

The background of the title slide is a collection of Feynman diagrams. These diagrams use various symbols: wavy lines for photons (γ), solid lines for fermions, and dashed lines for Higgs bosons (H^+). Labels include x_1^+ , x_1^0 , x_1^- , W^+ , W^- , $2c$, $3b$, and $2c$. The diagrams are arranged in a somewhat chaotic but overlapping manner, creating a technical and scientific atmosphere.

Dark SUSY

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Introduction

- DarkSUSY is a set of Fortran routines for calculations of relic densities and different direct and indirect detection rates in supersymmetric models.
- Either all low-energy parameters can be given by the user, or MSSM *or mSUGRA** parameters can be used.

***) Interface to ISASUGRA, SUSPECT**

- Vertices
- Mass spectrum
- Accelerator bounds
- Relic density
- Scattering cross sections
- Rates in neutrino telescopes
- Fluxes from the halo: antiprotons, positrons, continuum gammas, gamma lines (χ^0 and χ^\pm) and neutrinos.



Vertices

- Most of the three-body and four-body vertices are calculated numerically and are available to the user.
- The convention and Feynman rules closely follow Haber & Kane and Gunion & Haber. Details will be given in the forthcoming manual.



Mass spectrum

- All the masses are calculated.
- For the Higgs bosons, different routines can be used, e.g. Carena et al, FeynHiggsFast, FeynHiggs, ...
- For the neutralinos, loop corrections from Drees et al are included.

- Routines to check current accelerator constraints are available:

m_{H_2} b s m_+
sfermion masses $(g-2)_\mu$ etc

- It is easy to replace the standard routines with your own ones.

- The relic density is calculated by
 - solving the Boltzmann equation numerically
 - including all resonances and thresholds
 - including coannihilations between the neutralinos, charginos *and all the sfermions**.
- All tree-level two-body final states and gg , W , and Z at the 1-loop level are included.
- The accuracy is of the order of $\sim 1\%$, but a fast option with an accuracy of $\sim 5\%$ exists.

**) in progress, will be released after full testing*

- The dark matter density is parameterized as

$$\rho_\chi(\vec{x}) = \rho_0 \frac{r_0^\gamma}{|\vec{x}|^\gamma} \frac{1 + (r_0/a)^\alpha}{1 + (|\vec{x}|/a)^\alpha}^{(\beta-\gamma)/\alpha}$$

whereas the velocity distribution is assumed to be Maxwell-Boltzmann.

- **Remark:** If $h^2 < (h^2)_{\min}$ we need to rescale the local halo density. This is done with `dshmrescale_rho` and *affects all subsequent rate calculations.*



Scattering cross sections

- The scattering cross sections on protons and neutrons are calculated.
- The quark and spin content of the nucleons can be changed by the user.

- From WIMP annihilation in the Earth/Sun, we can calculate:
 - the neutrino flux
 - the neutrino to muon conversion rate
 - the neutrino-induced muon flux
- Both differential and integrated fluxes/rates can be obtained.
- The new population of WIMPs (Damour-Krauss) that have scattered in the outskirts of the Sun can be included.

- Different propagation models can be used: Chardonney et al, Bottino et al, Bergström et al*.
- Energy losses of antiprotons are included.
- Many diffusion model parameters are adjustable.
- Solar modulation can be included.
- Fluxes from a clumpy halo can be calculated.

*) Default



Positrons from the halo

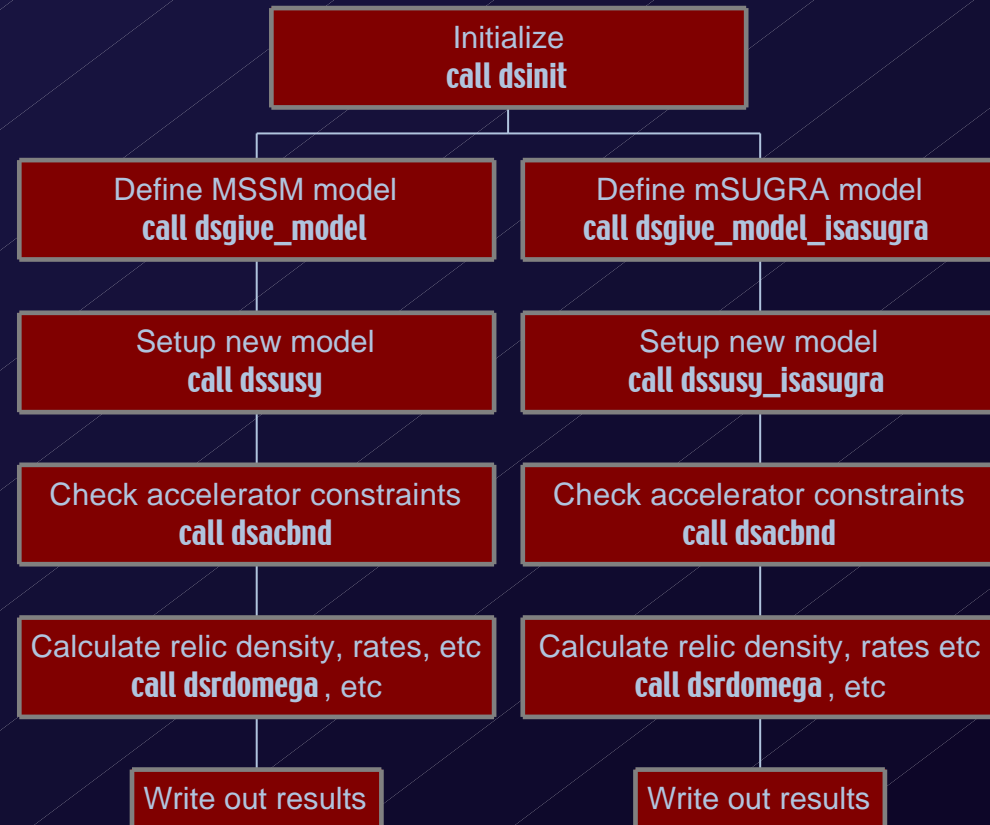
- Different diffusion models included:
Kamionkowski-Turner and Baltz-Edsjö with* and without a cut-off in the diffusion constant.
- Both integrated and differential fluxes can be obtained.

*) Default

- The flux in a given direction (averaged or not averaged over detector resolution) can be obtained for
 - continuum gamma rays
 - monochromatic gamma lines from
 - monochromatic gamma lines from Z
- Both differential and integrated fluxes can be obtained.

- From a given direction (averaged or not averaged over detector resolution) we can obtain the
 - neutrino flux
 - neutrino to muon conversion rate
 - neutrino-induced muon flux
- Both differential and integrated fluxes/rates can be obtained.

- The code is written in Fortran.
- The user has to provide a main program – an example program is provided.





Release / download

- Tested on RedHat Linux, MacOS X and Alphas.
- Current public version: 3.14.02-beta (does not include sfermion coannihilations or ISASUGRA interface).
- Download at
www.physto.se/~edsjo/darksusy/
- If you use it, please sign up on the DarkSUSY mailing list on that page!
- There is also an online version available for quick MSSM calculations.

Dark SUSY

Future / Outlook

- A long paper is in progress.
- A manual is being worked on.
- The sfermion coannihilations are coming.
- If you write code that you think should be included, we can (after a careful review...) include it in the distribution as a contributed package.

DarkSUSY – A numerical package for supersymmetric dark matter calculations

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Abstract

The question of the nature of the dark matter in the Universe remains one of the most outstanding unsolved problems in basic science. One of the best motivated particle physics candidates is the lightest supersymmetric particle, assumed to be the lightest neutralino - a linear combination of the supersymmetric partners of the photon, the Z boson and neutral scalar Higgs particles. In this paper, we describe DarkSUSY, an advanced numerical FORTRAN package for supersymmetric dark matter calculations.



Summary

- DarkSUSY contains code to calculate masses, relic densities and different direct and indirect detection rates for supersymmetric models.
- Beta version can be downloaded at
www.physto.se/~edsjo/darksusy/
- Questions? Talk to any of the authors.