Experimental wish list

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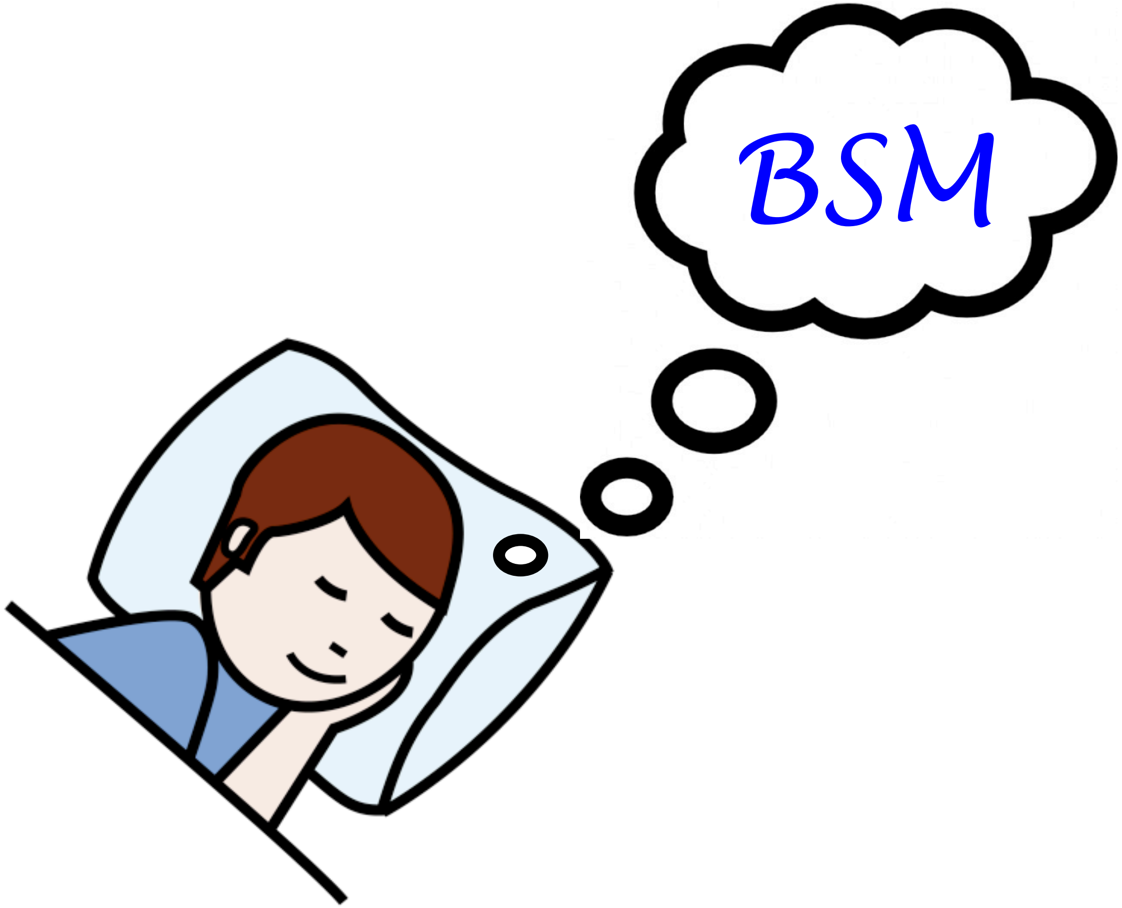


★ Certainly, we have not seen any BSM physics yet

★ However, the reasons to believe in BSM remain almost intact:

- Origin of the EW scale (naturalness)
- Flavour puzzle
- Dark Matter
- ⋮

I will focus on these three

- Origin of the EW scale (naturalness)
- Flavour mysteries
- Dark Matter

These are very strong indications of BSM physics

... but not necessarily in a scale potencially reachable by current experiments, except the Naturalness Problem.

Naturalness problem

Simple (maybe naive) arguments, related to the size of the EW scale, suggest that

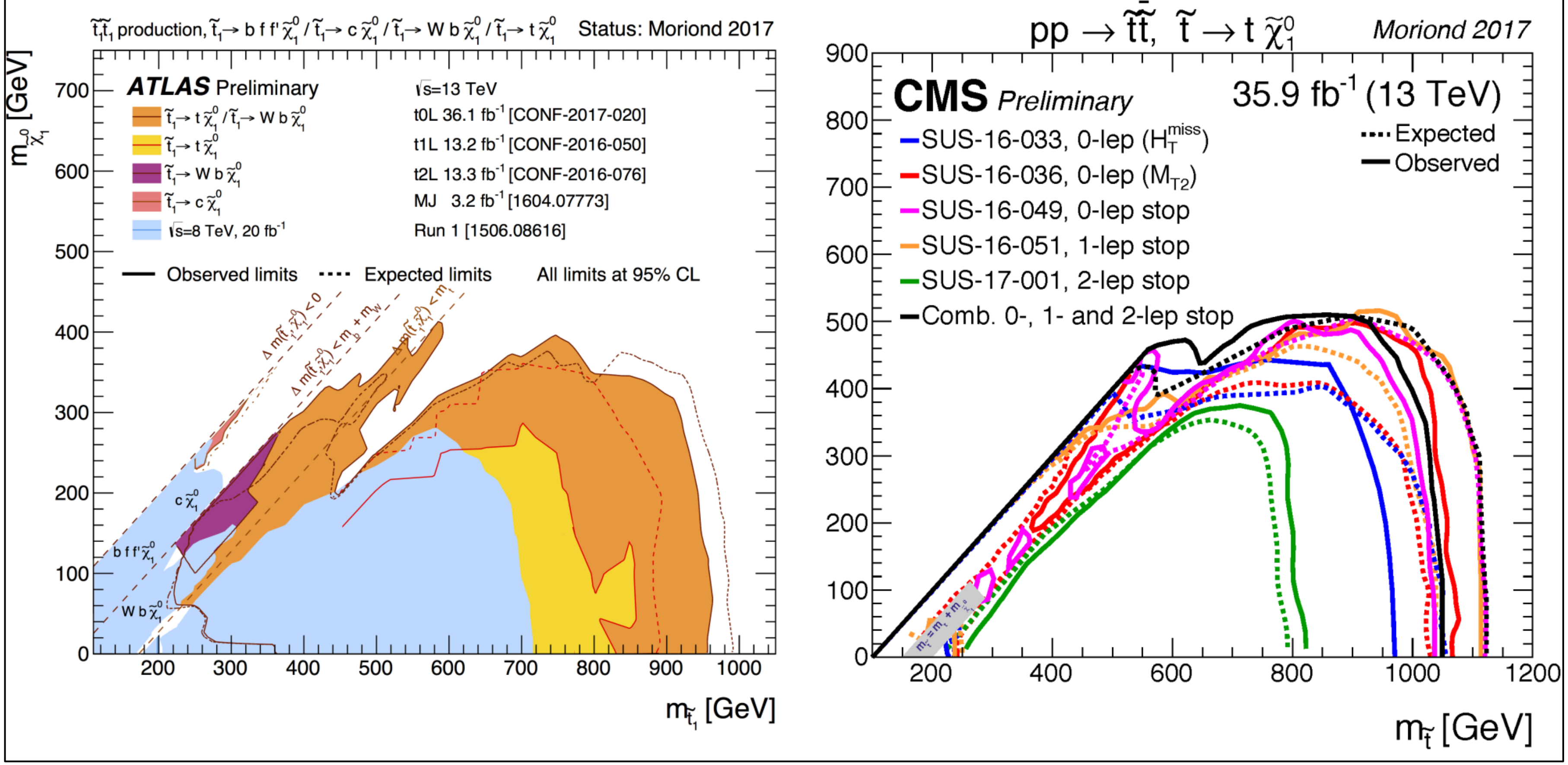
$$\Lambda_{\rm NP} \lesssim \mathcal{O}(\rm TeV)$$

However, it should be noticed that the naturalness bound applies to the BSM physics associated to the top

$$\delta m^2 = \frac{\Lambda^2}{4\pi^2 v^2}\left(-3m_t^2 + \cdots\right)$$

$$\left|\frac{\delta m^2}{m^2}\right| \le 10 \quad \Rightarrow \qquad \Lambda \lesssim 1.5 \ \rm TeV$$

stop: Combination of channels:



from J. Cuevas talk

Still a lot of space to explore !

Naturalness problem

Another promising territory to explore is Higgs physics:

- ★ Directly related to the naturalness problem

- ★ Still large uncertainties and many important SM predictions to be tested: $y_{\mu\mu}, \lambda_3, \lambda_4, \cdots$

Prospects, New ideas ?

- ★ Last sector of SM discovered: new opportunities to find BSM

Flavour puzzles

We do not have a theory of flavour (it is a big mystery).

So we can only hope that "by chance" we will discover some New Physics relevant for flavour at LHC

Maybe LHCb anomalies? It is a hope, although difficult to understand theoretically.

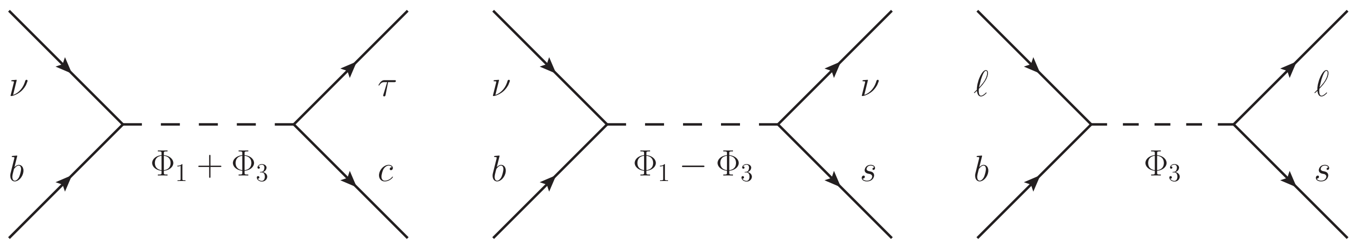
Flavour puzzles

All explanations so far proposed only "accommodate" the anomalies.

E.g.

- simultaneous solution of $R_{K^{(*)}}$ and $R_{D^{(*)}}$ requires two scalar lepto-quarks: [Crivellin,Müller,Ota'17]

Φ_3: $SU(2)_L$ triplet, Φ_1: $SU(2)_L$ singlet



$SU(2)$ singlet Φ_1 needed to cancel contribution to $b \to s\nu\bar{\nu}$

from L. Hofer talk

But they do not offer hints about a theory of flavour.

Flavour puzzles

But, of course, if confirmed, LHCb anomalies would be a great discovery

Prospects at LHCb

- $Br(B_s \to \mu^+\mu^-)$ and $Br(B_d \to \mu^+\mu^-)$ with Run2
- R_K with improved Run1 data (new calo reco) + Run2
- R_ϕ : narrower resonance as compared to K*, but less stat. (f_s/f_d) $\mathcal{R}_\phi = \frac{\mathcal{B}(B_s^0 \to \phi \mu^+\mu^-)}{\mathcal{B}(B_s^0 \to \phi e^+ e^-)}$
- $R_{\Lambda(*)}$: lepton universality in baryons, different spin structure $\mathcal{R}_{\Lambda^{(*)}} = \frac{\mathcal{B}(\Lambda_b \to \Lambda^{(*)} \mu^+\mu^-)}{\mathcal{B}(\Lambda_b \to \Lambda^{(*)} e^+ e^-)}$
- Angular analysis of $B^+ \to K^+ \ell^+ \ell^-$, $B^0 \to K^{*0} \ell^+ \ell^-$ ...
- Branching fractions, isospin asymmetries ... in $B \to X \ell^+ \ell^-$
- $B_s \to \phi\gamma$, $B \to K^*\gamma$, $B \to K\pi\pi\gamma$, $\Lambda_b \to \Lambda\gamma$, $\Xi_b \to \Xi\gamma$ ...

from A. Oyanguren's talk

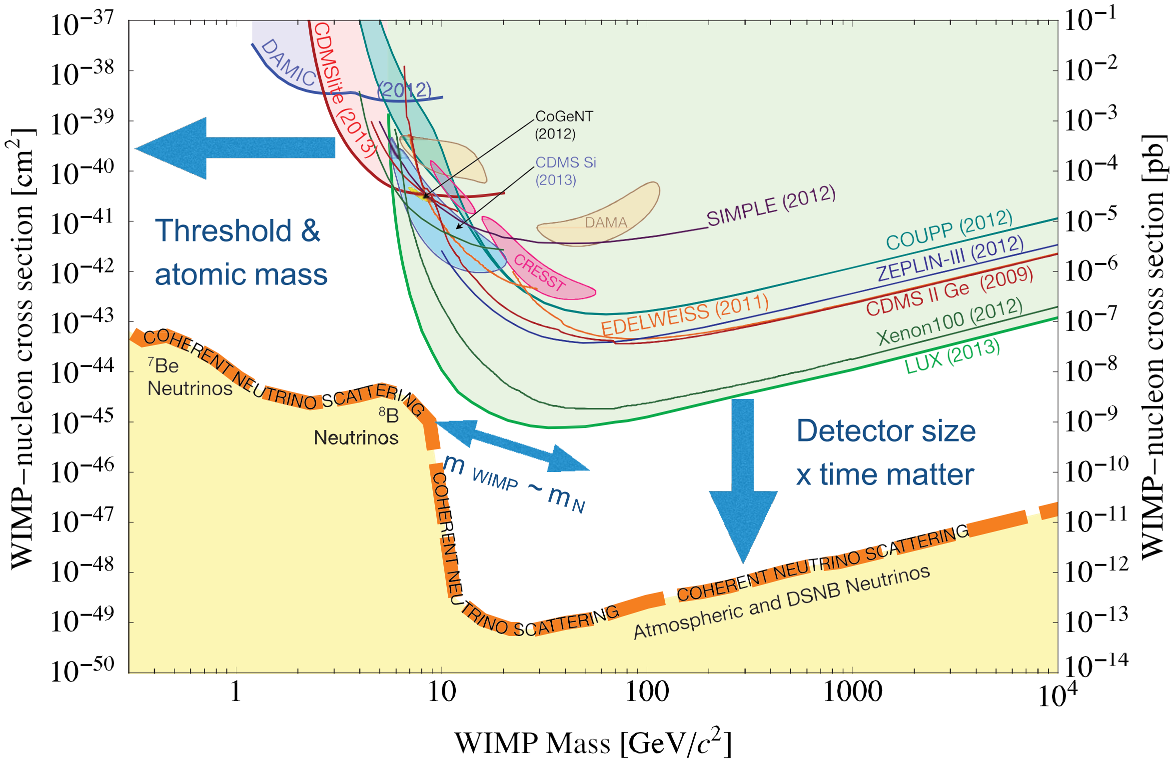
When will we have a confirmation of the R-anomalies??

Dark Matter

Maybe the strongest signal of BSM physics

We can hope a positive detection at LHC **if DM is a WIMP**

Unfortunately, there is Direct-Detection "Tsunami" in the WIMP parameter space



Dark Matter

Several strategies to discover WIMPS at LHC

- Mono-X + MET, $t\bar{t}$ +MET
- Di-jet (DM mediator) resonances
- Contribution to Higgs invisible width

Already LHC provides the **strongest bounds** for the **spin-dependent DM-nucleon cross section, and spin-independent DM-nucleon cross section** for **$m_{DM} < 10$ GeV, though they are model-dependent**

New ideas for WIMP discovery??

Conclusion

So far great experimental job.

Please continue pursuing the search for BSM
in any conceivable way.