Renormalisation of the NMSSM in SloopS

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Outline

- NMSSM
- SloopS
- Renormalisation
- Phenomenological applications
NMSSM

- MSSM + a new Higgs gauge singlet chiral superfield
- Solves the $\mu$-problem by generating this parameter dynamically
- Extended Higgs sector:
  - 3 CP-even Higgs bosons $h_1, h_2, h_3$
  - 2 Pseudoscalars $A_1, A_2$
  - 2 charged Higgs bosons $H^\pm$
- $h_1$ or $h_2$ could be the one observed at LHC
- Easier to get a SM-like 125 GeV Higgs boson
  \[ m_h^2 = m_{h,MSSM}^2 + \lambda^2 v^2 \sin^2(2\beta) \]
- Propose new scenarios to account for Dark Matter compared to the MSSM

Vincent Bizouard
SloopS

- An automatic code for the calculation of cross sections at one loop in SUSY (Boudjema, Baro, Semenov, Chalons)
- Full renormalisation of electroweak sector of MSSM performed in the OS-scheme
- Full renormalisation of NMSSM (this talk)
SloopS

Process

- $p_1 \ p_2 \rightarrow p_3 \ p_4 \ldots$
- Restrictions

LoopTools

- *libooptools.a*
- Defines A,B,C,D...

FeynArts/FormCalc

- *model.mod*
- Defines Feynman rules.

Fortran Output

- *xsection.F*
- Defines $\mathcal{M}(p_1 \ p_2 \rightarrow \ldots)$.

Cross-section

- *run*
- Computes $\sigma(P)$.

lanHEP

- *model.src*
- Defines $\Phi, P, L, \delta P, \delta Z$

Automatic generation of Feynman rules and counterterms

Mathematica output

- $\mathcal{M}(p_1 \ p_2 \rightarrow \ldots)$
Renormalisation of the NMSSM

- $M_1, M_2, \mu, \tan(\beta), \lambda, \kappa, A_\lambda, A_\kappa, m_{Hd}, m_{Hu}, m_{Hs}$

- $\tan(\beta)$ links together all sectors: OS-scheme complicated!

- Solution: take a DR condition for $\tan(\beta)$ to decouple sectors:
  - $\mu, M_2$ from the 2 charginos
  - $M_1, \lambda, \kappa$ from 3 neutralinos
  - $A_\lambda, A_\kappa$ from 2 pseudoscalars
  - $m_{Hd}, m_{Hu}, m_{Hs}$ from minimization equations of Higgs potential

\[ \tan(\beta) = \frac{v_u}{v_d} \]
Renormalisation of the NMSSM

• Achievements:
  – Complete renormalisation of gauge, (s)fermions, chargino, neutralino sectors.
  – Any one-loop decay widths in these sectors can be calculated.

• Work in progress:
  – Implementation of the Higgs sector.
Phenomenological applications

- Computation of radiative corrections to some physical observables:
  - Precise calculation of Dark Matter relic density. For example in the annihilation of 2 singlinos.
  - Interplay of NMSSM scenarios with dark matter and collider observables