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Using SOFTSUSY

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Abstract: SOFTSUSY [1] is a computer program that calculates the masses of supersymmetric particles (and couplings of the particles etc) in the Minimal Supersymmetric Standard Model, consistent with some theoretical boundary conditions on supersymmetry breaking terms, and consistent with measurements of Standard Model fermion masses and gauge boson masses and couplings and electroweak symmetry breaking. We will download the SOFTSUSY computer program, compile it and run it, preparing computer input with the SUSY Les Houches Accord. The output can be fed into collider (eg LHC) simulations, programs that calculate dark matter properties, decay calculators etc.

Keywords: Supersymmetric Phenomenology, exclusion, Large Hadron Collider

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1 Using SOFTSUSY

First, we need to download and compile the program.

1. Google SOFTSUSY
2. Click on the SOFTSUSY homepage: it should be at http://softsusy.hepforge.org.
3. Scroll down to "latest release", then click on the most recent "source" link (at the time of writing, this is source 3.3.3).
4. Your browser may save it, or ask whether you want to do so (you should).
5. Now, do

```
> tar -xvzf softsusy-3.3.3.tar.gz
> cd softsusy-3.3.3
```

6. Now we compile the code:

```
> ./configure F77=gfortran
> make
```

7. We are going to use the main program softpoint.x. If it's run without any arguments, you'll see some options come up:

```
> ./softpoint.x
```

8. Now let's run the program. We're going to pick an mSUGRA/CMSSM parameter point that is called CMSSM10.1.1 [2]. We have a universal scalar SUSY breaking mass of $m_0 = 125$ GeV, a universal gaugino mass of $m_{1/2} = 500$ GeV, ratio of the two Higgs vacuum expectation values $\tan\beta = v_u/v_d = 10$ and SUSY breaking trilinear scalar couplings all $A_0 = 0$. We also pick the μ parameter from the superpotential to be positive.

```
> more lesHouchesInput
```

You can find out more about how to change this input file, and understand the output at http://arxiv.org/pdf/hep-ph/0311123v4.pdf [3].

```
> ./softpoint.x leshouches < lesHouchesInput > lesHouchesOutput
```

9. Now have a look at the output file

   ```
   > more lesHouchesOutput
   ```

   In `Block MASS`, you can see the masses, in units of GeV, of the various particles. The '`#`' denotes the start of a comment, and the particles are all handily labelled after this. So, for example, you can see that at this point, the gluino mass is predicted to be $m_{\tilde{g}} = 1147$ GeV, whereas the lightest higgs is at 115.4 GeV (note that this is *inconsistent* with the recent Higgs measurements, so this point doesn't agree with data).

10. Try changing

    m_0 to 10^4 GeV. You should see a

    ```
    4   Point  invalid: [ MuSqWrongsign ]
    ```

    message under `Block SPINFO`.

11. Next reduce m_0 to 5×10^3 GeV. What is the Higgs mass now?

12. Competition: play with the numerical values of the inputs in `Block MINPAR`: can you get the Higgs mass higher? The first one to hit 125±1 GeV without any warning message wins.

13. If you're mega fast at this, try a harder problem: by referring to the SUSY Les Houches accord `hep-ph/0311123`, produce some output at CMSSM10.1.1 (that was originally used above) but with a separate mass parameter for the stop squarks at the GUT scale: $m_{\tilde{t}_R} = m_{\tilde{Q}_{3,L}} = 5000$ GeV.

Acknowledgements

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References

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