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https://wimpydd.hepforge.org

WimPyDD: an object-oriented Python code for WIMP-nucleus scattering direct detection in virtually any scenario

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- WimPyDD calculates accurate predictions for the expected rate in WIMP direct detection experiments
- WimPyDD works in the framework of Galilean-invariant non-relativistic effective field theory and can be matched to any high-energy model of particle dark matter
- WimPyDD handles different scenario:
  1- inelastic scattering
  2- WIMP of arbitrary spin
  3- Generic velocity distribution of WIMP
  4- Annual modulation effect

- The expected rate in an experiment:

Astrophysics — Particle physics

$$\frac{dR}{dE_R}(t) = N_T \frac{\rho_\chi}{m_\chi} \int_{vmin} d^3 v_T f(\vec{v}_T, t) v_T \frac{d\sigma_T}{dE_R}$$

- Differential cross-section:

$$\frac{d\sigma_T}{dE_R} = \frac{2m_T}{4\pi v_T^2} \left[\frac{1}{2j_\chi + 1} \frac{1}{2j_T + 1} |\mathcal{M}_T|^2 \right]$$

- The scattering amplitude:

$$\frac{1}{2j_\chi + 1} \frac{1}{2j_T + 1} |\mathcal{M}_T|^2 = \frac{4\pi}{2j_T + 1} \times \sum_{\tau,\tau'} \sum_k R_k^{\tau\tau'} \left[c_j^\tau, (v_T^\perp)^2, \frac{q^2}{m_N^2} \right] W_{Tk}^{\tau\tau'}(y)$$

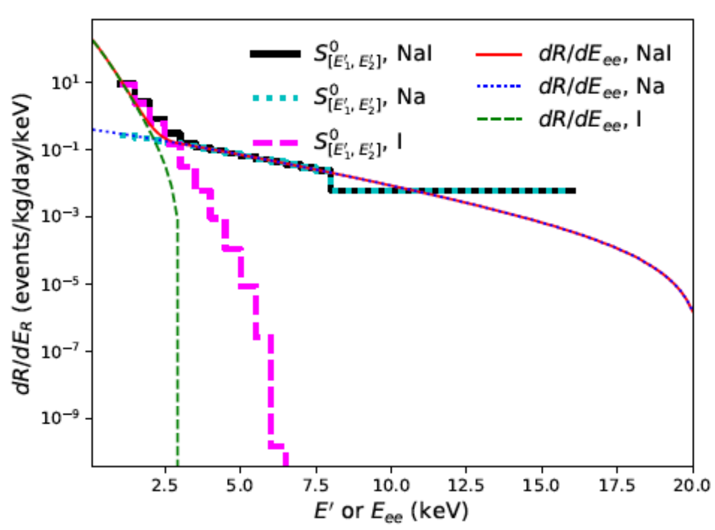
Dark Matter — Nuclear Physics

- WimPyDD factorizes the expected rate calculation into three parts:

i- Wilson coefficients of the effective theory
ii- The detector response functions (acceptance, energy resolution, response to nuclear recoils etc.)
iii- Halo-function

- Example: diff_rate routine:

```
er_vec=np.linspace(0.1,20,100)
mchi=20.
diff_rate=[WD.diff_rate(nai, SI, mchi, er,
  vmin, delta_eta0,M=1e3) for er in er_vec]
import matplotlib.pyplot as pl
pl.plot(er_vec,diff_rate)
```



Codes	EFT Interactions	Arbitrary DM spin	Inelastic scattering	Velocity Distribution flexibility	DAMA modulation
DarkSUSY	✓	✗	✗	✓	✗
MicrOMEGAs	✗	✗	✗	Limited: Maxwellian, SHM++	✗
GAMBIT /DDcalc	✓	✗	✗	✓	✗
WIMpy_NREFT	Limited: O1-O11	✗	✗	Limited: Maxwellian	✗
Dmdd	✗	✗	✗	Limited: Maxwellian	✗
MadDM	✗	✗	✗	Limited: Maxwellian	✗
WimPyDD	✓	✓	✓	✓	✓