Setting up WimpSim and running WimpAnn

July 20, 2018

First, let's set the variable for the directory where all the fun will be happening. I pick mine to be in `/data/user/jlazar` since some of the files involved are pretty large, but you can make it anywhere. We'll also define some other variables for later

```
WS_DIR=/data/user/jlazar/wimpsim
mkdir $WS_DIR; cd $WS_DIR
WA_DIR=$WS_DIR/wimpann
NUOSC_FILE=$WS_DIR/wimpsim-4.1.1/data/nuosc_params.txt
NUM_RUNS=1000000
```

Now, make sure that you have `wget` installed by running:

```
brew install wget
```

Next navigate to the directory where you would like to install `WimpSim`. Keep in mind that this directory will likely end up containing a lot of data, so it might be advisable to put it somewhere in your `/data/user/` directory. Personally, I have mine in the path `/data/user/jlazar/wimpsim`. Once there, download `WimpSim` and all its dependencies by running:

```
wget http://wimpsim.astroparticle.se/code/pythia-6.4.26.f
wget http://staff.fysik.su.se/~edsjo/darksusy/tars/darksusy-6.1.0.tar.gz
wget http://wimpsim.astroparticle.se/code/nusigma-1.19-pyr.tar.gz
wget http://wimpsim.astroparticle.se/code/wimpsim-4.1.1.tar.gz
```

Note: These are the most up to date versions of these programs as of July 20, 2018. Make sure that these are still up to date on the WimpSim website. Next compile Pythia by running:

```
gfortran -O -c pythia-6.4.26.f
```

Next, unzip all the `.tar` files by running:

```
tar -xvf darksusy-6.1.0.tar.gz
tar -xvf nusigma-1.19-pyr.tar.gz
tar -xvf wimpsim-4.1.1.tar.gz
```

These will all take a decent amount of time, and will produce quite a bit of command line output. Next change to the unpacked `DarkSUSY` directory with:

```
cd darksusy-6.1.0
```

And finally run:

```
./configure
make
```

Once again, both of these will produce a lot of output text on the command line. Next change directories to the `nusigma` directory and compile it by running:

```
cd ../nusigma-1.19-pyr
./configure
make libnusigma
```

All the dependencies should now be configured. Now navigate to the WimpSim directory by running:

```
cd ../wimpsim-4.1.1
```

Before configuring, we must change the paths in configure to reflect the paths to DarkSUSY, nusigma, and Pythia. These are under the variable names DARKSUSY_DIR, NUSIGMA_DIR, and PYTHIA respectively. For me these paths are $WS_DIR/darksusy-6.1.0, $WS_DIR/nusigma-1.19-pyr, and $WS_DIR/pythia-6.4.26.o. Now compile WimpSim by running:

```
./configure
make all
```

Congratulations, WimpSim is now installed! There are a few more steps to go before being able to run WimpAnn. First you must make a file with the neutrino oscillation parameters. There is one on my website which is up to date as of July 20, 2018. You can get this file with:

```
wget http://www.jefflazar.zone/research/files/nuosc_params.txt
```

I moved this to my /wimpsim-4.1.1/data/ directory for neatness. This can done with:

```
mv nuosc_params.txt data/
```

If you (reasonably) do not trust my parameters and want to make your own nuosc_params.txt file, the layout of the file is:

```
<theta12>
<theta13>
<theta23>
<cp-violating phase>
<Delta 21>
<Delta 31>
```

Now turn our attention to the setup code for WimpAnn, wasetup.pl. You can go into this file with:

```
vi scr/wasetup.pl
```

and edit which m_χ (in GeV) you want to simulate, and which decay channels as well. The decay channels are numbered according to fig. 1. Now that you have set those parameters, you can run:

```
./scr/wasetup.pl $WA_DIR $NUOSC_FILE $NUM_RUNS
```

I got some errors at this point about run-wa-rev.one and run-wa.one not being moved successfully. Not to worry though, you can do this easily with:

```
cp scr/run-wa.one scr/run-wa-rev.one $WA_DIR/scr
```

Then go to the WimpAnn directory and start the simulation with:

```
cd $WA_DIR
./scr/run-wa.one
```

run-wa.one is a script which runs the simulations one at a time and then moves the simulations that are done from the runs directory to runs-done. If you need to do further simulations, return to the wimpsim-4.1.1 directory, and edit the wasetup.pl file to suit your needs.

	Pythia codes		
Channel number	Particle 1	Particle 2	Annihilation products
1	1	-1	$d\bar{d}$
2	2	-2	$u\bar{u}$
3	3	-3	$s\bar{s}$
4	4	-4	$c\bar{c}$
5	5	-5	$b\bar{b}$
6	6	-6	$t\bar{t}$
7	21	21	gg
8	24	-24	W^+W^-
9	23	-23	Z^0Z^0
10	13	-13	$\mu^-\mu^+$
11	15	-15	$\tau^-\tau^+$
12	12	-12	$\nu_e\bar{\nu}_e$
13	14	-14	$\nu_\mu\bar{\nu}_\mu$
14	16	-16	$\nu_\tau\bar{\nu}_\tau$
100	-	-	KK DM (UED B(1))

Figure 1: The annihilation channels implemented into WimpAnn, together with the particle codes for these channels in Pythia. Note that channel 10 is just included to use the same channel numbering as in DarkSUSY, it gives no neutrinos for annihilations in the Sun/Earth. Channel 100 is using a standard set of branching fractions for UED DM B(1).