

THU and THN

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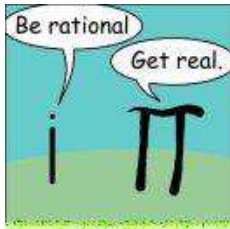
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Higgs, opinions are made to be changed or how is truth to be got at?

(Paraphrasing George Byron)

On behalf of the **HXSWG**



THU + PU combination:

It is an opportunity

to draw the attention to the issue.

- flat or log-normal?
- More coherent work to be done?

Let's start! Translation of the flat distribution to log-normal distributions?

- Please, clarify *We've checked that using flat distributions in the combination leads to the same combination as using log-normal distributions*



Our starting point

Theorem

- *The scale dependence has no physical meaning, i.e. its correlation to anything else has no meaning as well. There is no correlation that can be quantified between the uncertainty band from higher orders to something.*
- *Once you try to set up something like this, you screw up the spirit of taking the scale as conservatively quantifying missing corrections.*



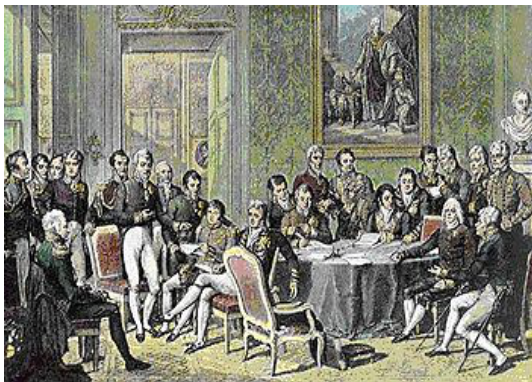
Hypothesis

- Flat prior for log-parameter, requires the introduction of a new, a priori unknown, parameter which controls the spread;
- agreement with the conventional method; not a surprise (built and refined over the years)!





FreakingNews.com



Resonances

Heavy - Higgs or heavy resonances?

- There are boundaries from gauge invariance
- There is sense and nonsense in ad hoc parametrizations.



The off-shell Higgs production

is currently computed according to

$$\sigma_{OS}(\mu_H^2) \delta(z \hat{s} - \mu_H^2) \implies \sigma_{OFS}(z \hat{s}) \text{BW}(z \hat{s}),$$

at least at lowest QCD order, where the *so-called* modified Breit–Wigner distributions is defined by

$$\text{BW}(s) = \frac{1}{\pi} \frac{s \Gamma_H^{\text{OS}} / \mu_H^2}{\left[s - \mu_H^2 \right]^2 + (s \Gamma_H^{\text{OS}} / \mu_H)^2},$$

where now $\mu_H = M_H^{\text{OS}}$.



This ad-hoc Breit–Wigner

- cannot be derived from QFT and also is not normalizable in $[0, +\infty]$.
- Its practical purpose is to enforce a *physical* behavior for low virtualities of the Higgs boson but the usage cannot be justified.
- This modified Breit–Wigner cannot be derived from QFT.
- Note that this Breit–Wigner for a running width comes from the substitution of $\Gamma \rightarrow \Gamma(s) = \Gamma s/M^2$ in the Breit–Wigner for a fixed width Γ . This substitution is not justifiable.



High-Mass

What is the physical meaning of an *heavy Higgs* search?

New Physics

- An Higgs above 600 GeV requires new physics at 1 TeV;
- This is based on partial-wave unitarity but should not be taken quantitatively or too literally:
 - With Fermi theory the unitarity bound is at $\mathcal{O}(10^2)$ GeV and we have been lucky that the vector boson scale is 80–90 GeV
- Violation of unitarity bound $\leftrightarrow J = 0, 1$, resonances
 - but there is no way to predict their masses, simply scaling the $\pi-\pi$ system gives you the 1 TeV ballpark.
- Anyway, it would be a good idea to address it as *search* for $J = 0, 1$ *heavy new resonances* decaying into $VV \rightarrow 4f$.



Signal/background interference:

That's just a homework

- that should be done, and in fact
- a full LO study (which is possible with present tools such as Sherpa, Phantom, etc.) would do.



MSSM issues:

- Most likely covered by other sessions, if not . . .



Beware of

- EW effects! Comments on THU?



Fermiophobic Higgs:

Theory has a problem here

- EW corrections become ill-defined when switching off the Yukawa couplings but keeping the fermion masses. UV divergences do not cancel anymore due to the non-renormalizability of this *model*.
- explicit calculations (Stefan) show that this is the case.
- THU of the LO analysis
- Full calculation?



Ready to go

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"We know that communication is a problem, but the company is not going to discuss it with the employees."

