

# Tools 2017

Tools for the SM and New Physics

Fawzi BOUDJEMA

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- The TOOLS series started in 1998 in Annecy. It was called **Tools for SUSY**. This was an outgrowth of the French GDR.

$M_{Pl}^2 = V_0 M_D^{2+\delta}$   
 $\{Q_\alpha, Q_\beta\} = 2(\sigma_{\mu\nu})_{\alpha\beta} P^\mu$

## Tools for SUSY and the New Physics

$\tilde{\chi}_i^+ \rightarrow \tilde{\chi}_j^0 l^+ \nu$  June 26-28, 2006  $\Lambda_\pi = M_{Pl} e^{-kr c \pi}$

**LAPTh-LAPP, Annecy-le-Vieux, FRANCE**

$$\mathcal{L}_{int} = -\frac{1}{2} W^{ij}(\phi) \psi_i \psi_j + V(\phi, \phi') + c.c.$$

$$\Psi = \begin{pmatrix} \psi_\alpha \\ \bar{\eta}^\alpha \end{pmatrix}$$

Welcome	Registration	Program	Participants	Accommodation	Committee
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### TOOLS 2006







Tools for Susy and the New Physics

June 26-28, 2006 LAPTh-LAPP, Annecy-le-Vieux, France

The aim of the Workshop is to review the main calculational tools, including generators and Monte-Carlos, for the beyond standard model particle searches at present and future colliders as well as in non collider physics experiments such as dark matter searches. Apart from the talks, discussion sessions are planned. In these round tables we expect to discuss how the existing programs could be improved, how to incorporate different existing constraints, how to best present future data and how modules from different codes could be sewn together and interchanged.

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The GDR, was initiated by Pierre Binetruy to which this meeting is dedicated

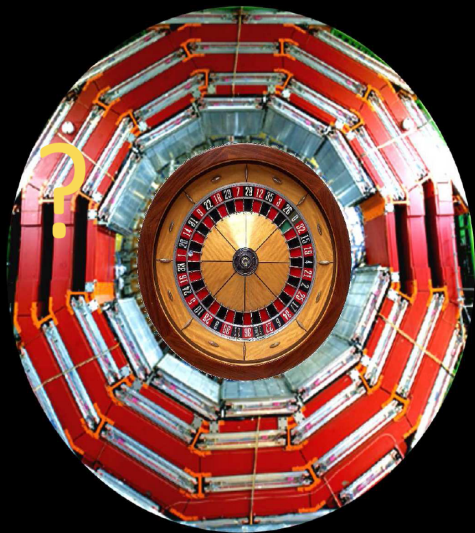


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- The first Tools events were organised with Stavros Katsaneva (then in Lyon)

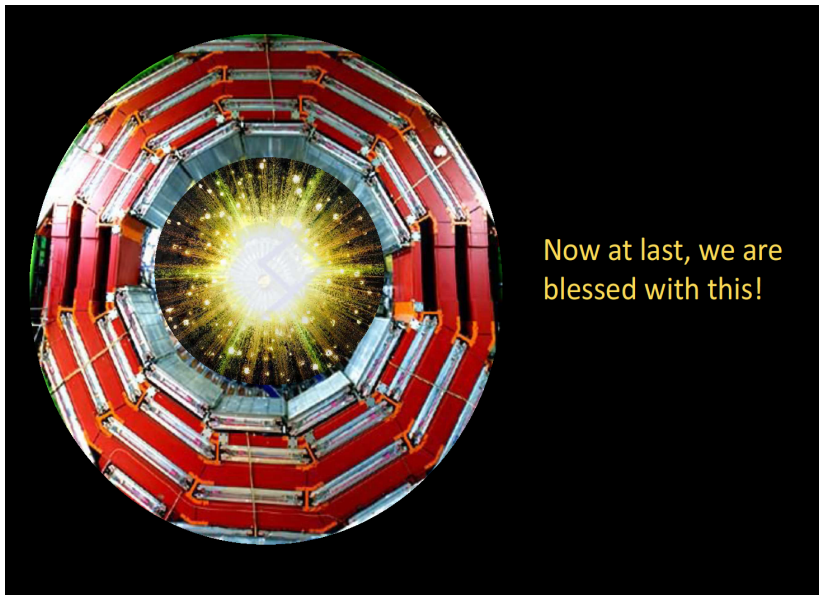
- The TOOLS series started in 1998 in Annecy. It was called **Tools for SUSY**. This was an outgrowth of the French GDR.
- Stavros Idea was to call it **STOOLS**....
- in 1999 this also coincided with Les Houches series

What has changed since then

For a loooooooooong  
time we had this:



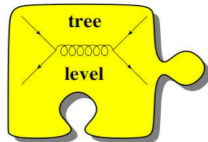
## Data that needs more and more precision



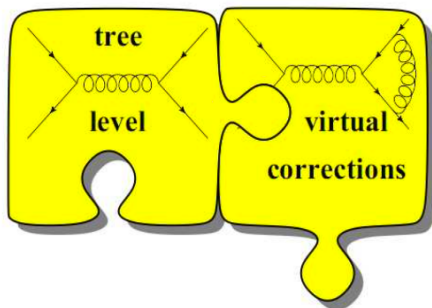
Now at last, we are  
blessed with this!



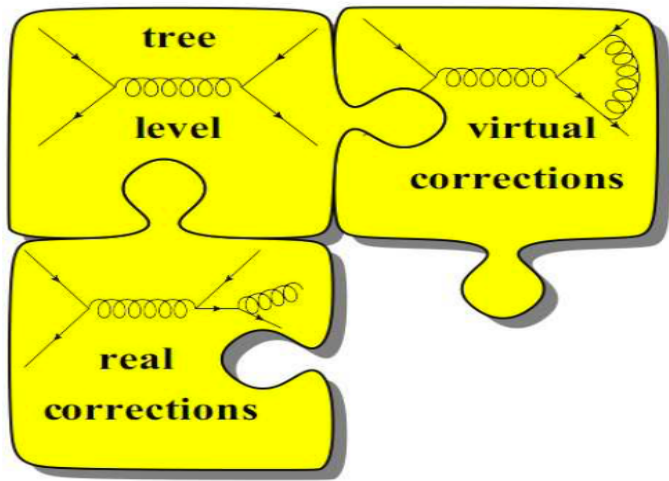
## More Precision N(N)LO and modularity



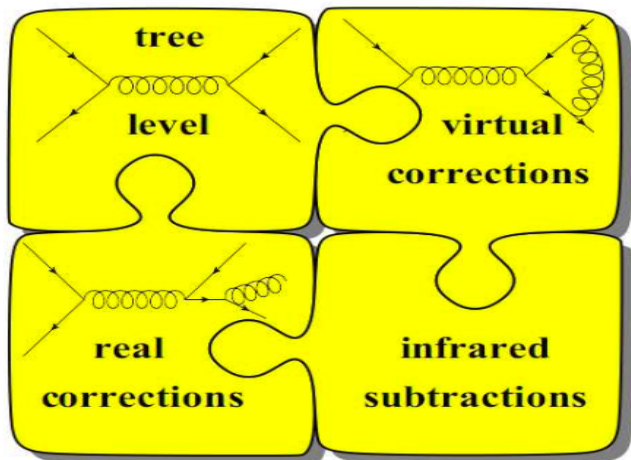
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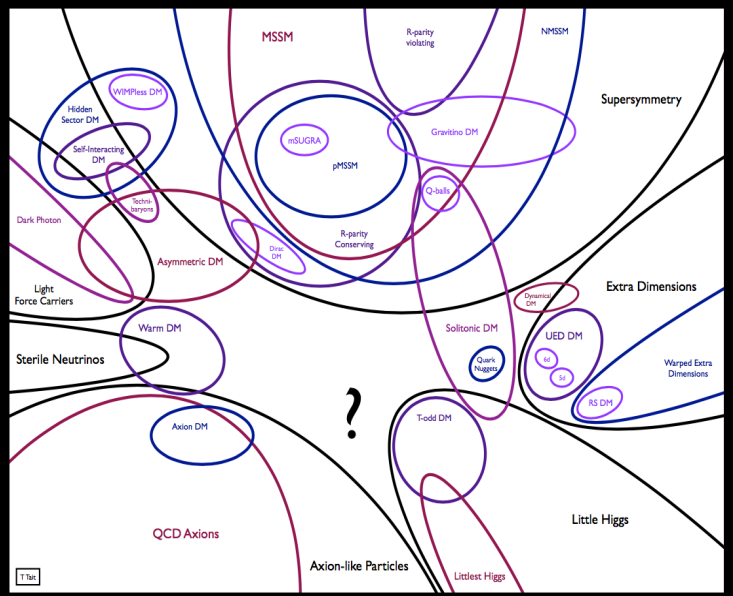


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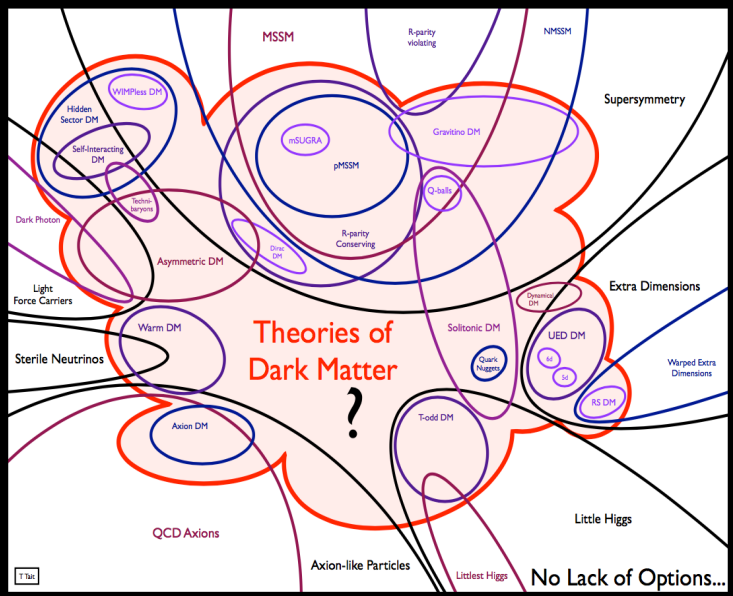


with extensions beyond one-loop. New loop techniques.

# More and more models of New Physics from Tim Tait



# New Physics Models/DM from Tim Tait



## Too many Codes?

from Konstantin Matchev

Experimentalist's complaint: This model is very nice,  
but do you have an event generator for it? is it in Pythia?  
not that many MC developers

On the other hand, too many model builders

$$N_{\text{model builders}} \gg N_{\text{MCdev.}} \rightarrow$$

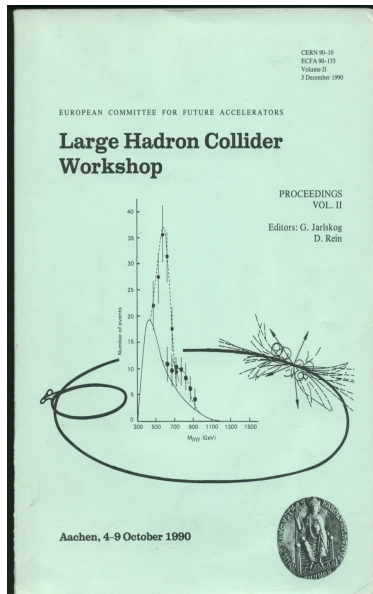
$$N_{\text{existing models}} \gg N_{\text{implemented model}}$$

even worse

$$dN_{\text{existing models}}/dt \gg dN_{\text{implemented model}}/dt$$

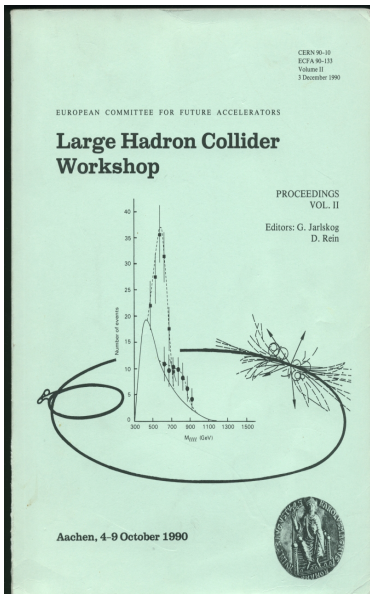
Yes. But we have a modular structure. Codes talk to each. Automation.

# LHC Dark Matter Connection is new: The new paradigm the Aachen Proceedings





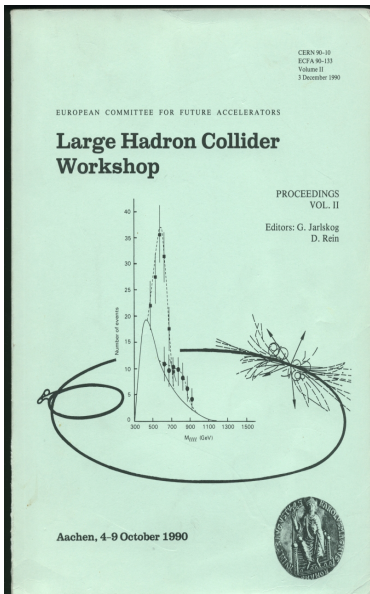
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There is a mention of LSP to be stable/neutral because of cosmo reason, but no attempt at identifying it or **weighing the universe at the LHC**

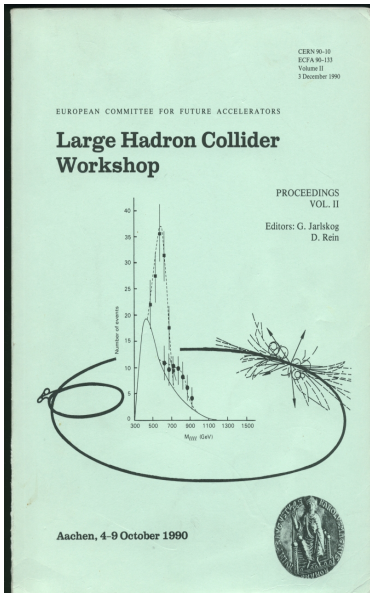
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- LHC: Symmetry breaking and Higgs

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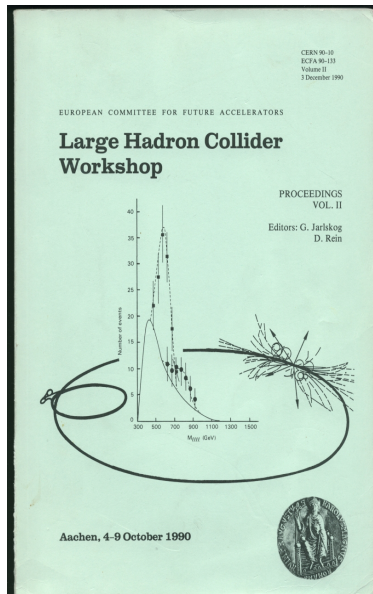


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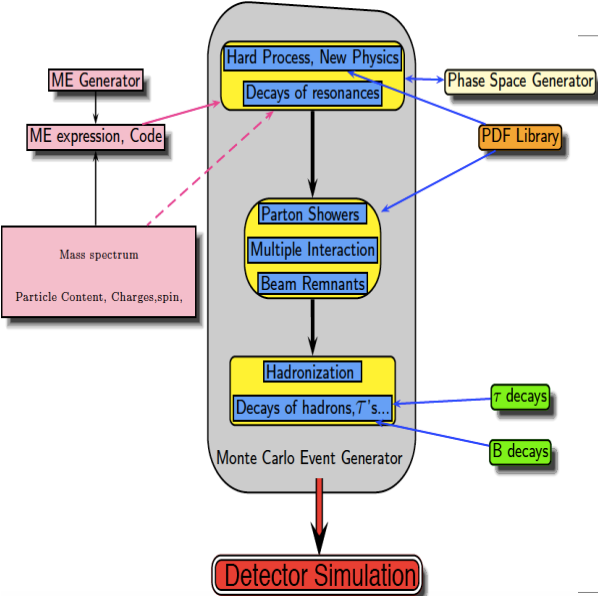
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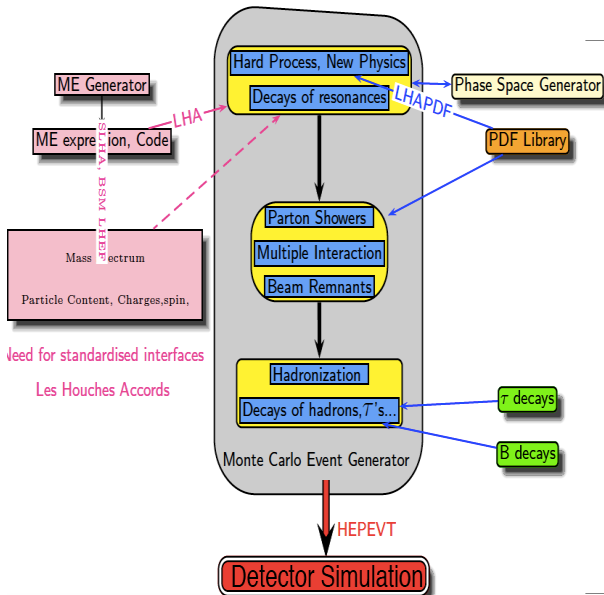
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- New Paradigm, Particle Physics to match the precision of recent cosmological measurements

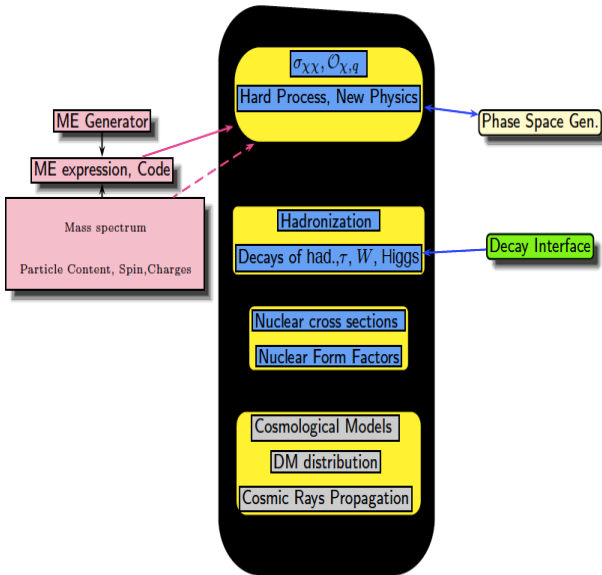
# Tools and Interface: Colliders (1)



## Tools and Interface: Colliders (2)



# Tools and Interfaces: DM



## Nobel Dreams

Great Idea: A New Physics Model

FINAL AIM

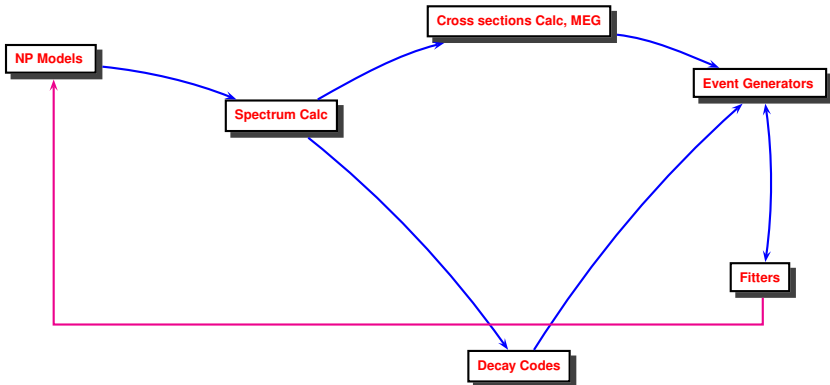
Nobel Prize if LHC validates!

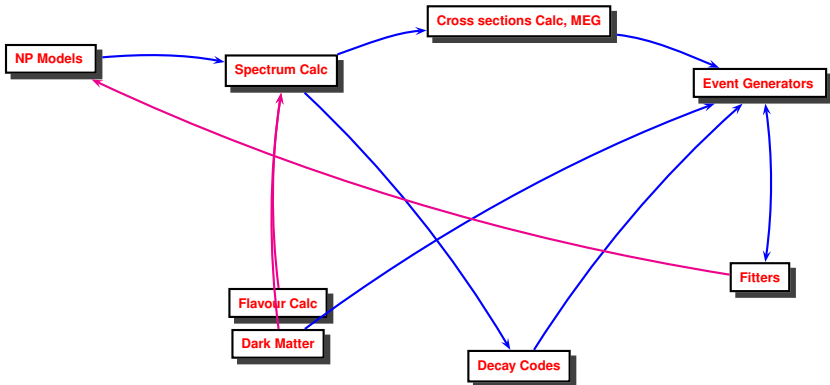


**NP Models**

**FINAL AIM**

**Event Generators**





## NP Models

- ▶ SUSY
  - MSSM
  - mSUGRA
  - GMSB, AMSB
  - NMSSM
  - RPV, CPV,...
- ▶ TeXColour
- ▶ Extra-dim
- ▶ Little Higgs
- ▶  $f^*$ ,  $V'$
- ▶ Black Holes (!)

## Spectrum Calc

## Flavour Calc

## Dark Matter

## Cross sections Calc, MEG

## Decay Codes

## Event Generators

## Fitters

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## Spectrum Calc

- ▶ FeynHiggs
- ▶ NMHDECAY\*
- ▶ RGE Codes Isasusy
- SoftSusy
- Spheno
- Suspect

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## Cross sections Calc, MEG

## Flavour Calc

- ▶  $(g - 2)_\mu$
- ▶  $b \rightarrow s\gamma$
- ▶  $B_S \rightarrow \mu^+ \mu^-$
- ▶ Asym,  $\Delta M$ , ...

## Dark Matter

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## Flavour Calc

### Dedicated Codes

- ▶ SusyBSG
  
- ▶ SuperIso

## Dark Matter

## Cross sections Calc, MEG

- ▶ Tree-level,any  
CalcHEP, CompHEP  
GRACE, FORMCalc  
Madgraph  
SHERPA/Amegic++  
Whizard/O'Mega
- ▶ 1-loop dedicated  
AF's SLEPTONS  
Prospino, hprod
- ▶ 1-loop/General GRACE-SUSY  
  
FormCalc, SloopS

## Decay Codes

## Event Generators

## Fitters

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- ▶ BRIDGE
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## Event Generators

## Filters



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## Flavour Calc

## Dark Matter

- ▶ SISOrelic
- ▶ micrOMEGAs  
SloopS\*
- ▶ DARKSUSY
- ▶ IsaRED/RES

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## Event Generators

- ▶ [Isajet]
- ▶ Herwig++
- ▶ Pythia
- ▶ Sherpa

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## Fitters

- ▶ Fittino
- ▶ SFitter
- ▶ SuperBayes
- ▶ HiggsBounds
- ▶ MasterCode!

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CatFish, Charybdis,  
TrueNoir

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## Feynman rules

(Eff. Pot.)

## Spectrum Calc

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manual

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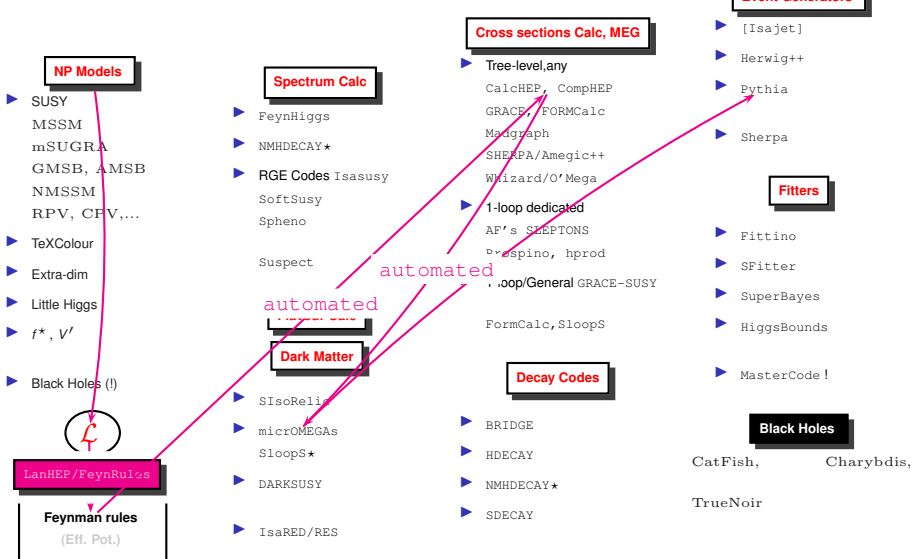
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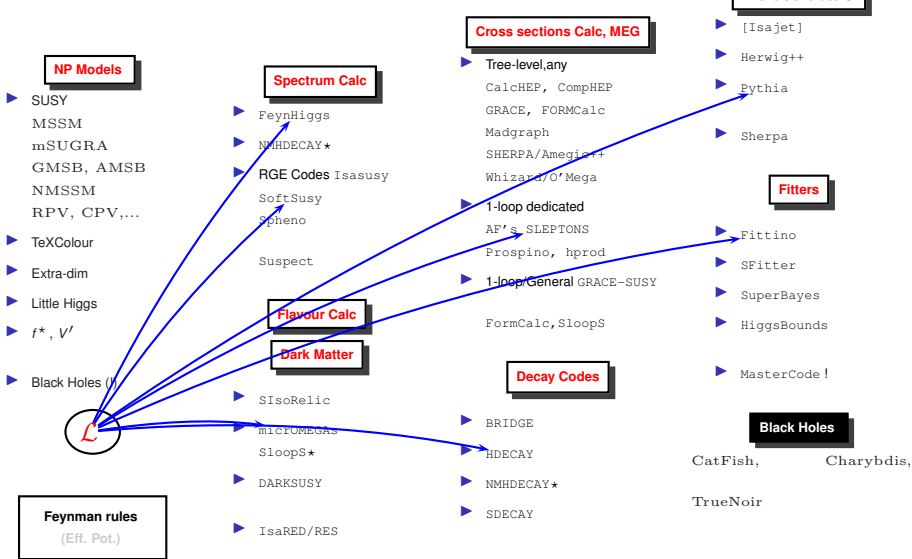
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**Cross talks**

**NP Models**

**SLHA,BSM-LHEF**

**Cross sections Calc, MEG**

[Isajet]

**Spectrum Calc**

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- ▶ NMSSM
- ▶ RPV, CPV,...
- ▶ TeXColour
- ▶ Extra-dim
- ▶ Little Higgs
- ▶  $f^*, V'$
- ▶ Black Holes (L)

- ▶ FeynHiggs
- ▶ NMHDECAY\*
- ▶ RGE Codes Isasusy
- ▶ SoftSusy
- ▶ Sphenx
- ▶ Suspect

- ▶ Tree-level,any
- ▶ CalcHEP, CompHEP
- ▶ GRACE, FORMCalc
- ▶ Madgraph
- ▶ SHERPA/Amegic++
- ▶ Whizard/O' Mega

- ▶ Herwig++
- ▶ Pythia
- ▶ Sherpa

**Flavour Calc**

**Dark Matter**

**Decay Codes**

**Black Holes**

- ▶ SISOrelic
- ▶ micrOMEGAs
- ▶ SloopS\*
- ▶ DARKSUSY
- ▶ IsaRED/RES

- ▶ 1-loop dedicated
- ▶ AF's SLEPTONS
- ▶ Prospino, hprod
- ▶ 1-loop/General GRACE-SUSY
- ▶ FormCalc, SloopS

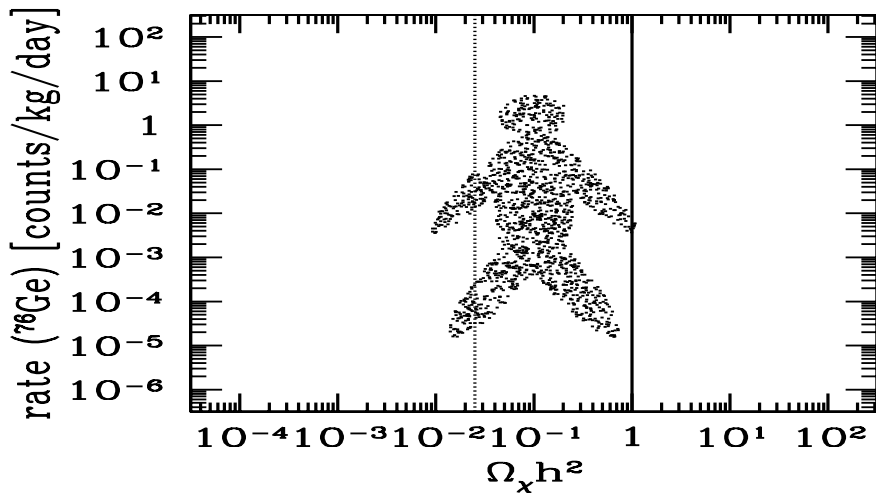
- ▶ Fittino
- ▶ SFitter
- ▶ SuperBayes
- ▶ HiggsBounds
- ▶ MasterCode!

- ▶ CatFish,
- ▶ Charybdis,
- ▶ TrueNoir

**Feynman rules**  
(Eff. Pot.)



P. Gondolo, J. Edsjo



Let's have a fruitful meeting!