Heavy Flavour Physics with Supercomputers

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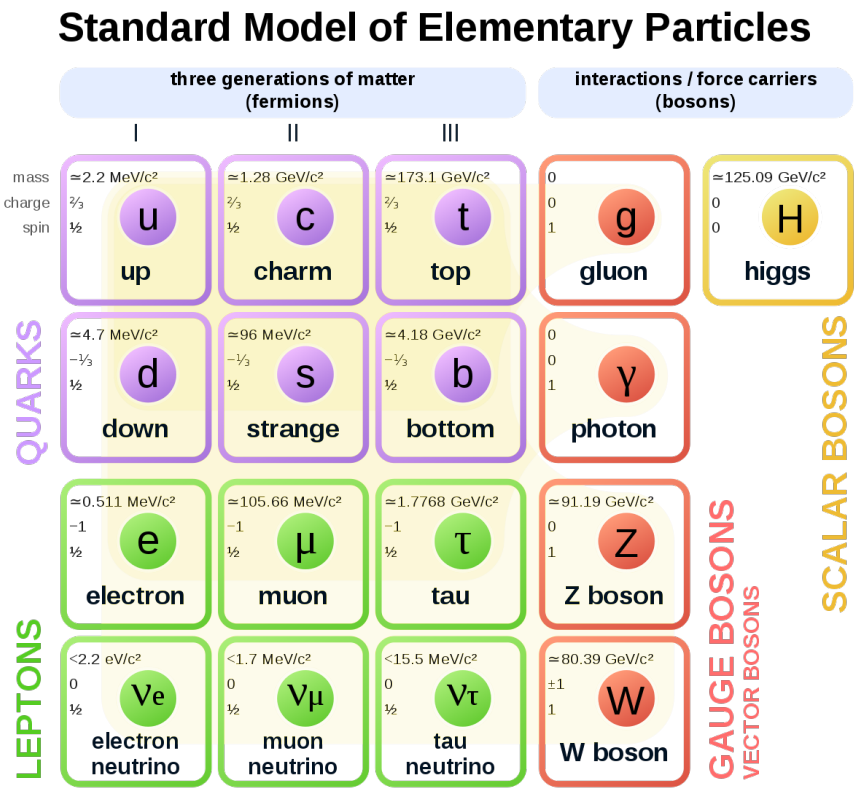
07.03.2019

Standard Model



- 12 particles + 12 antiparticles
- 12 gauge bosons
- higgs boson

SM problems

- matter - antimatter assymetry
- dark matter
- neutrino oscillation

Extensions of Standard Model

- Minimal Supersymmetric Standard Model
- GUT-scale SUSY model
- string theory

Global fit

It is statistical fit of many models to many data sets simultaneously

- models comparison
- parameters estimation of given models
- consistency with data (Goodness-of-fit)

Global fit

Global fit is very useful tool because of so many BSMs:

- supersymmetry
- grand unified theories
- string theory

and many data:

- colliders experiments (ATLAS, ALICE, CMS)
- astrophysics (Cherenkov Telescope Array, WMAP)
- dark matter searches (XENON, CDMS)
- flavour physics (LHCb, BelleII)

Global fit

How it works?

- link all constraints into a composite likelihood

$$\mathcal{L} = \mathcal{L}_{Collider}\mathcal{L}_{Astro}\mathcal{L}_{DM}\mathcal{L}_{Flavour}$$

- parameter scan (specifies ranges and priors of the model parameters)
- interpretation of results
- visualisation of results

Gambit

Gambit - The **G**lobal **A**nd **M**odular **B**eyond the Standard Model **I**nference **T**ool

- global fitting code for BSM theories
- designed to allow fast and easy definition of new models, observables, likelihoods, scanners
- large model database and observables libraries
- open source

[gambit.hepforge.org]

Gambit

Physics modules:

- **ColliderBit** - LEP, ATLAS and CMS searches for new particles
- **DarkBit** - calculates DM observables and likelihoods
- **DecayBit** - decay rates in the BSM, decay data for SM
- **FlavBit** - observables and likelihoods from flavour physics (B,D, K decays)
- **PrecisionBit** - model-dependent precision corrections to masses, couplings etc.
- **SpecBit** - interfaces to one of a number of possible ESG in order to determine pole masses and running parameters

Scanning module:

- **ScannerBit** - responsible for parameter sampling and optimisation packages

Gambit

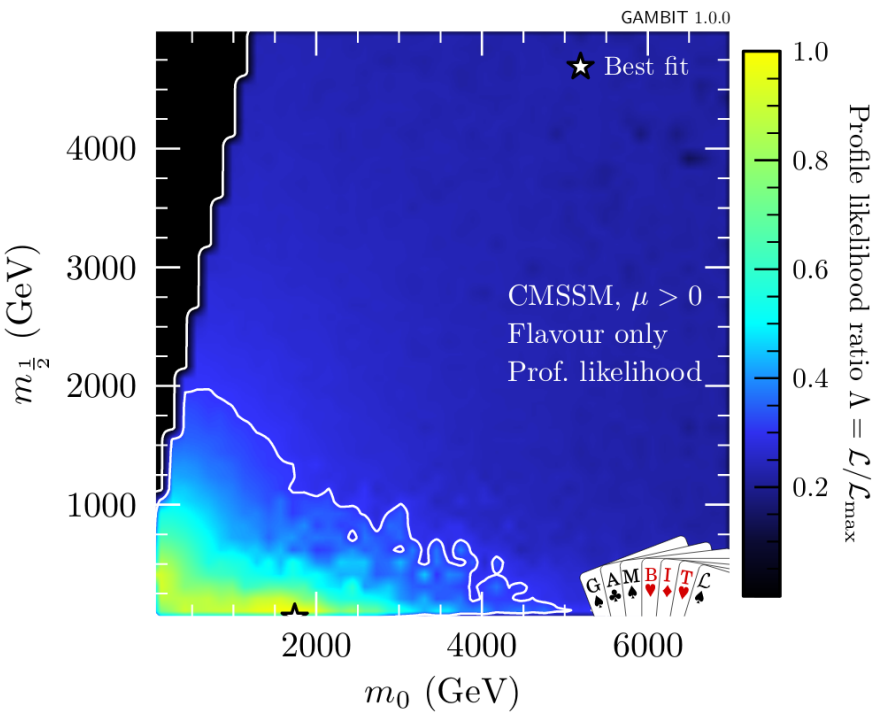
Backends:

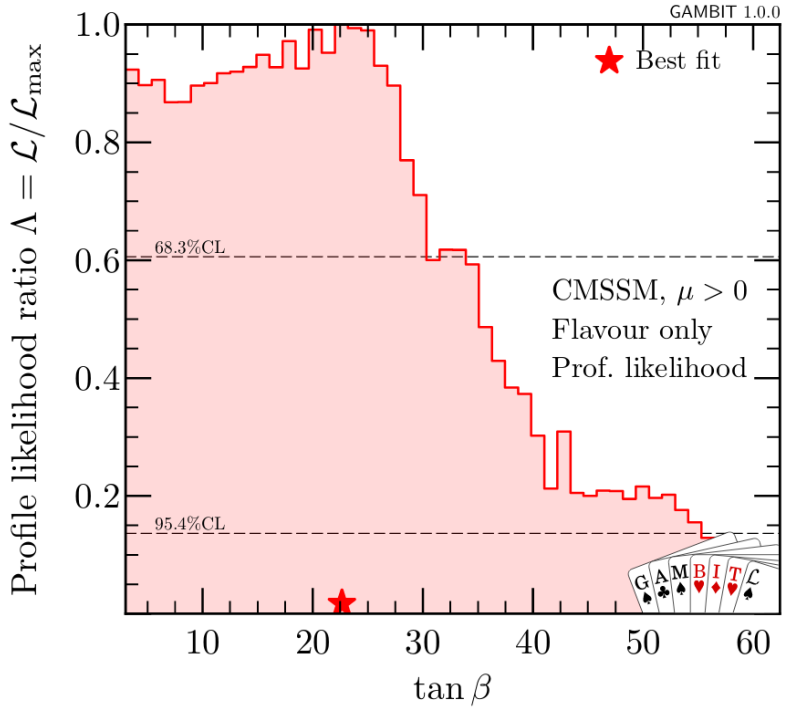
- external tools and libraries used by GAMBIT to calculate observables (Pythia, DarkSUSY, FeynHiggs, etc.)
- can be written in any language (e.g. C++, Mathematica, Python)

Results - CMSSM

CMSSM - flavour likelihood

arXiv:1705.07933 [hep-ph]





Summary

Global fits

- are very useful and powerful tool in phenomenological and statistical analysis
- May help in discovery of New Physics

Gambit

- is very helpful, flexible and extensible tool for analysis BMS theories
- includes specialised modules (DM, collider, flavour)
- many analysis are already done (CMSSM, MSSM7,EWMSSM, scalar singlet)
- many analysis are planned (RH neutrinos, gravitino, leptoquarks)

The end

Thank you for your attention