MadDM

V.2.0

Dark Matter Phenomenology in the MG5_aMC@NLO framework

Gopolang (Gopi) Mohlabeng

with

Mihailo Backovic, K.C. Kong, Antony Martini and Olivier Mattelaer

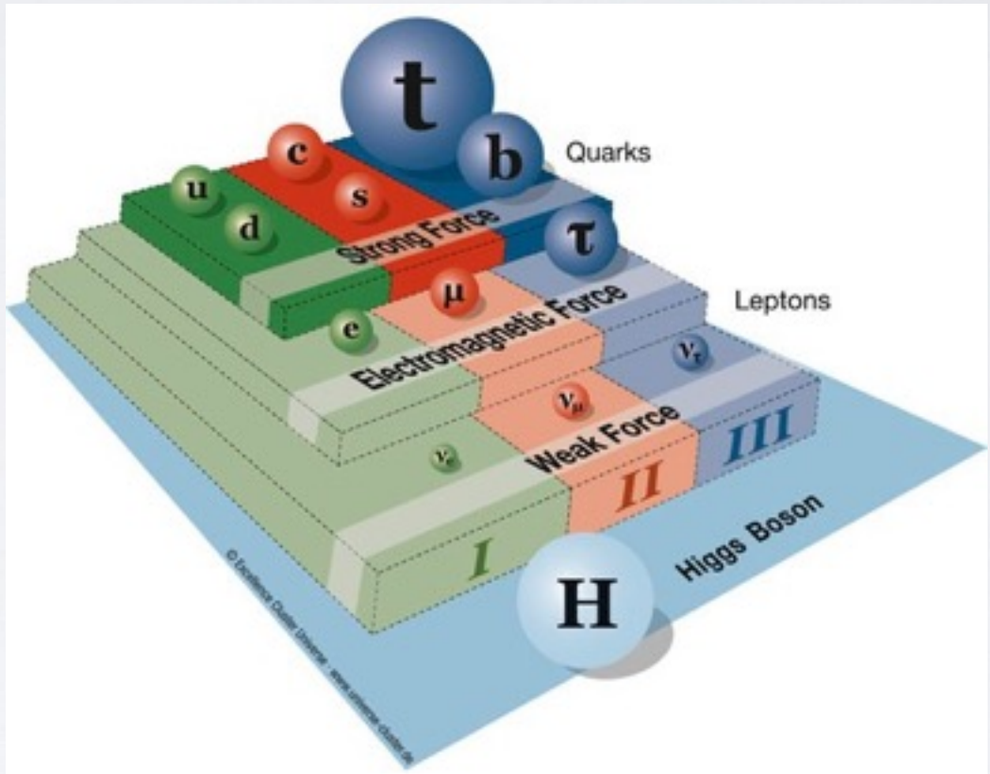
arXiv:1505.04190

BSM Physics in LHC era

- Standard Model has been very successful in explaining observed particle physics phenomena.

Some deficiencies:

★ Baryogenesis.
★ Leptogenesis.
★ Neutrino Masses.
★ Dark Matter.
★ Dark Energy.



- DM is very well motivated for New Physics beyond SM.

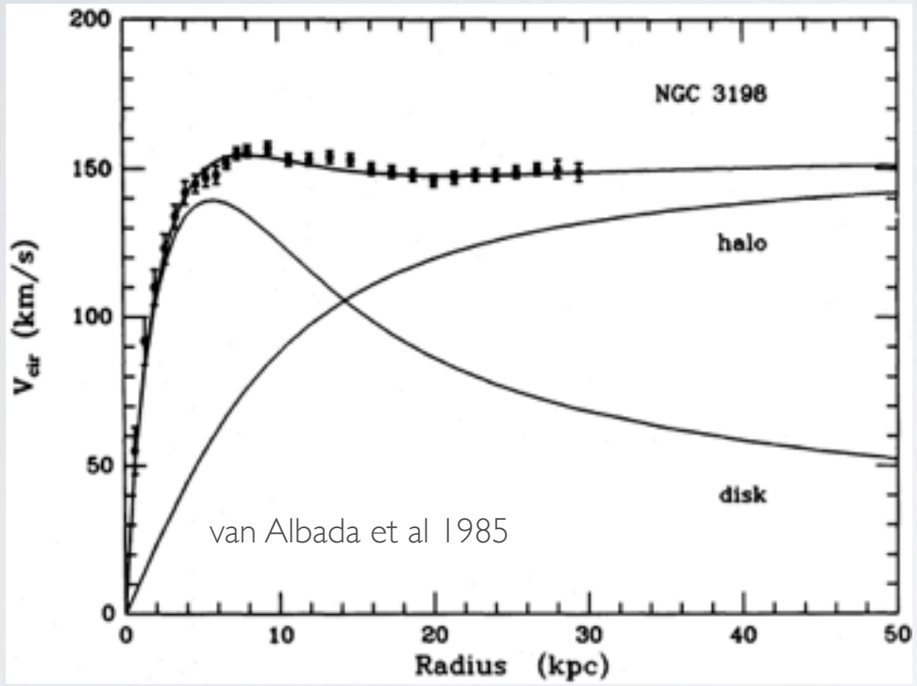
Why?

Many intriguing and undeniable hints that DM exists

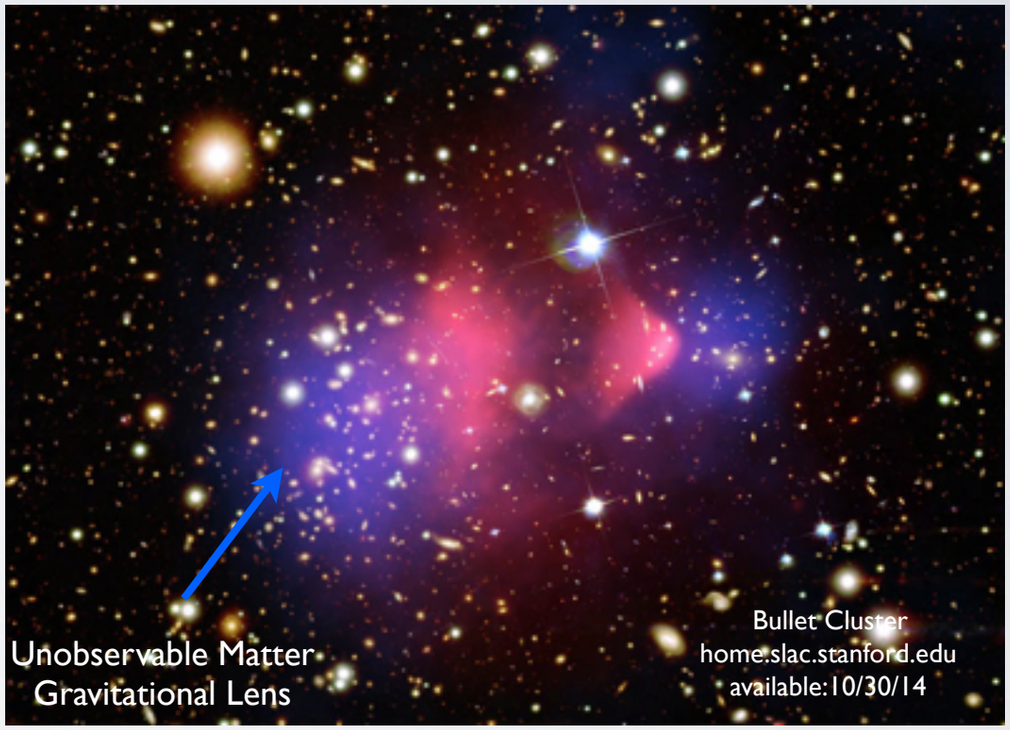
DARK MATTER

Evidence From Astrophysics and Cosmology

Rotational velocities of spiral galaxies

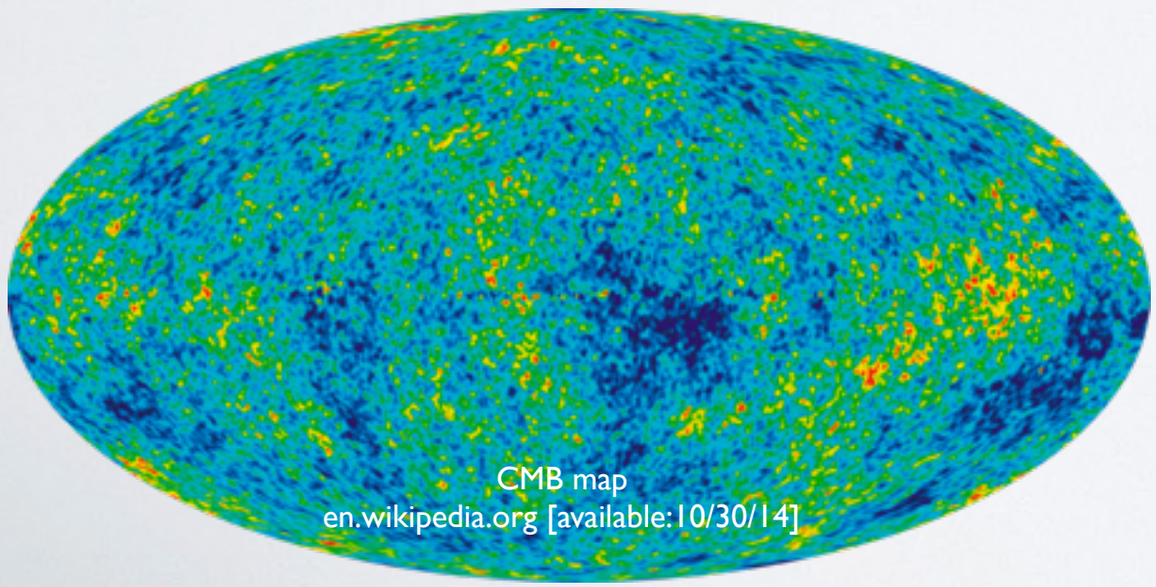


van Albada et al 1985

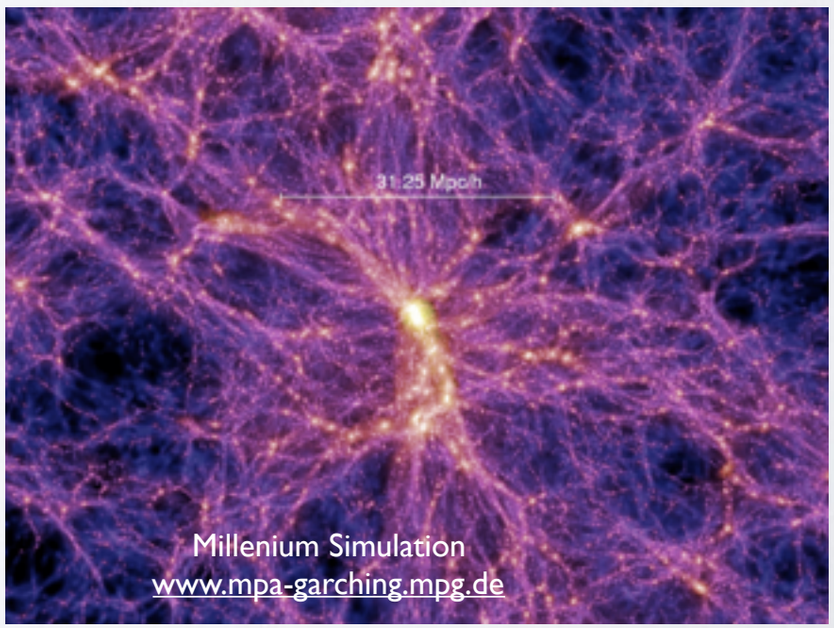


Gravitational Lensing

Velocity dispersions, CMB maps, N-body simulations



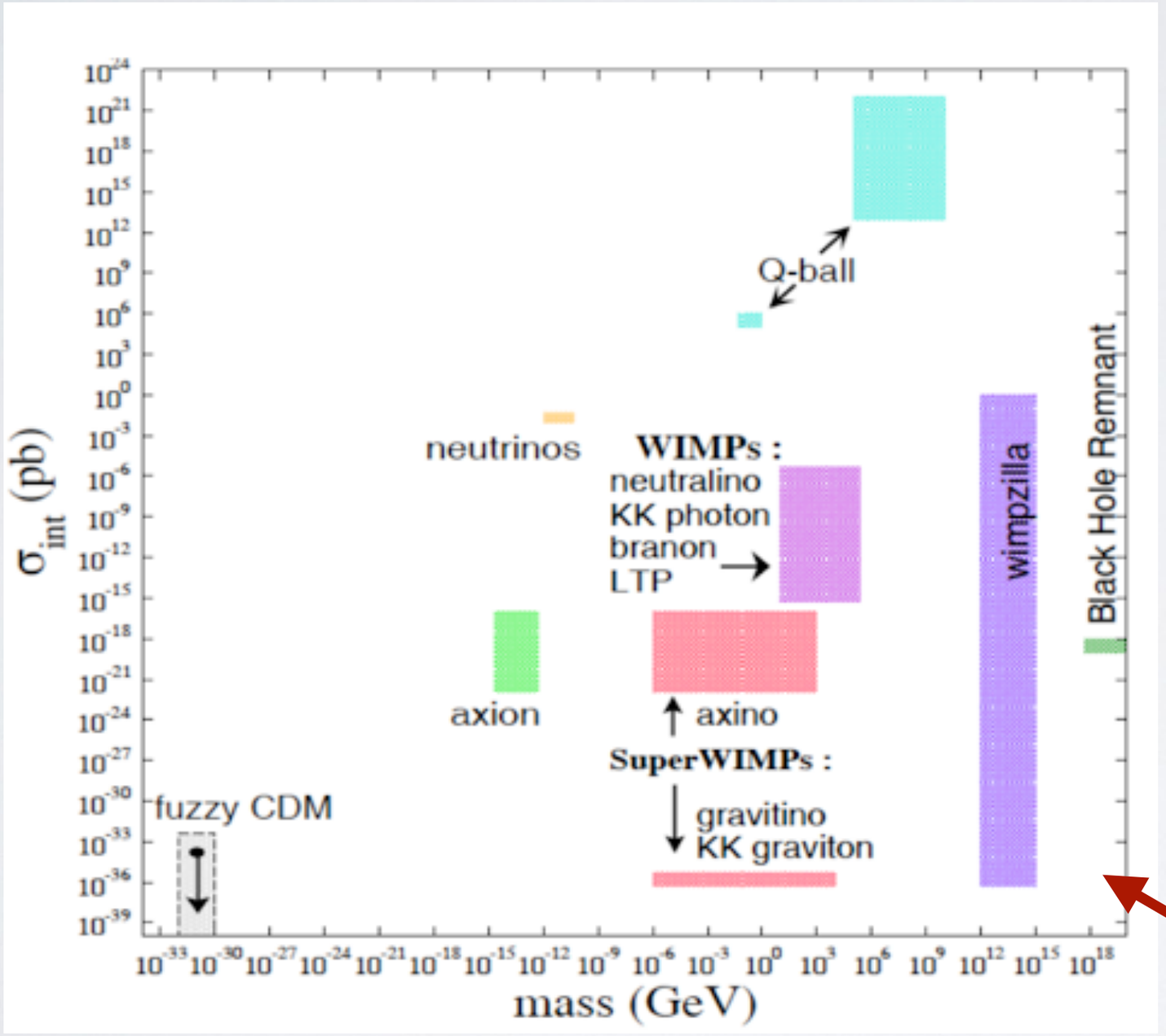
CMB map
en.wikipedia.org [available:10/30/14]



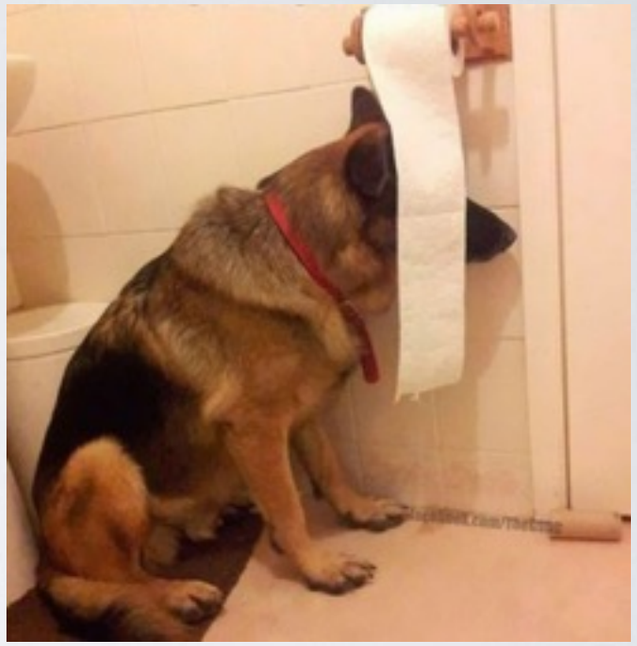
Millenium Simulation
www.mpa-garching.mpg.de

Dark Matter Complementarity

- We have no sense of where new physics is hiding



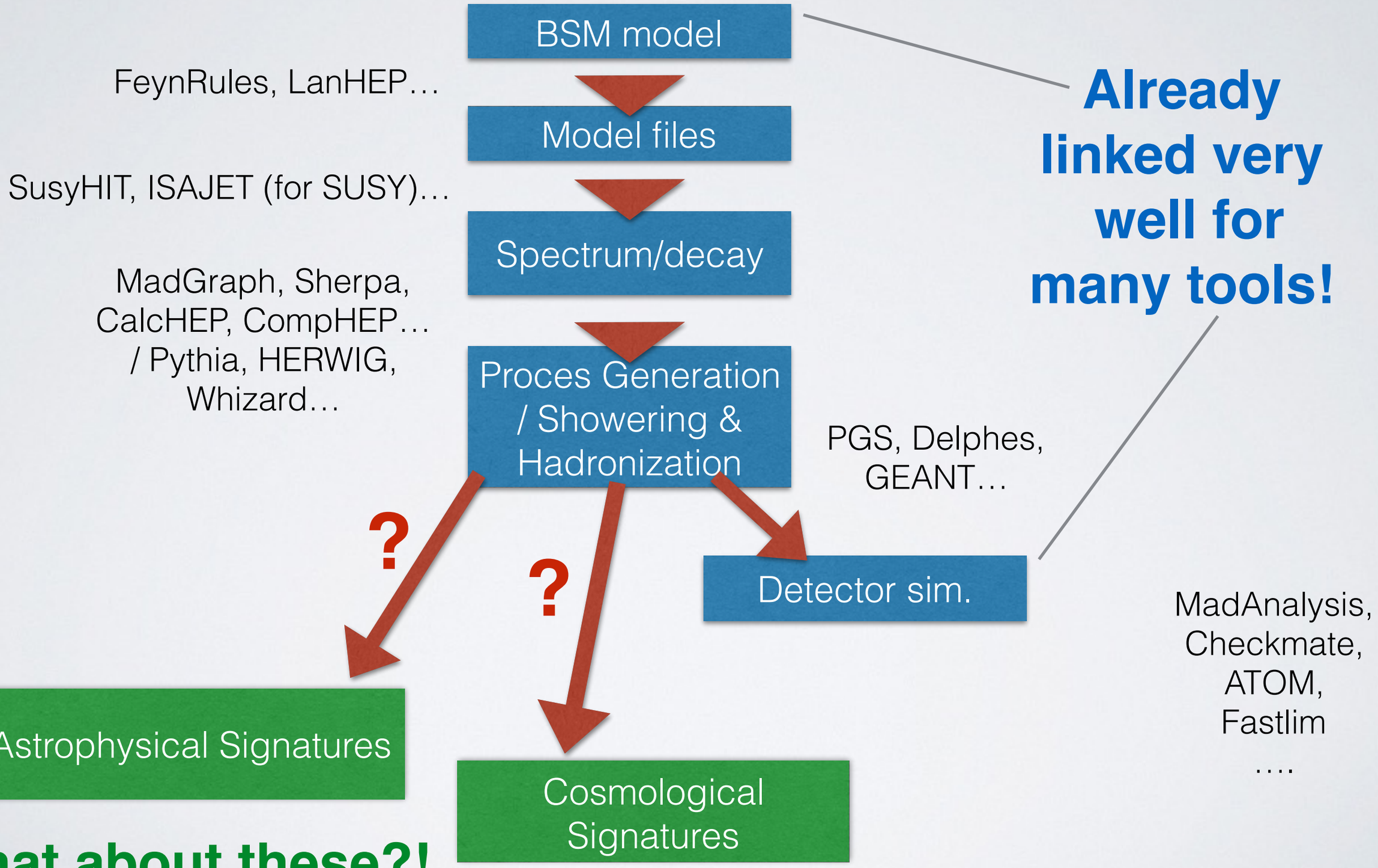
http://home.physics.ucla.edu/~arisaka/home/Dark_Matter/



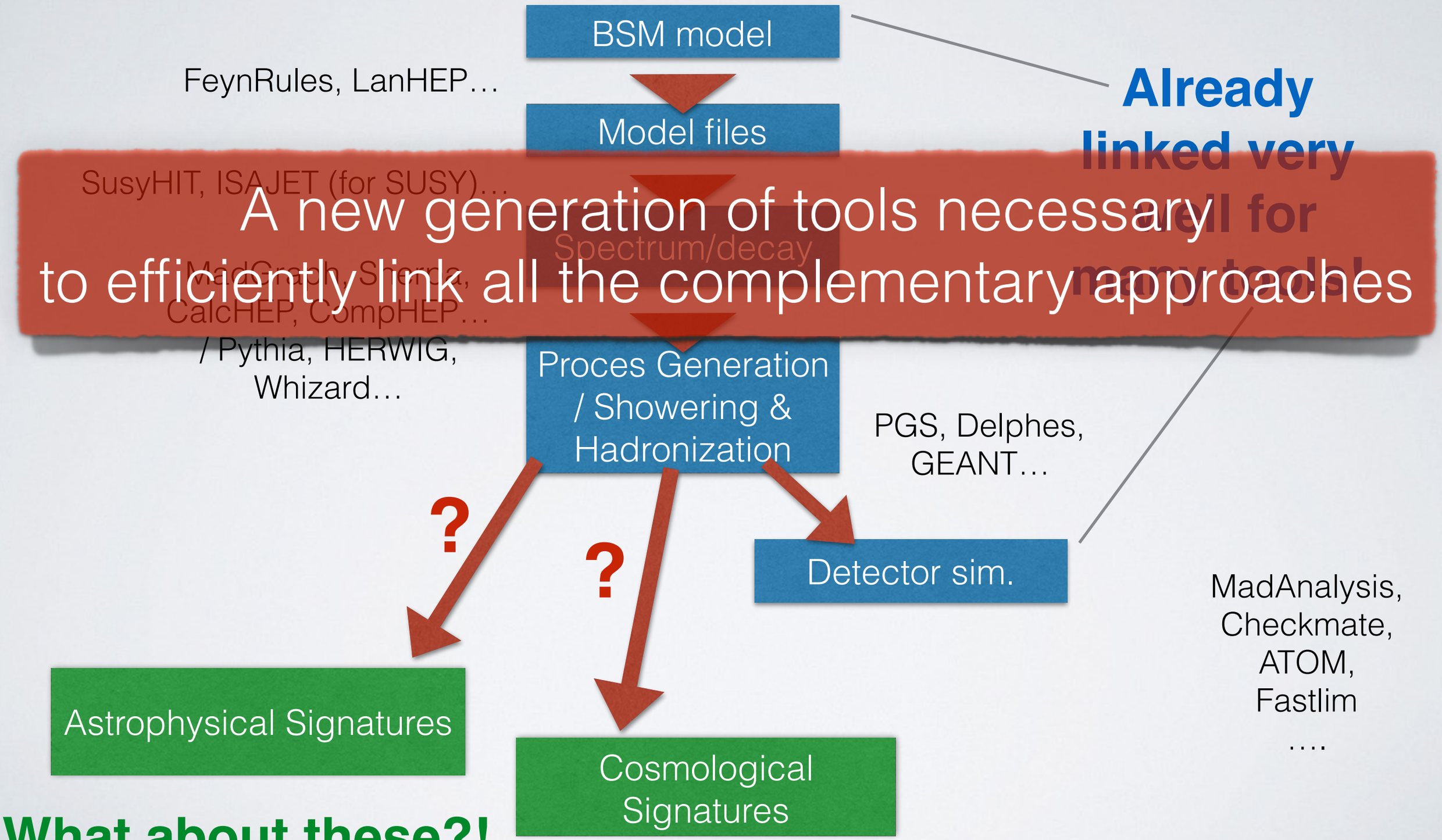
DM models alone span many orders of magnitude in energy scales

Complementarity studies require powerful simulation tools

BSM tools in LHC era



BSM tools in LHC era



MadDM

MadDM emerged as an effort to link:

- **DM collider searches**, with
- **early cosmology** signatures (relic density) and
- **direct/indirect detection**.

Goal is to allow both **Experimentalists** and **Theorists** to calculate signatures of DM models at all interfaces with click of a button.

User friendly architecture of **MadGraph_aMC@NLO** provides ideal framework for MadDM development.

MadDM

MadDM emerged as an effort to link:

- **DM collider searches**, with
- **early cosmology** signatures (relic density) and
- **direct/indirect detection**.

Version 1.0 of MadDM focused on calculations of **DM relic density** (in a generic UFO model).

Version 2.0 of MadDM extends the functionality to **DM direct detection.**

Testing of model points

MadDM v.2.0 also incorporates a **simplified model testing functionality**:

The user can **compare the results to existing constraints** (relic density, direct detection cross section etc.)

Example output:

```
-------------------------------------------------------
Running the exclusion analysis on the parameter point...
Considering relic density and bound on SI cross section from LUX

        The parameter point is Excluded.
                Excluded by relic density: True
                Excluded by direct detection: False
-------------------------------------------------------
```

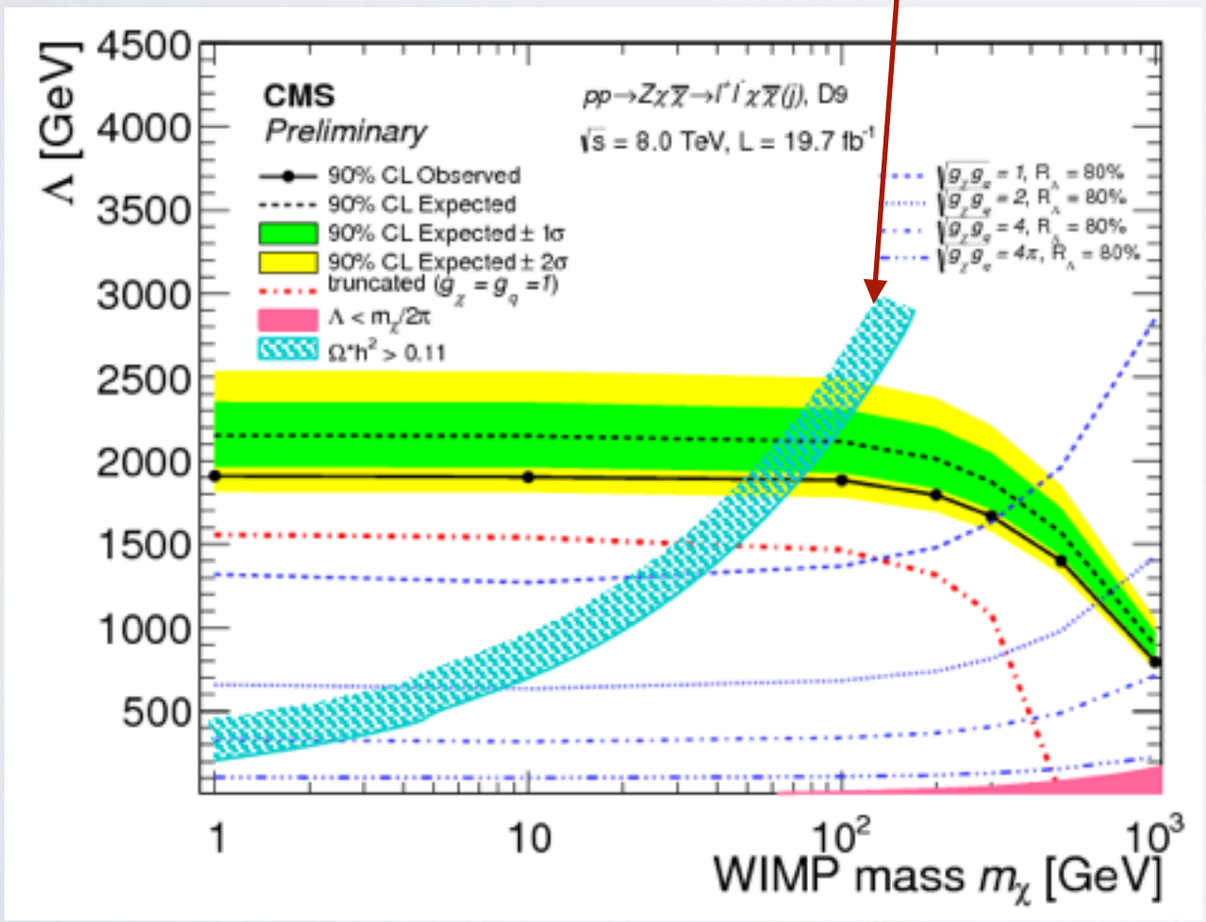
The ultimate goal is to **confront DM models** with collider, astro physical and cosmological constraints in a fully automated framework!

i.e. we would like to have **Collider bounds** together with **Astrophysical** and **Cosmological** signatures.

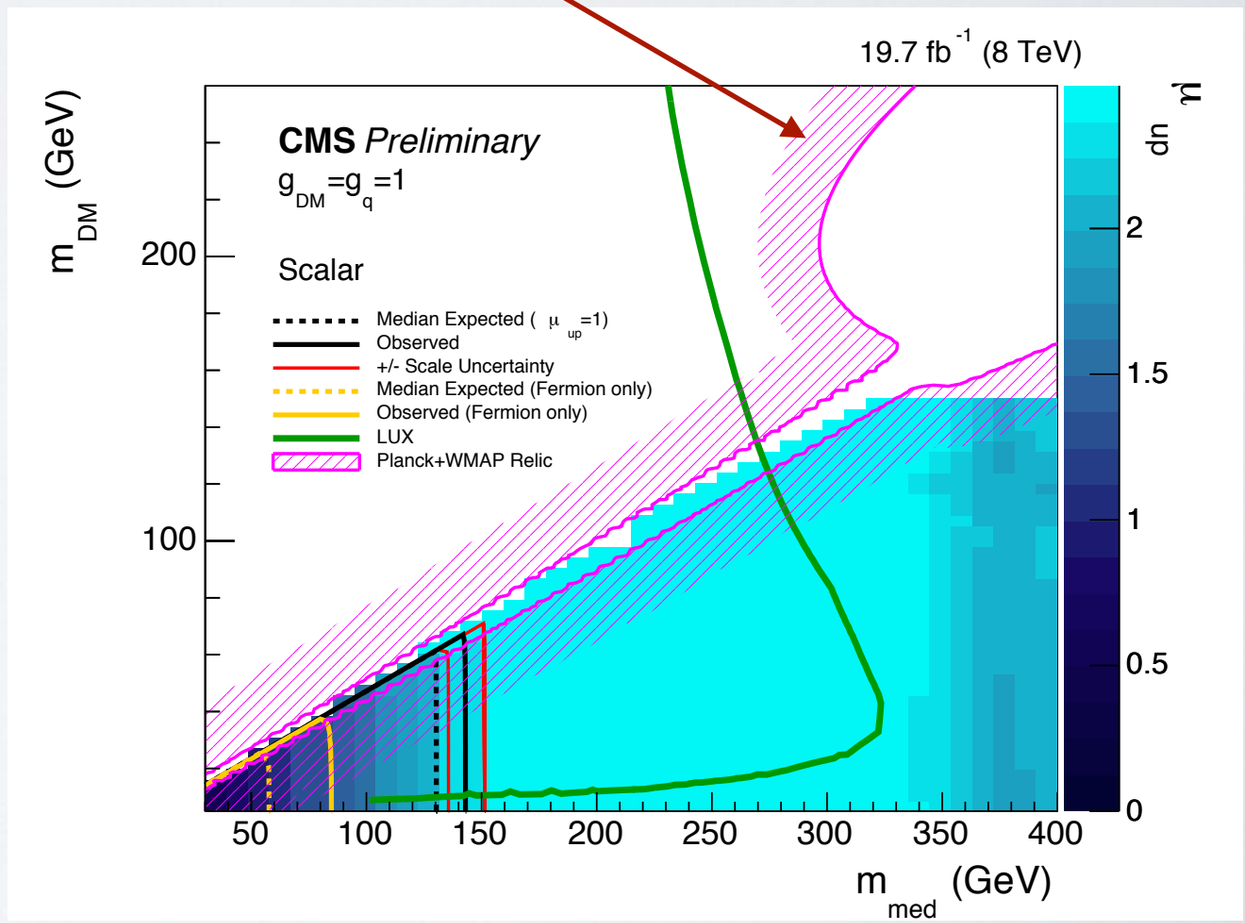
- MadDM has already been used by the CMS experiment,

  in the search for DM EFT's in Mono-jet/Z analyses

Relic Density using MadDM



CMS collaboration 2015: CMS-PAS-EXO-12-054



CMS collaboration 2015: CMS-PAS-EXO-12-055

MadDM Status

MadDM

In Progress

Model testing

Link to Pythia/ GALPROP

Still discussing…

Database of experimental results (e.g. HiggsBounds)

NLO

Urgent!

Integration with MG5_aMC@NLO

Finished

Direct detection

Indirect detection

Urgent!

Directional detection

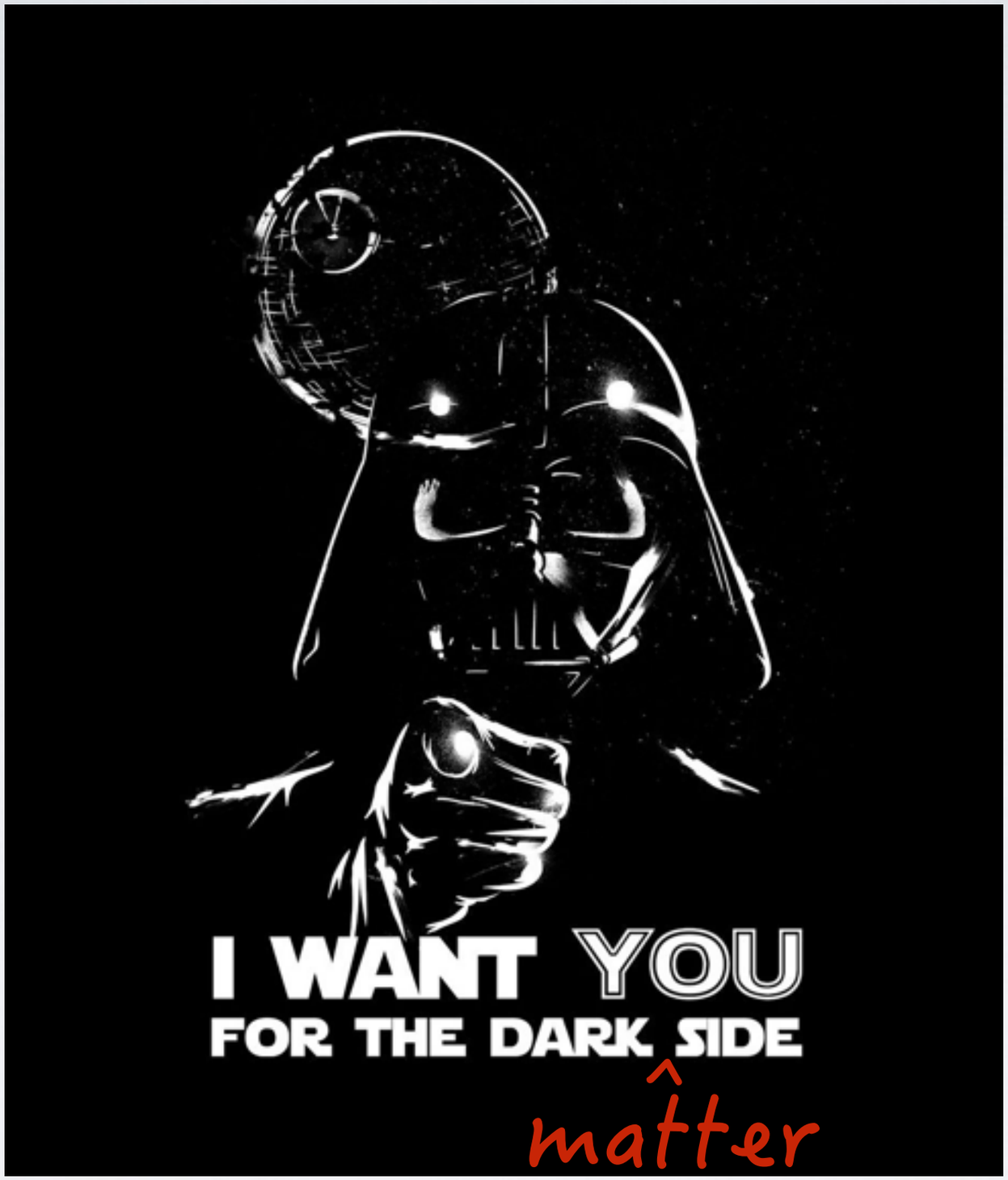
Finished

Web interface

MadDM v3.0


KEEP CALM
AND
WATCH THIS SPACE
IT'S GOING TO BE AWESOME!!


MORE
COMING SOON



Help us build the best DM phenomenology tool!

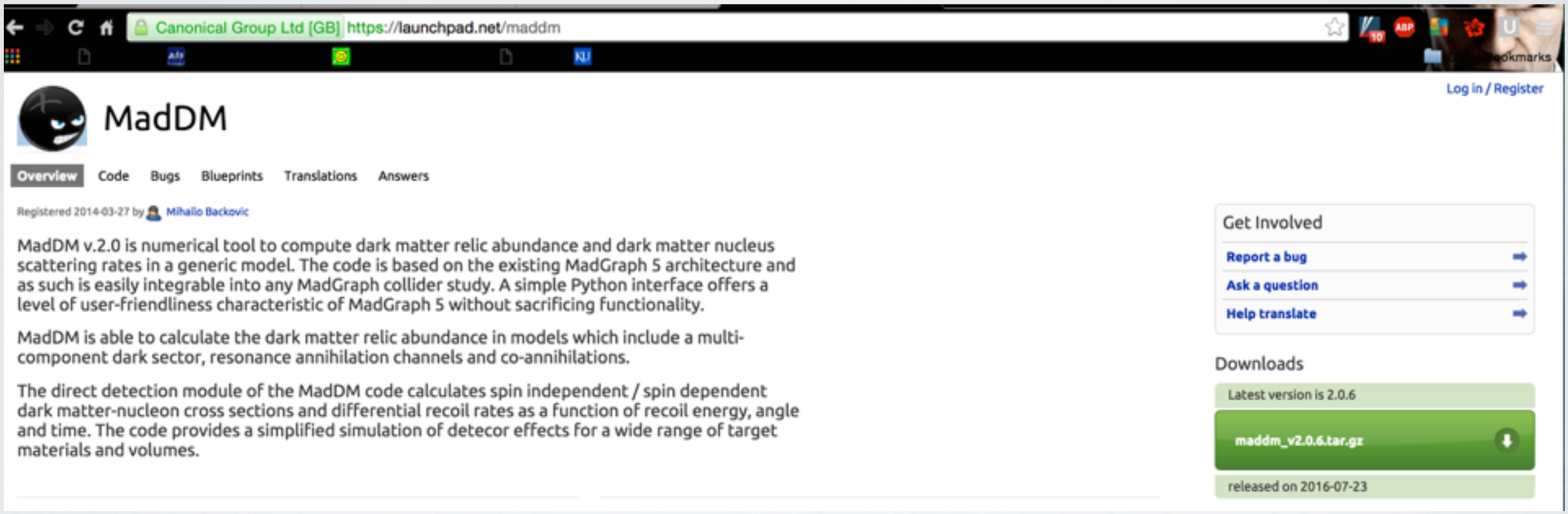
Not convinced yet?

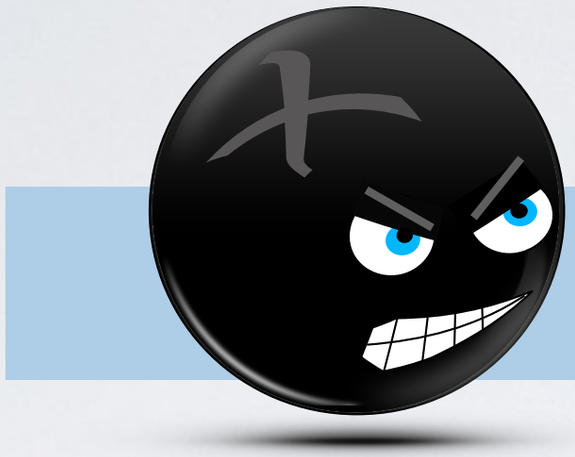
matter

How about now?!

A version of MadDM available for download at:

launchpad.net/maddm





MadDM

susy.phsx.ku.edu/~mihailo/

Thank you!

Any (**constructive**) suggestions, comments,
and criticisms are welcome!