# MadGraph Tutorial III

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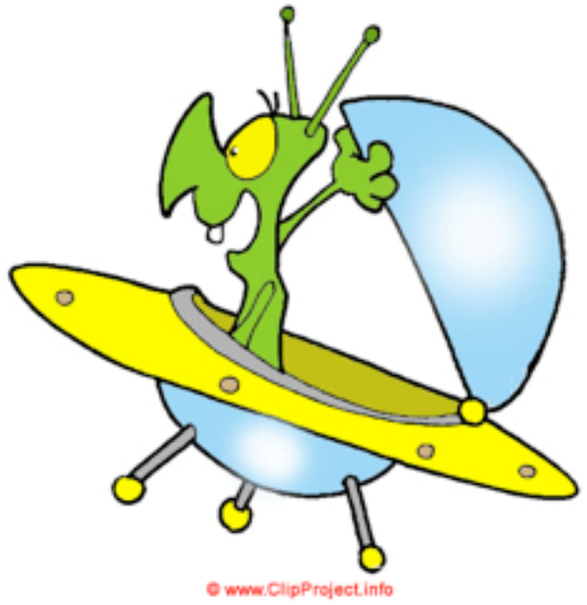
# Plan

- Monday: MadGraph5
  - ➡ Install MadGraph 5
  - ➡ Learn the various syntax
  - ➡ Be a able to run without the interactive interface
- Yesterday: FeynRules
  - ➡ Install FeynRules
  - ➡ Create your own Model
- Today: BSM
  - ➡ Use the FR model to do some phenomenology
  - ➡ Next-to-leading order
    - ✦ Please install gcc4.6 to your laptop.

# BSM in MadGraph5




- MG5 relies on UFO and ALOHA
  - ➡ Basically All BSM supported in MG5
  - ➡ Field supported: 0, 1/2, 1, 3/2*, 2
  - ➡ Any number of particles in the interactions
  - ➡ Color representation: 0, 3, 6, 8
    - ✦ support of Epsilon structure
  - ➡ Multi-fermion operator (But no majorana/flow violation in multi-fermion operator)
  - ➡ custom propagator supported
  - ➡ Form Factor allowed
  - ➡ Assume:
    - ✦ CPT Invariance
    - ✦ Local Operator


* In progress

# FeynRules

- If you didn't have your own model. Don't hesitate to download the solution on the wiki: https://cp3.irmp.ucl.ac.be/projects/madgraph/raw-attachment/wiki/TASISchool13/Tutorial.tar.gz

# Exercise I: Check the model validity

- Check the model validity:
  - ➡ check p p > uv uv~
  - ➡ check p p > ev ev~
  - ➡ check p p > t t~ p1 p2
  - ➡ ...

- Check with MG the width computed with FR:
  - ➡ generate uv > all all; output; launch
  - ➡ generate ev > all all; output; launch
  - ➡ generate p1 > all all; output; launch
  - ➡ generate p2 > all all; output; launch

# Exercise II:

- Compute cross-section and distribution
  - ➡ uv pair production with decay in top and $\Phi_1$(semi leptonic decay for the top
- Hint: The width of the new physics particles has to be set correctly in the param_card.
  - ➡ You can either use "Auto"
  - ➡ or use the value computed in exercise 1
- Hint: For sub-decay, you have to put parenthesis:
  - ➡ example:

    p p > t t~ w+, ( t > w+ b, w+ >e+ ve), (t~ > b~ w-, w- > j j), w+ > l+ vl

# Exercise III

- Do the same for the top pair production background.
  - ➡ Compare the distributions
- Generate Signal + Background plot
  - ➡ Do this for different value of the coupling
  - ➡ Propose a strategy of measurement

# Exercise IV

- Have Fun!!!
  - ➡ Looks at your strategy after shower/detector simulation
  - ➡ Generate the background at NLO
  - ➡ Compute expected exclusion limit
- Hint for shower/detector:
  - ➡ install pythia-pgs
  - ➡ install Delphes
- Hint for NLO:
  - ➡ Need 2.0.0 version
  - ➡ generate p p > t t~ [QCD]
    - ✦ Use MadSpin for the decay of the top pair.

# WORK

- Take the model + those slides: https://cp3.irmp.ucl.ac.be/projects/madgraph/wiki/TASISchool13
- use the check command and a couple of process
- check the FR formula for two body decay
- compute cross-section for uv pair production. decay in top, $\Phi_1$ (top in semi-leptonic)
- Compare with the top pair irreducible background
- Have fun!
  - ➡ pythia/Delphes
  - ➡ NLO
  - ➡ Exclusion limit