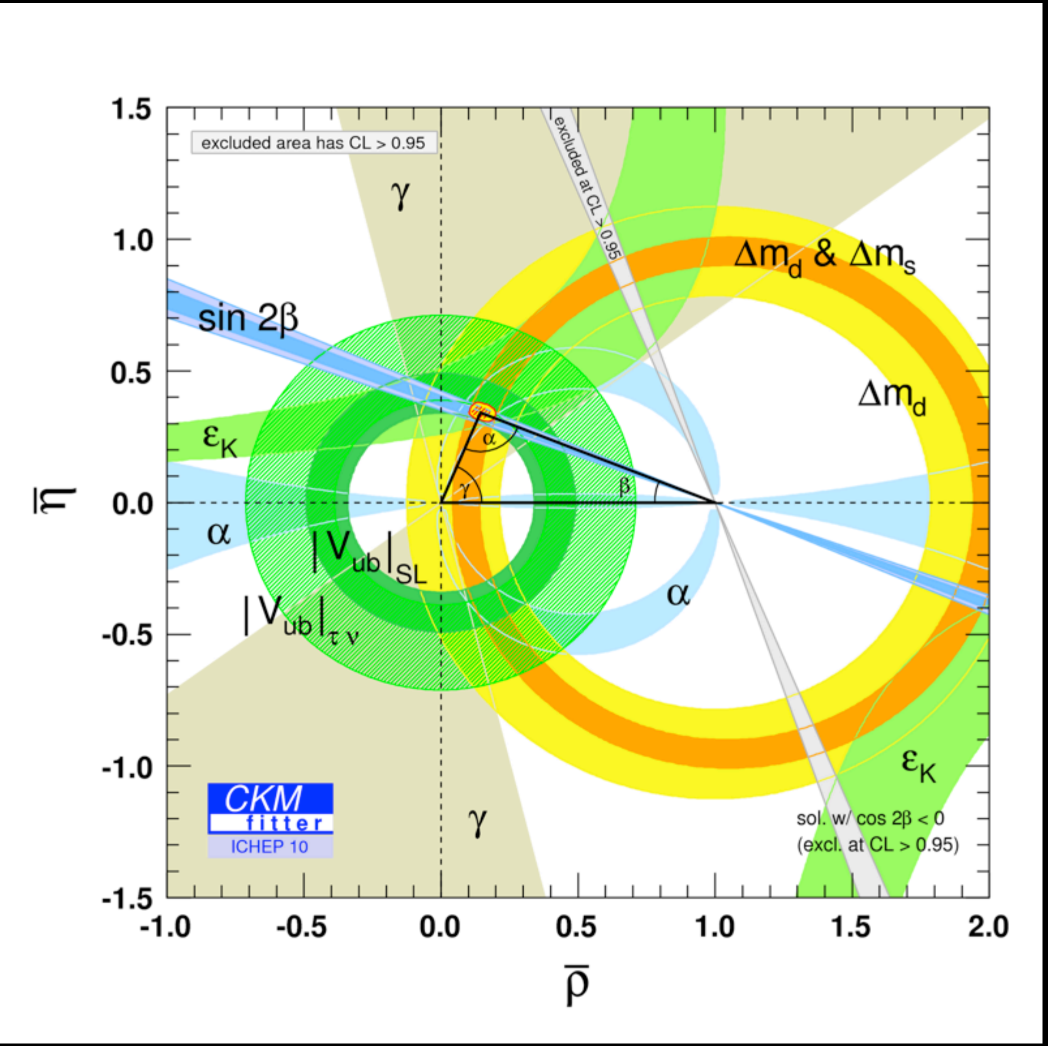
Flavor

- The CKM description of quark flavor works exquisitely well.
  - We still don't understand the quark mass hierarchy or mixing angles.
- Lepton flavor remains clouded by our uncertainty as to Dirac versus Majorana neutrinos.
  - Still no data about the absolute scale of neutrino masses.



Flavor

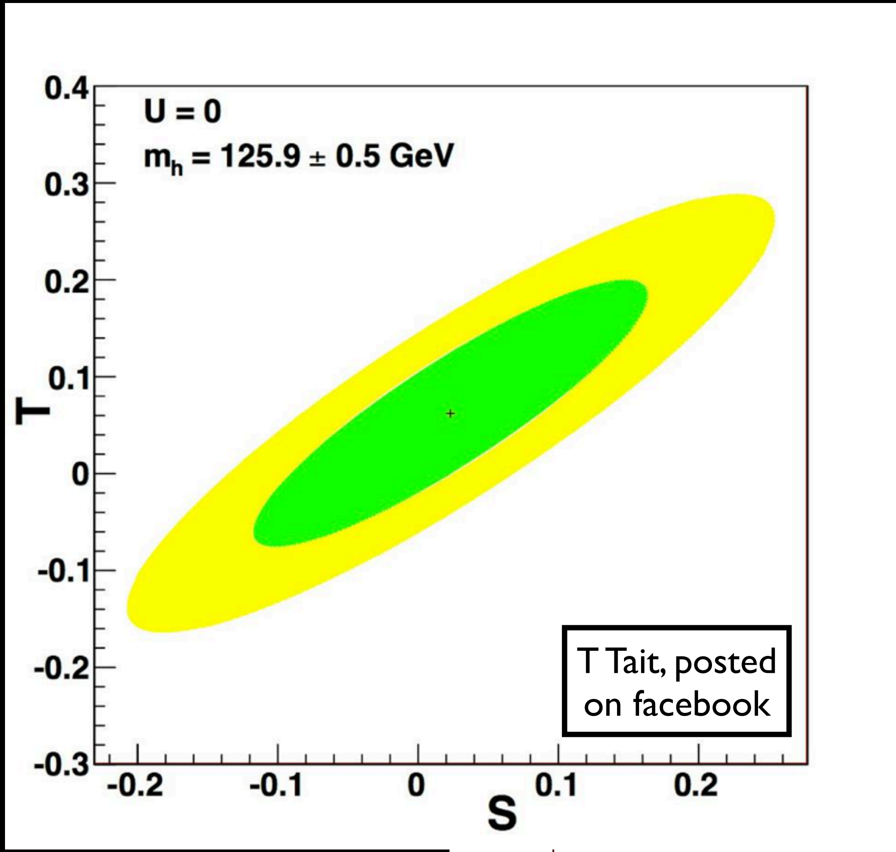
Operator	Bounds on Λ in TeV ($c_{ij}=1$)		Bounds on c_{ij} ($\Lambda = 1$ TeV)		Observables
	Re	Im	Re	Im	
$(\bar{s}_L \gamma^\mu d_L)^2$	9.8×10^2	1.6×10^4	9.0×10^{-7}	3.4×10^{-9}	Δm_K; ϵ_K
$(\bar{s}_R\, d_L)(\bar{s}_L d_R)$	1.8×10^4	3.2×10^5	6.9×10^{-9}	2.6×10^{-11}	Δm_K; ϵ_K
$(\bar{c}_L \gamma^\mu u_L)^2$	1.2×10^3	2.9×10^3	5.6×10^{-7}	1.0×10^{-7}	Δm_D; $\lvert q/p \rvert, \phi_D$
$(\bar{c}_R\, u_L)(\bar{c}_L u_R)$	6.2×10^3	1.5×10^4	5.7×10^{-8}	1.1×10^{-8}	Δm_D; $\lvert q/p \rvert, \phi_D$
$(\bar{b}_L \gamma^\mu d_L)^2$	5.1×10^2	9.3×10^2	3.3×10^{-6}	1.0×10^{-6}	Δm_{B_d}; $S_{\psi K_S}$
$(\bar{b}_R\, d_L)(\bar{b}_L d_R)$	1.9×10^3	3.6×10^3	5.6×10^{-7}	1.7×10^{-7}	Δm_{B_d}; $S_{\psi K_S}$
$(\bar{b}_L \gamma^\mu s_L)^2$	1.1×10^2		7.6×10^{-5}		Δm_{B_s}
$(\bar{b}_R\, s_L)(\bar{b}_L s_R)$	3.7×10^2		1.3×10^{-5}		Δm_{B_s}

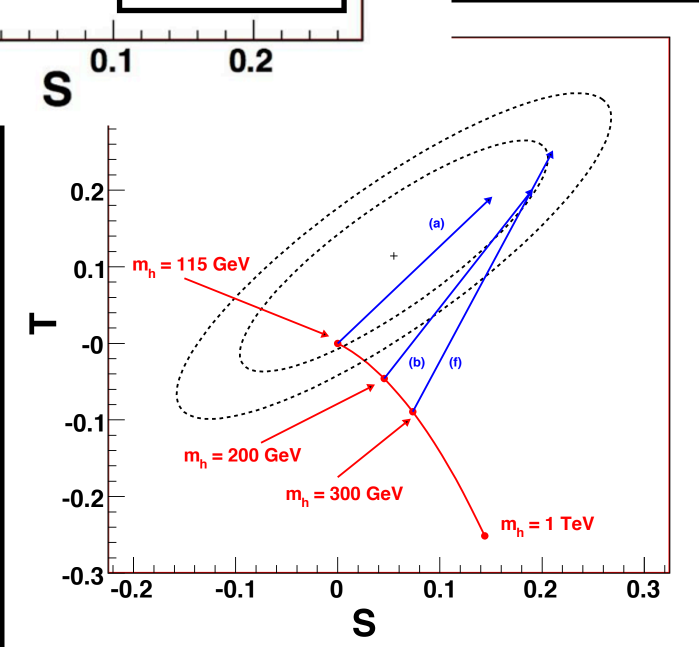
Isidori, Nir, Perez arXiv:1002.0900

- The exquisite CKM success turns into horrific bounds on any new physics which violates flavor.
- For order one couplings, mass scales must be > 100 - 100,000 TeV!

Oblique Corrections

- Now that we (think we) know the Higgs mass, we can't use it to ``fix up'' theories which otherwise lead to huge corrections to the oblique observables which describe precision EW measurements.
- Of course, we aren't entirely sure this is the Higgs yet, but as we zero in on its properties, huge classes of theories fall away.





Kribs, Plehn, Spannowsky, Tait arXiv:0706.3718

"Bye bye simple 4th generation..."

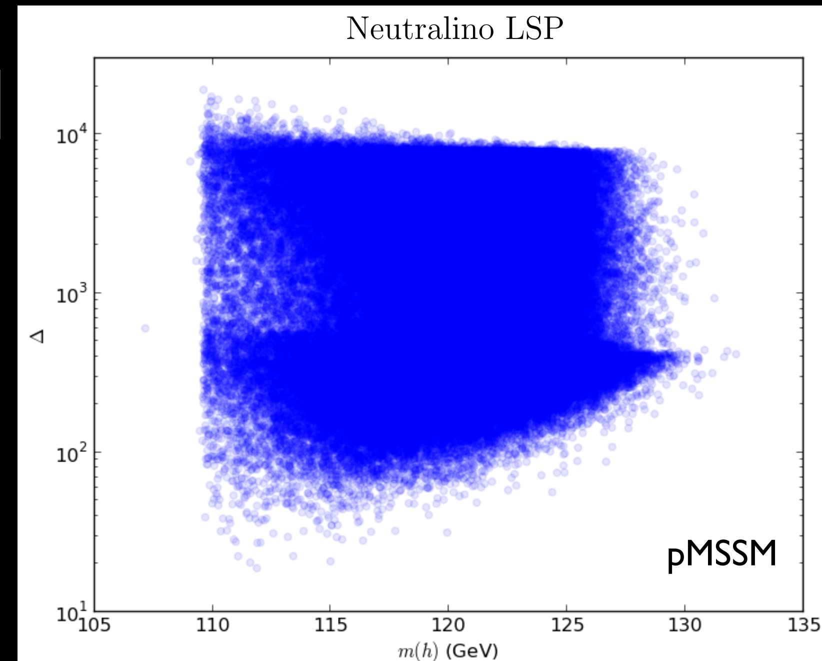
A Little Hierarchy?

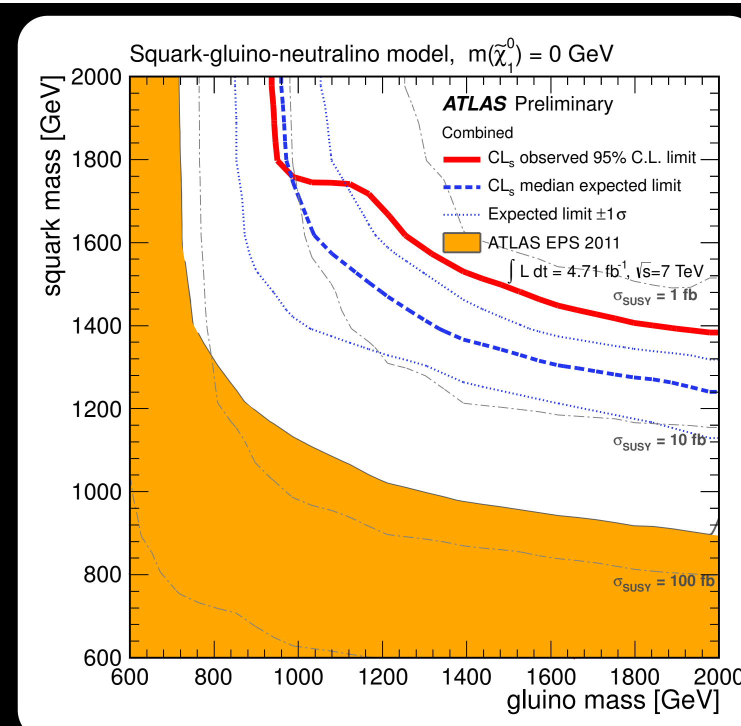
- Put together, both flavor and precision measurements seem to be suggesting that new physics is either:
  - very tightly constrained by powerful symmetries;
  - or has a mass scale >> TeV.
- It is really challenging to reconcile this with the idea that something protects the Higgs mass in a natural way.

Is SUSY in Serious Trouble?

Cahill-Rowley, Hewett, Ismail, Rizzo 1206.5800

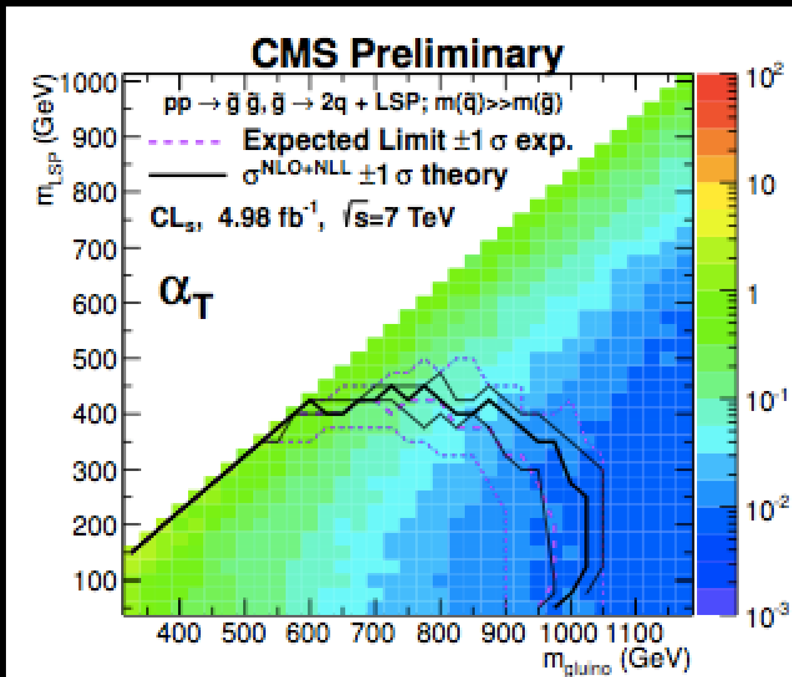
- A Higgs mass at ~126 GeV has a huge cost of fine-tuning in the MSSM, even if one defines the theory to evade the worst of the flavor constraints.
  - We know how to engineer heavier Higgs masses (NMSSM, Fat Higgs, D-terms, ...).
  - 126 GeV is a big problem for the MSSM, not SUSY in general.
- Should we be worried about the lack of evidence in jets + MET ?
  - Squark and gluino masses > 1.5 TeV!



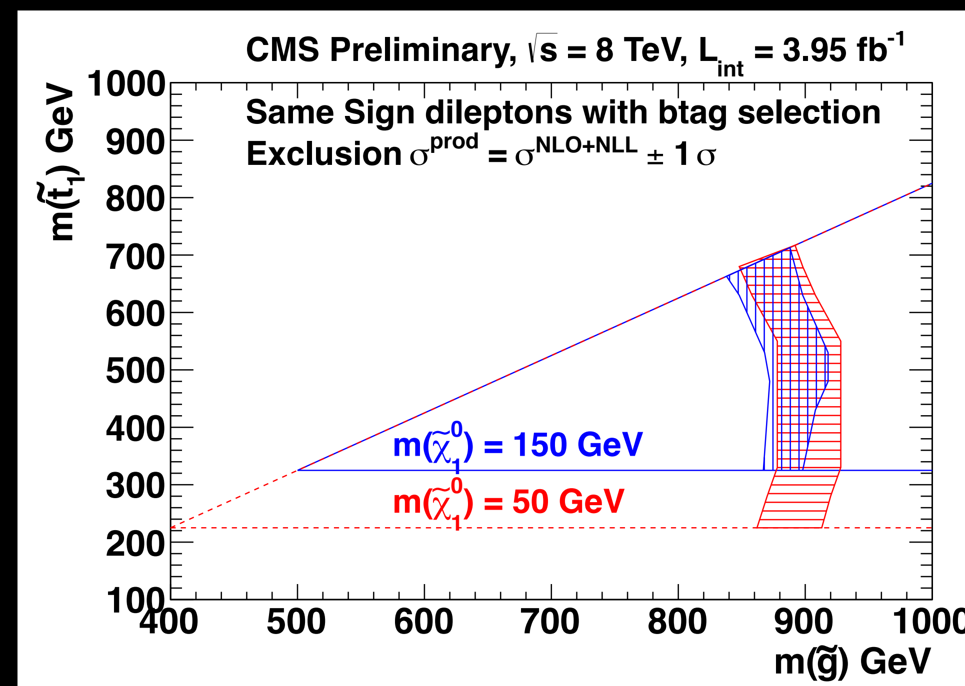


No jets+MET = No SUSY?

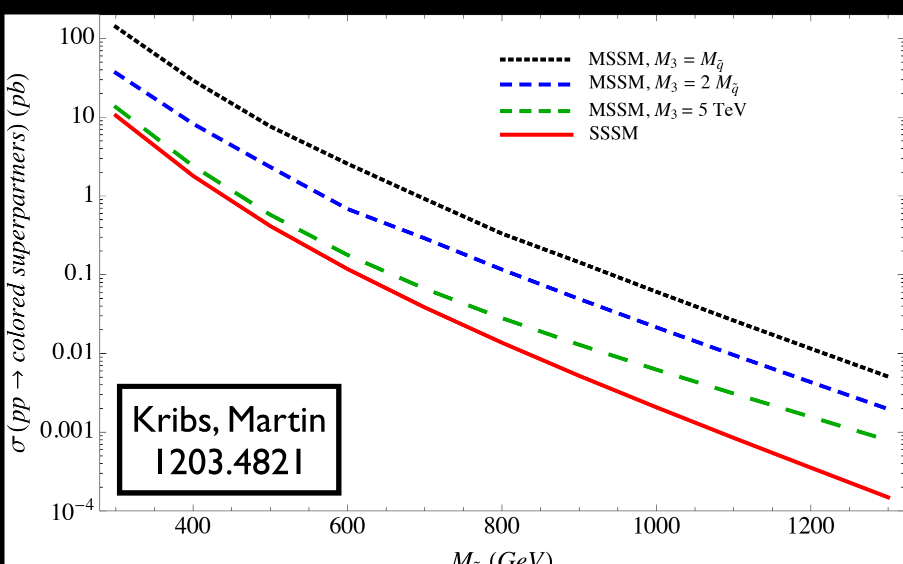
It’s too early to draw this conclusion. Some rebuttals include:



“Neutralinos aren’t massless!”



“Limits on stops are weak!”



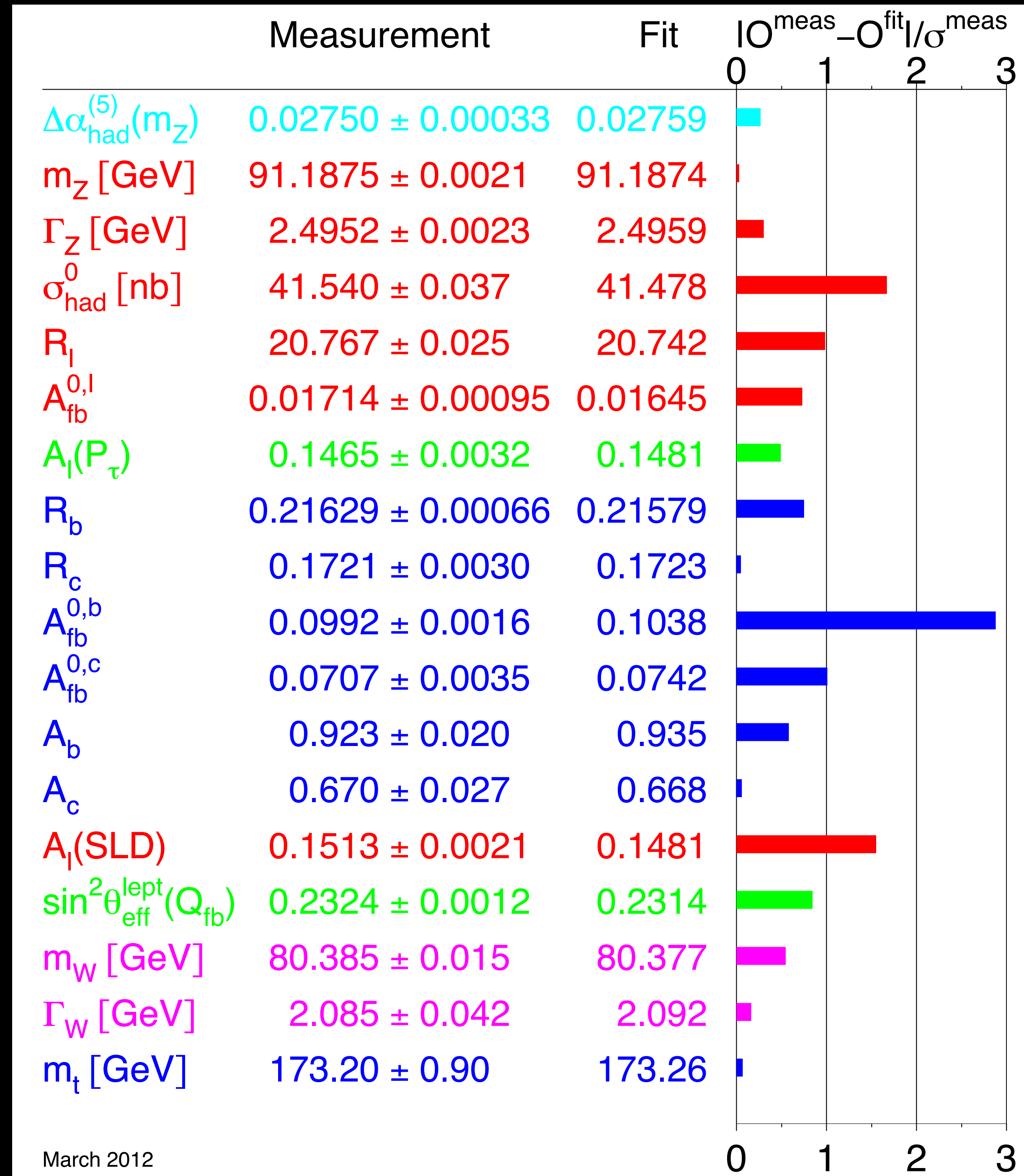
“Nature is R-symmetric!”

+ many more...

Hints of Things to Come?

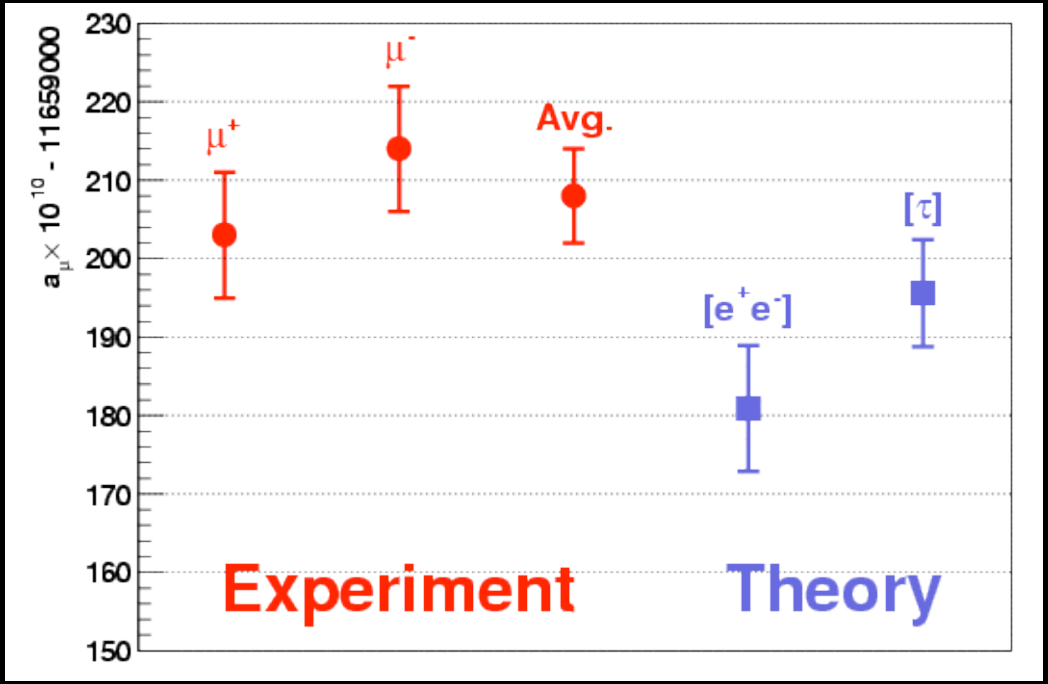
A^{FB}_b

- There are 6 important inputs to describe Z decay, so with ~20 measurements the system is over-constrained.
- Over-all, the agreement with theory is fantastic.
- One measurement stands out: the forward-backward asymmetry of bottom quarks disagrees at 2.9σ.
- This measurement has been around for more than 10 years, and has resisted conventional explanation the entire time.



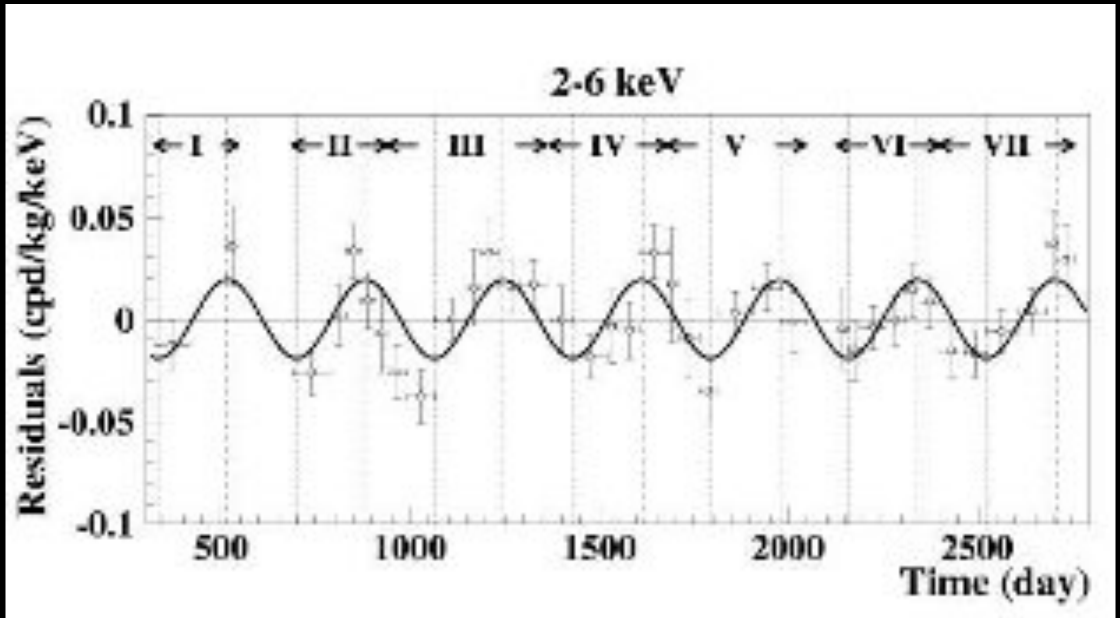
g-2 of the Muon

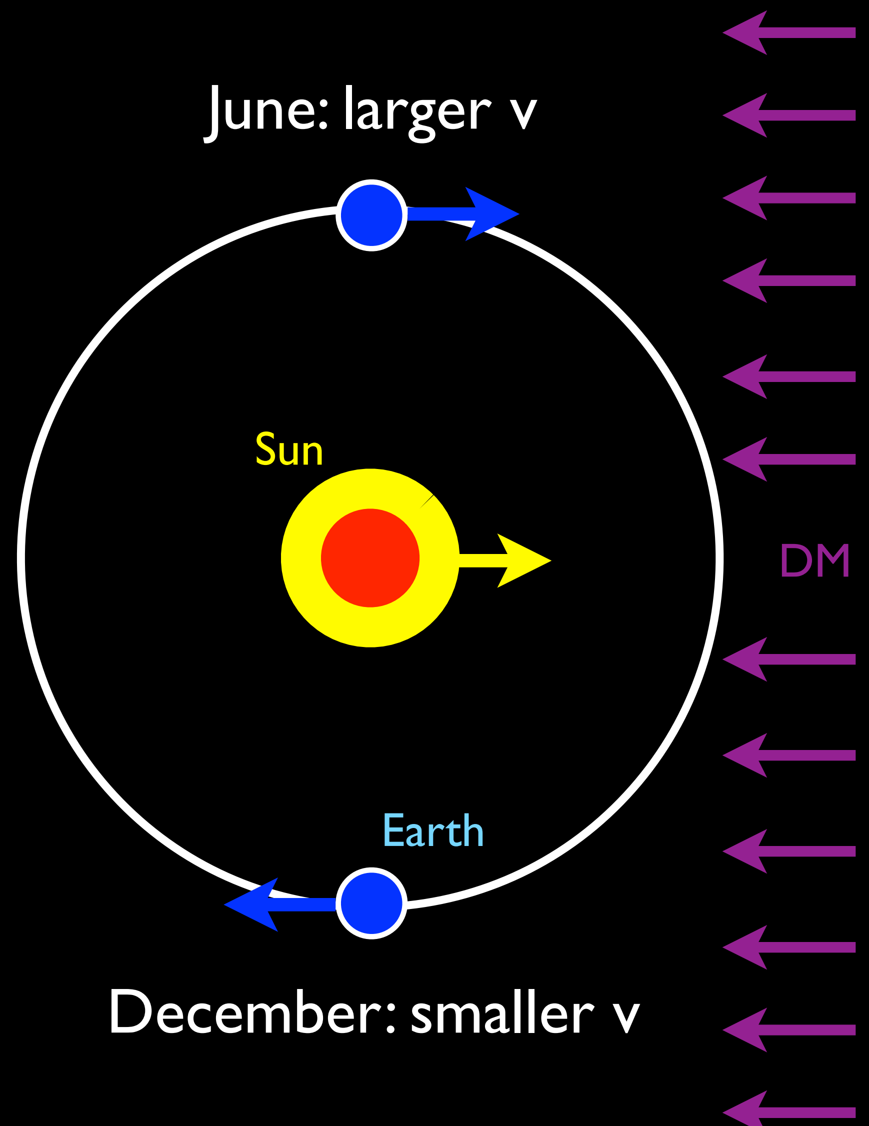
- The g-2 experiment measures the anomalous magnetic moment of the muon to great precision.
- Despite ongoing improvements in theory calculations, the experiment remains ~2-3σ away from the SM predictions.
- Is this just revealing the limits of the computations, or is it telling us something important about Nature?



DAMA / Libra

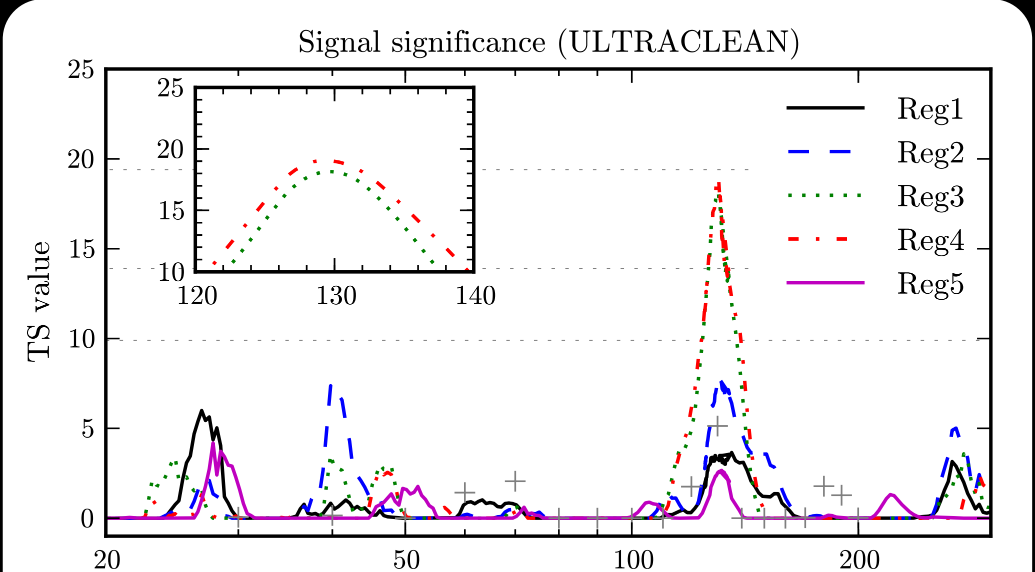
- DAMA/Libra looks for an annual variation in DM scattering from an NaI target.
- Data collected over more than a decade show a significant (~9σ) annual modulation of a few percent with a maximum in June.
- Low mass WIMPs are a possible explanation, but simple implementations are in tension with other experiments.



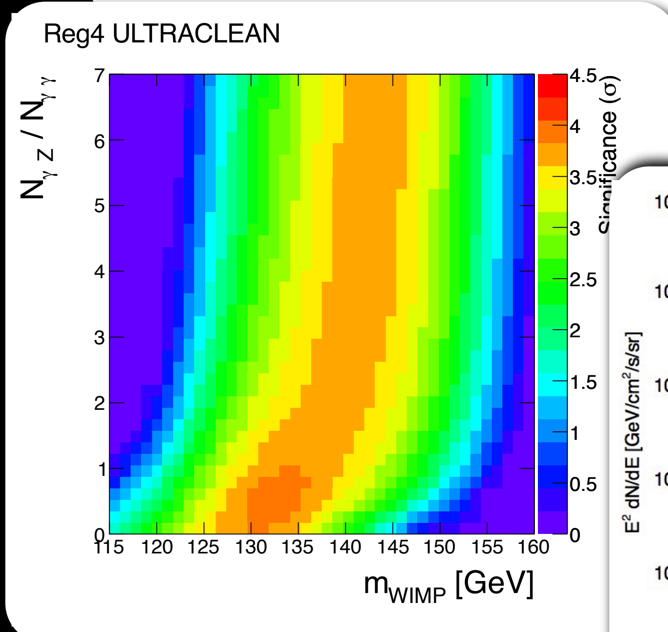


The ‘Weniger’ Line

- Recently, Weniger (et al) claim observation of a feature around ~130 GeV corresponding to a cross section around ~10^{-27} cm^3/s in the Fermi γ-ray data.
- The feature is more prominent in the galactic center (with the galactic plane removed).
- Follow-ups show the excess is correlated with the center, and evidence of a second (γZ?!) line.
- The question now is: is this real? is it instrumental? Astrophysics? Dark matter...?!?!

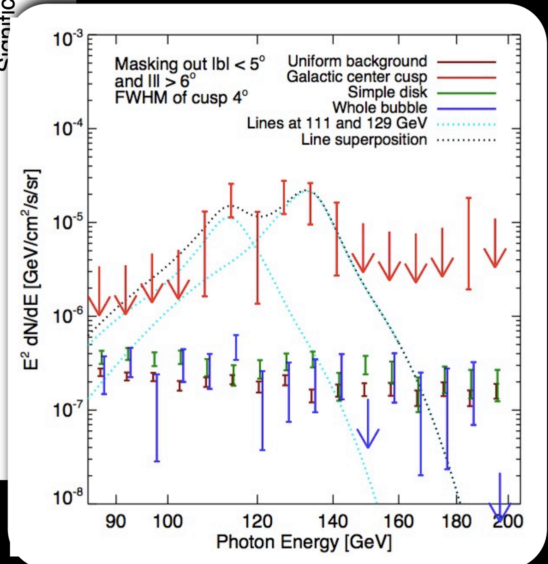


Weniger, 1204.2797



Rajaraman, Tait, Whiteson, 1205.4723

Su, Finkbeiner 1206.1616



Final Thought

“If you want your children to be intelligent, read them fairy tales. If you want them to be more intelligent, read them more fairy tales.”

--Albert Einstein

It may be that the models of the last few decades *are* only fairy tales.

But just like a fairy tale, each model contains a lesson that may persist past its immediate context.

Now that you're intelligent enough, go write our reality!