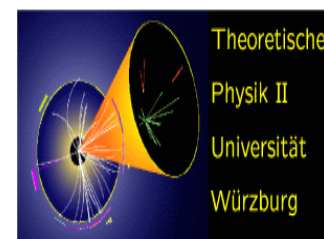


SPheno 3.0, latest developments

Werner Porod



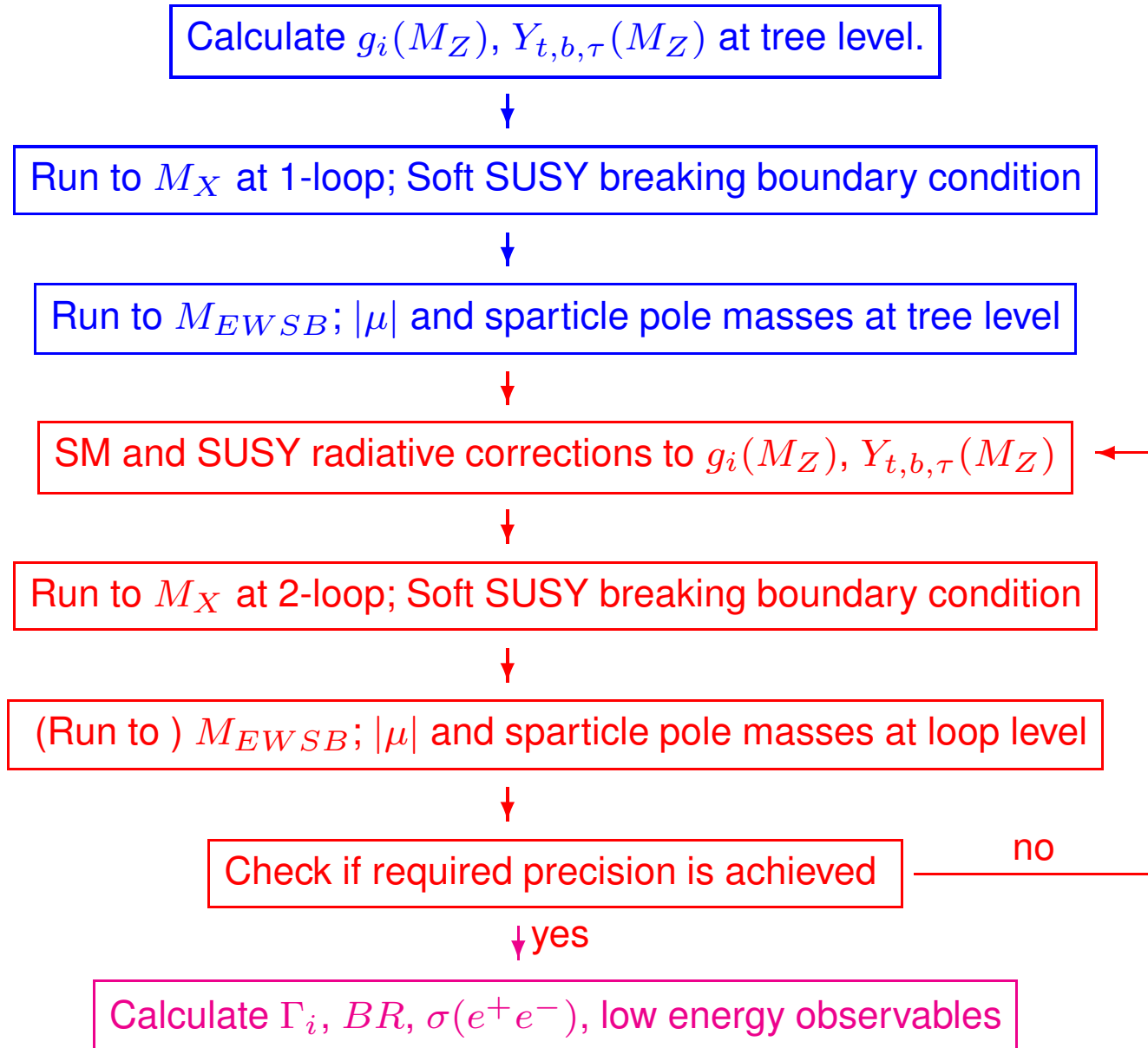
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- General scheme
- MSSM implementation
- NMSSM
- R-parity violation

SPheno is available at:

www.physik.uni-wuerzburg.de/~porod/SPheno.html



- complete 2-loop SUSY RGEs
- complete 1-loop SUSY masses + 2-loop Higgs masses + μ at 2-loop
- includes complete flavour structure of the MSSM in RGEs and 1-loop masses
- includes CP phases in RGEs and 1-loop masses but for the mixing of (h^0, H^0) with A^0
- all 2-body decays of SUSY and Higgs particles at tree-level, but running couplings
- all 3-body decay modes of $\tilde{\chi}_k^0, \tilde{\chi}_j^\pm, \tilde{g}, \tilde{t}_1$ + some 3-body decays of sleptons relevant for GMSB + decays into gravitino in case of GMSB models
- SUSY and Higgs production in e^+e^- annihilation

Models, input via SLHA 2 (arXiv:0801.0045)

- MSSM at M_{EWSB}
- mSUGRA, GMSB, AMSB, string inspired scenarios
- mSUGRA with seesaw I or seesaw II
- at M_{GUT} : specification of all SUSY parameters is possible including flavour structures

low energy observables

- $b \rightarrow s\gamma$, $b \rightarrow sl^+l^-$, $s\nu\nu$, $B_s \rightarrow \mu^+\mu^-$, $B_u \rightarrow \tau\nu$, $\Delta M_{B_{d,s}}$
- ρ -parameter at 1-loop level
- a_e , a_μ , a_τ , d_e , d_μ , d_τ
- $\mu \rightarrow e\gamma$, $\tau \rightarrow e\gamma$, $\tau \rightarrow \mu\gamma$, $\mu \rightarrow 3e$, $\tau \rightarrow 3e$, $\tau \rightarrow 3\mu$,
 $Z \rightarrow e\mu$, $Z \rightarrow e\tau$, $Z \rightarrow \tau\mu$

```

Block MODSEL # Model selection
  1  0 # MSSM model
  6  1 # switching on flavour violation
Block MINPAR # Input parameters
  3  6.000000000E+00 # tanb at m_Z
  4  1.000000000E+00 # Sign(mu)
Block SMINPUTS # SM parameters
  1  1.27931417E+02 # alpha_em^-1(MZ)^MSbar
  2  1.16639000E-05 # G_mu [GeV^-2]
  3  1.19000000E-01 # alpha_s(MZ)^MSbar
  6  1.72900000E+02 # m_t(pole)
Block EXTPAR # parameters
  0  5.53831678E+02 # soft SUSY breaking masses at Q
  1  1.22974655E+02 # M_1
  2  2.31059174E+02 # M_2
  3  6.98447906E+02 # M_3
 23  4.62825271E+02 # mu
 26  5.16496307E+02 # m_A0
  .
  .
  .

```

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:
:
Block TUIN # trilinear u-squark couplings
  1  1    -7.93049123E-03    # T_(u,11)
  2  1     8.67268217E-07    # T_(u,21)
  3  1     2.89830720E-03    # T_(u,31)
  1  2     2.16816821E-09    # T_(u,12)
  2  2    -3.17217786E+00    # T_(u,22)
  3  2     3.45383877E-02    # T_(u,32)
  1  3     2.77154965E-08    # T_(u,13)
  2  3     1.32111532E-04    # T_(u,23)
  3  3    -5.78271096E+02    # T_(u,33)

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Block SPhenoLowEnergy # low energy observables
  1    3.78595608E-04   # BR(b -> s gamma)
  2    1.59036263E-06   # BR(b -> s mu+ mu-)
  3    4.00160348E-05   # BR(b -> s nu nu)
  4    5.24190461E-09   # BR(Bs -> mu+ mu-)
  5    9.91538244E-05   # BR(B_u -> tau nu)
  6    2.73010786E-01   # |Delta(M_Bd)| [ps^-1]
  7    1.91301834E+01   # |Delta(M_Bs)| [ps^-1]
 10    3.27905100E-14   # Delta(g-2)_electron
 11    1.40196941E-09   # Delta(g-2)_muon
 12    4.01099418E-07   # Delta(g-2)_tau
 16    1.07872476E-08   # Br(mu -> e gamma)
 17    2.91081381E-09   # Br(tau -> e gamma)
 18    3.99160386E-09   # Br(tau -> mu gamma)
 19    6.60046572E-11   # Br(mu -> 3 e)
 20    3.05343746E-11   # Br(tau -> 3 e)

```

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in near future

- $d_n, K \rightarrow \pi\nu\nu, K_L \rightarrow \mu^+\mu^-, \epsilon_K$
- theoretical uncertainties on masses via remaining scale dependence, take e.g. values $M_i(M_{EWSB}/2)$ and $M_i(2M_{EWSB})$
but two problems:
 - these values are not necessarily min and max
 - SLHA allows to fix M_{EWSB} , uncertainties depend on this parameter
- dominant 2-loop contributions to ρ -parameter
- documentation

- RGEs at 1-loop for gauge and Yukawa couplings
- tree level masses for SUSY particles, 1-loop effective potential for Higgs masses (alternative: calculate spectrum with NMHDECAY)
- all 2-body decays of SUSY and Higgs particles at tree-level, but running couplings
- all 3-body decay modes of $\tilde{\chi}_k^0$, $\tilde{\chi}_j^\pm$, \tilde{g}
- SUSY and Higgs production in e^+e^- annihilation

near future

- complete set of RGEs at 2-loop level
- B-physics observables, ρ -parameter, rare lepton decays
- documentation

at the scale of 1-2 years

- SUSY masses at 1-loop level, complete 1-loop Higgs masses + leading 2-loop contributions

- models: bilinear model ϵ_i (e.g. hep-ph/0011248), $\mu\nu$ SSM (arXiv:0903.3596)
- RGEs at 1-loop for gauge and Yukawa couplings
- tree level masses for SUSY particles, dominant 1-loop effective potential for Higgs masses
- all 2-body decays of SUSY and Higgs particles at tree-level, but running couplings
- all 3-body decay modes of $\tilde{\chi}_k^0$, $\tilde{\chi}_j^\pm$, \tilde{g}
- of SUSY and Higgs production in e^+e^- annihilation

near future

- complete set of RGEs at 2-loop level
- B-physics observables, ρ -parameter, rare lepton decays
- λ_{ijk} , λ'_{ijk} , spontaneous R -parity violation
- documentation

- it is only a beta-version due to missing documentation
- several of the near future plans are currently running projects
- interface to Prospino planned to include LHC processes