Breakout rooms

- Now go to one of the following breakout rooms

  You can swap later. Material from all rooms (1-5) will be provided later.

  1. Relic density (standard)
  2. Relic density (dark sector, coupled Boltzmann eqs.)
  3. Gamma-ray (and other CR) spectra
  4. J-factors
  5. Neutrino signals
  6. General technical support [installation/coding/shell usage/…]

- You can start right away with problem I and II above…

  See also the link to the tutorial from the ISAPP homepage

Actively help each other while Joakim and me go around !

Default annihilation / decay yields

- The yield is the (differential) number of photons [or other messengers] per annihilation (or decay) process

Problem III:

Copy $\mathrm{examples/aux/wimpyields.f}$ **to your private directory and**

1. **Make sure that you can compile and run this main program**
2. **Try to understand what the program does**
3. **Produce a plot that shows the differential photon yield, *dN/dE*, for *annihilating* DM with a mass of 500 GeV, and final states** $b\bar{b}, W^+W^-, \tau^+\tau^-$
4. **Produce a plot that shows the differential yield (*dN/dE$_{kin}$*) of photons, positrons and antiprotons from DM with a mass of 500 GeV *decaying* to** W^+W^-

Beyond default yields

- DarkSUSY has implemented a number of alternative yield tables. Besides, you can supply your own yields when calculating fluxes

Problem IV:

Produce a plot that compares the differential photon yield for DM with a mass of 1.5 and 15 GeV annihilating to light quarks, for
i) the default Pythia(*) tables used by DarkSUSY,
ii) the result of treating QCD-related uncertainties as in Amoroso+ (1812.07424), and
iii) the special treatment for light DM as in Plehn+ (1911.11147).

(*) So far still Pythia 6. New yields based on the most recent Pythia 8 version are on the way…
[but differences expected to be minor *for the most relevant energies* in the spectrum]

From yields to fluxes

- Going from yields to fluxes is straightforward for photons (and neutrinos from the halo), but involves solving diffusion equations for charged cosmic rays. DarkSUSY offers routines that do both.

Problem V:

1. **Create a very short (< 30 lines) program that calculates the gamma-ray flux, from the Galactic Center, for a 500 GeV ScalarSinglet DM candidate.**
2. **Plot the resulting flux based on the DarkSUSY default tables and the tables by Amoroso+, respectively**
3. **Explore how the *fluxes* change when replacing the underlying *yields* with user-defined versions: replace the full yield of the scalar singlet model with a simple** $dN/dE = 0.1\frac{m_S}{E^2}$

Hints :

- **@1 Have a look at the previous examples, and at** dsmain_wimp
- **@3 the most flexible (and most 'correct') way of doing this is by replacing the interface function** dscrsource **: This is the link between** src/ **and** src_models/ **that is used by all flux routines, including those for charged cosmic rays!**

Model-specific yields

- Some particle modules have model-specific options for the yields. The MSSM module, in particular, supplies full radiative corrections for $U(1), SU(2), SU(3)$ — though the latter two are not included per default, to improve performance in large scans.

Problem VI:

1. **Modify the previous program (for gamma-ray fluxes) to read in an SLHA file and tabulate the flux for annihilating neutralino DM in this model.**
2. **Plot the resulting flux when individually switching on/off radiative corrections due to final state photons or $SU(2)$ bosons**

Hints :

- **@1 Have a look at** dsmain_wimp **for how to read in SLHA files**
- **@2 you can steer this by calls to the functions** dsibset **and** dsib2set**, respectively. Note that the full *SU(2)* calculation can be time consuming.**