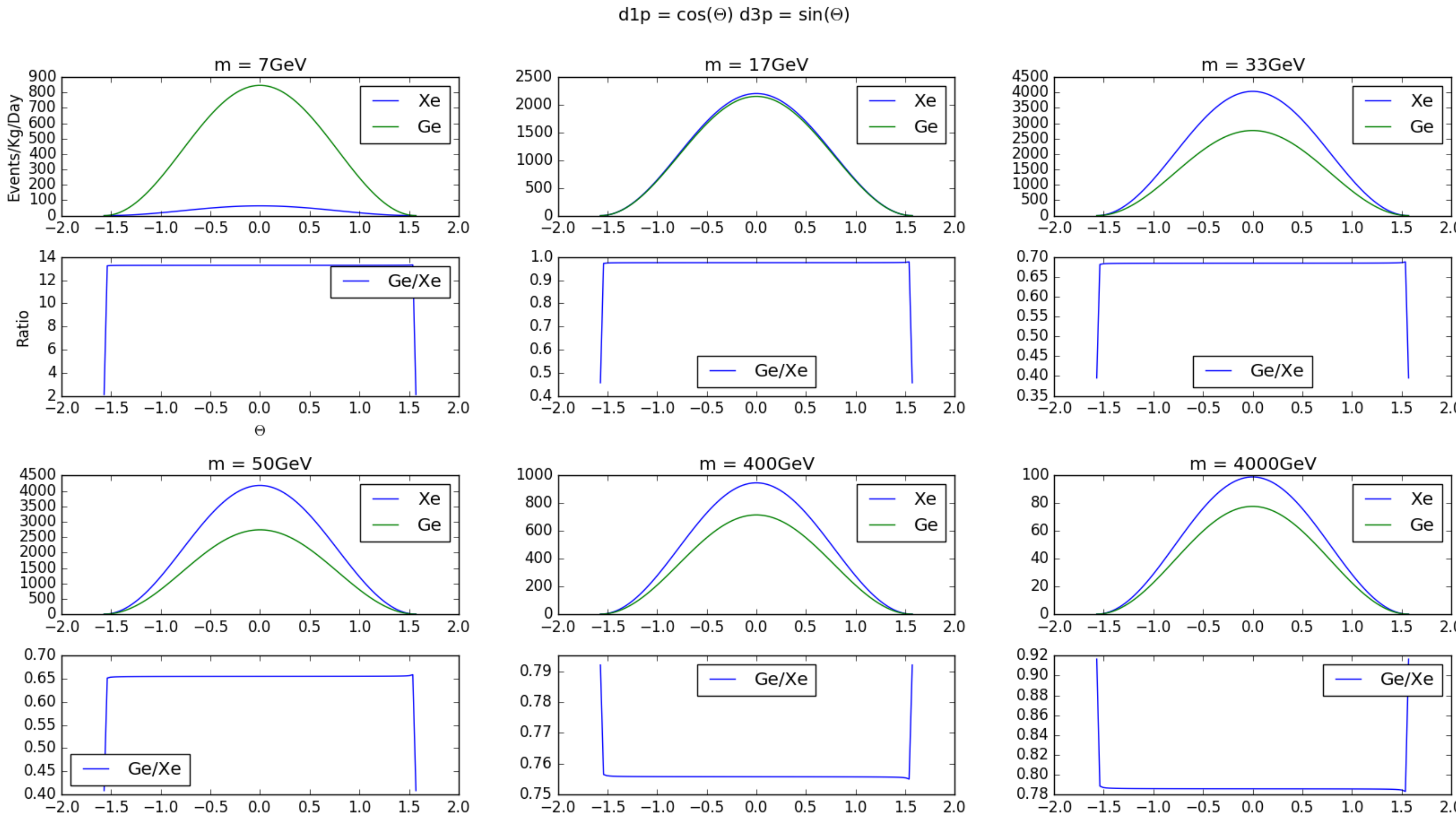
John P. Update

10/11/19

Differential Specs

- Last week, I mentioned scaling the SI curves in order to get them to match the y-intercepts on the Operator 1 curves.
- I recalculated the differential spectra for both using the same coupling constant and got matching y-intercepts.

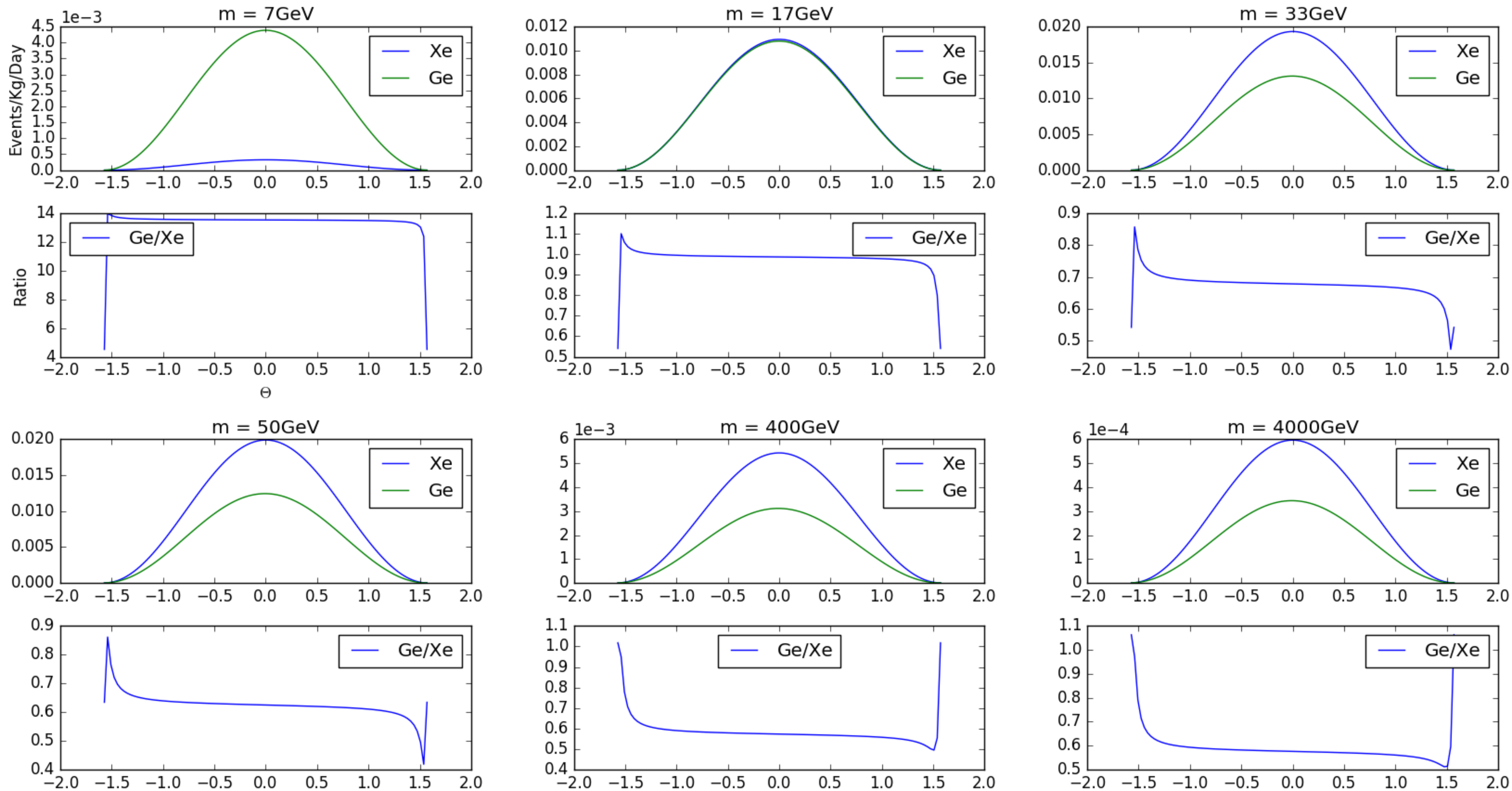
$$\mathcal{O}_3 = i\vec{S}_N \cdot (\vec{q} \times \vec{v}^{\perp}) \qquad \mathcal{O}_1 = 1$$



$$\mathcal{O}_4 = \vec{S}_\chi \cdot \vec{S}_N$$

$$\mathcal{O}_5 = i\vec{S}_\chi \cdot (\vec{q} \times \vec{v}^\perp)$$

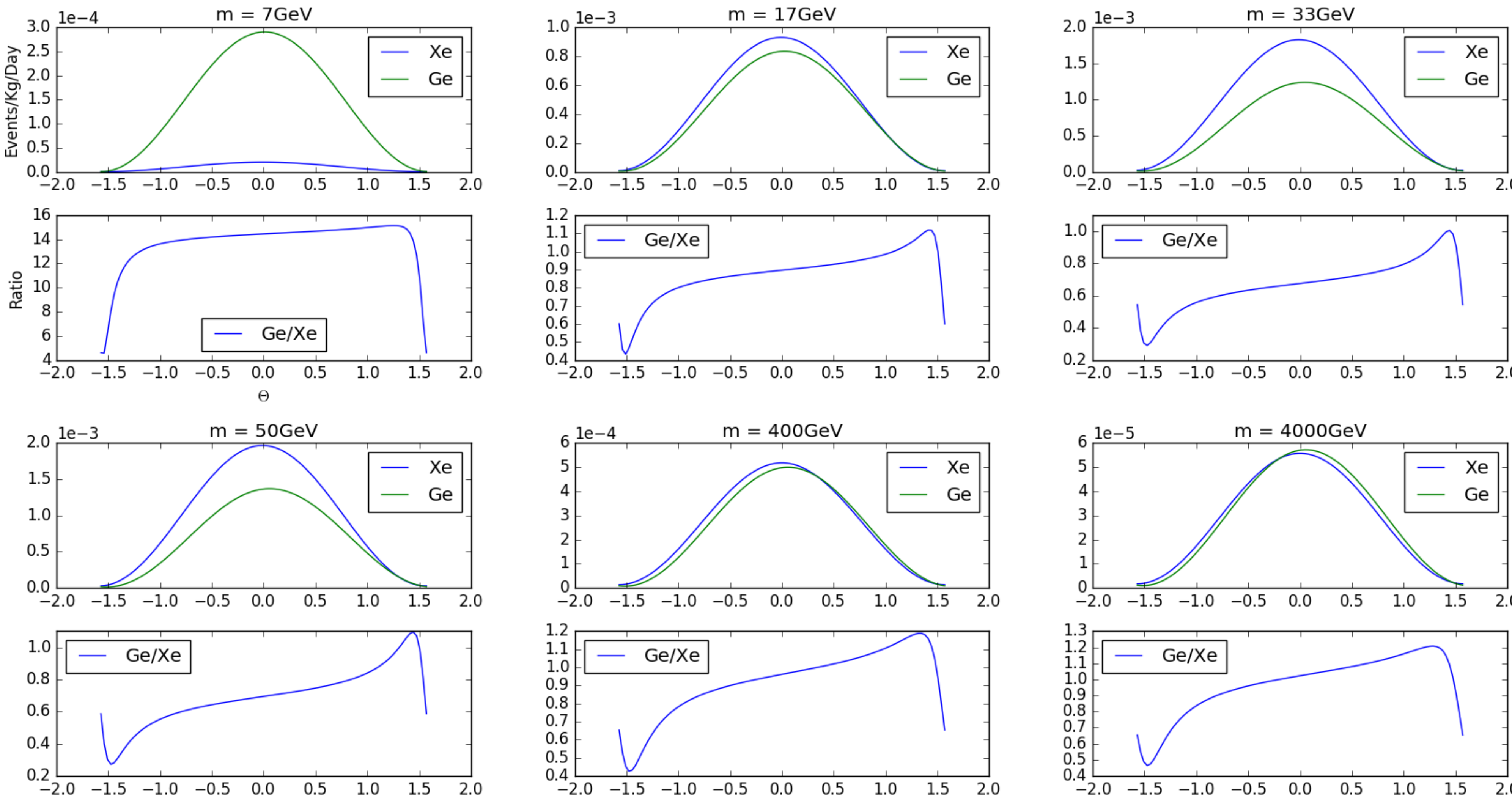
d4n = cos(Θ) d5n = sin(Θ)



$$\mathcal{O}_8 = \vec{S}_\chi \cdot \vec{v}^\perp$$

$$\mathcal{O}_9 = i\vec{S}_\chi \cdot (\vec{S}_N \times \vec{q})$$

d8n = cos(Θ) d9n = sin(Θ)



A note on 8,9 and 4,5 interferences for neutrons.

$y = (qb/2)^2$;

$b \approx \sqrt{41.467/(45A^{-1/3} - 25A^{-2/3})}$ fm.

$$F_{4,5}^{(N,N')} = -C(j_\chi)\frac{q^2}{8m_N}F_{\Sigma'\Delta}^{(N,N')}$$

$$F_{8,9}^{(N,N')} = C(j_\chi)\frac{q^2}{8m_N}F_{\Sigma'\Delta}^{(N,N')}$$

Ge73: $F_{\Sigma',\Delta}{}^{(n,n)} = e^{-2y}\left(-1.5 + 6.5y - 10.y^2 + 7.1y^3 - 2.6y^4 + 0.49y^5 - 0.048y^6 + 0.0019y^7\right)$

Xe131: $F_{\Sigma',\Delta}{}^{(n,n)} = e^{-2y}\left(0.31 - 1.9y + 3.8y^2 - 4.1y^3 + 2.5y^4 - 0.87y^5 + 0.15y^6 - 0.011y^7\right)$

Xe129: $F_{\Sigma',\Delta}{}^{(n,n)} = e^{-2y}\left(0.015 + 0.012y - 0.13y^2 + 0.11y^3 + 0.018y^4 - 0.030y^5 + 0.0050y^6 + 0.00051y^7 - 0.00012y^8\right)$

Note that these terms have opposite signs, hence why we see spikes in the regions of the heat maps where the interference terms become more appreciable.

New “Heat Maps”

- Remade heat maps using simple efficiency functions.
- Estimated minimum detectable recoil energy using

$$E_{min}(keV) = \frac{16 * M_{\chi}(GeV)^2}{A}$$

- Said efficiency is 1 for E >= Emin and 0 for E < Emin.
- Got Emin = 2keV for Xenon and Emin = 0.5keV for Germanium.
- Also included the ratio of rates for each “heat map”

Currently Working on

- Learning statistics
- Making similar “heat maps” for individual isotopes.

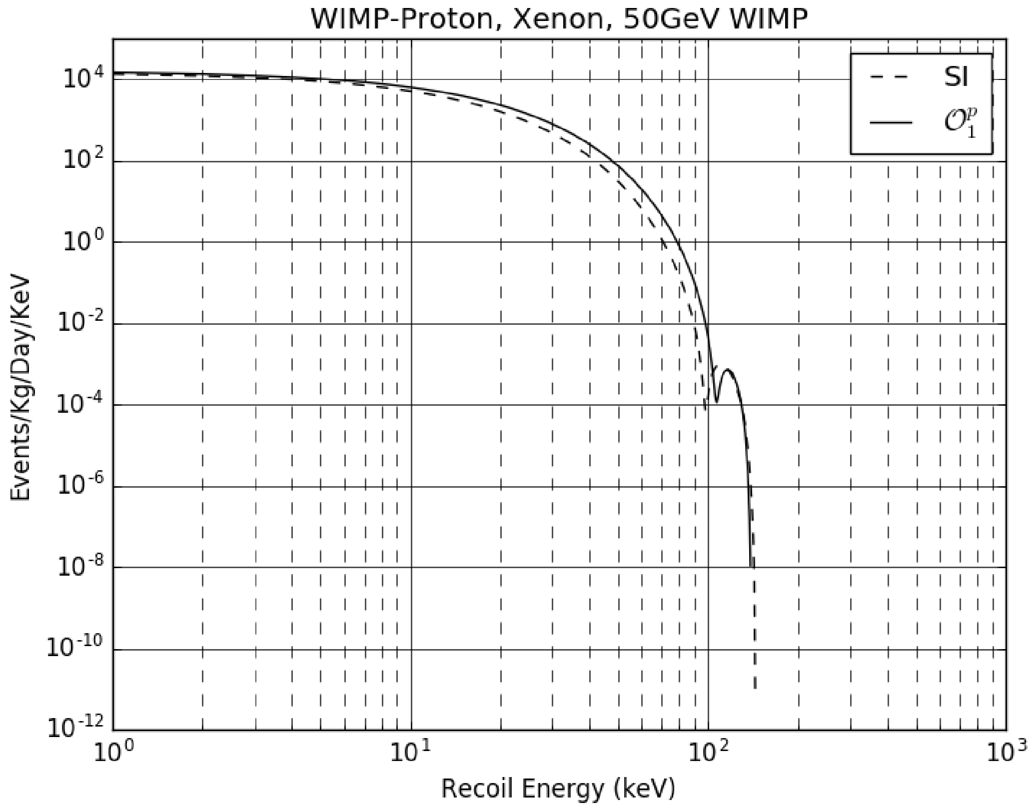
Previous Slides:

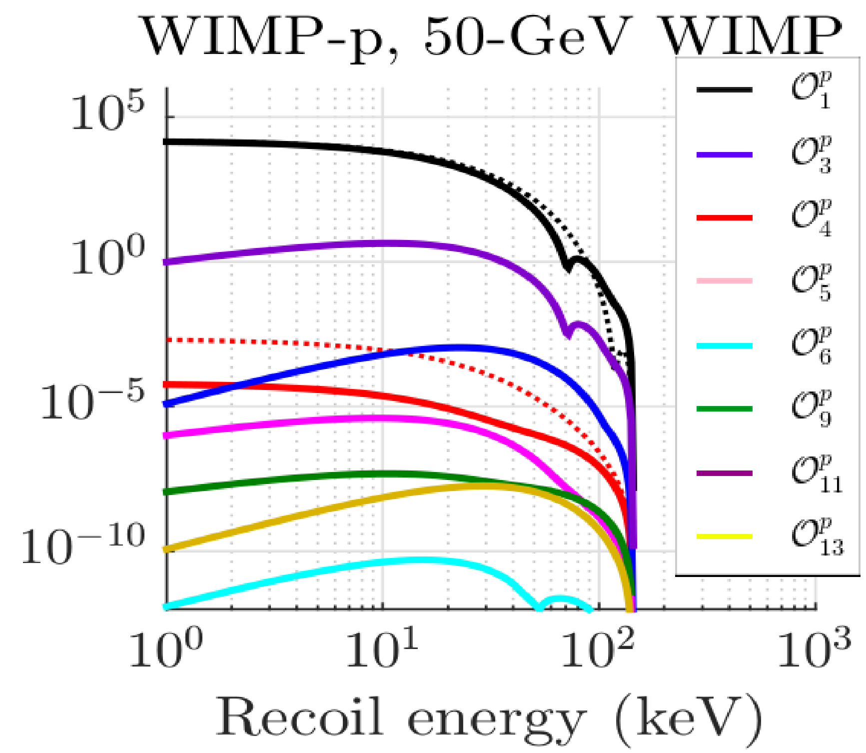
John P Update

9/27/19

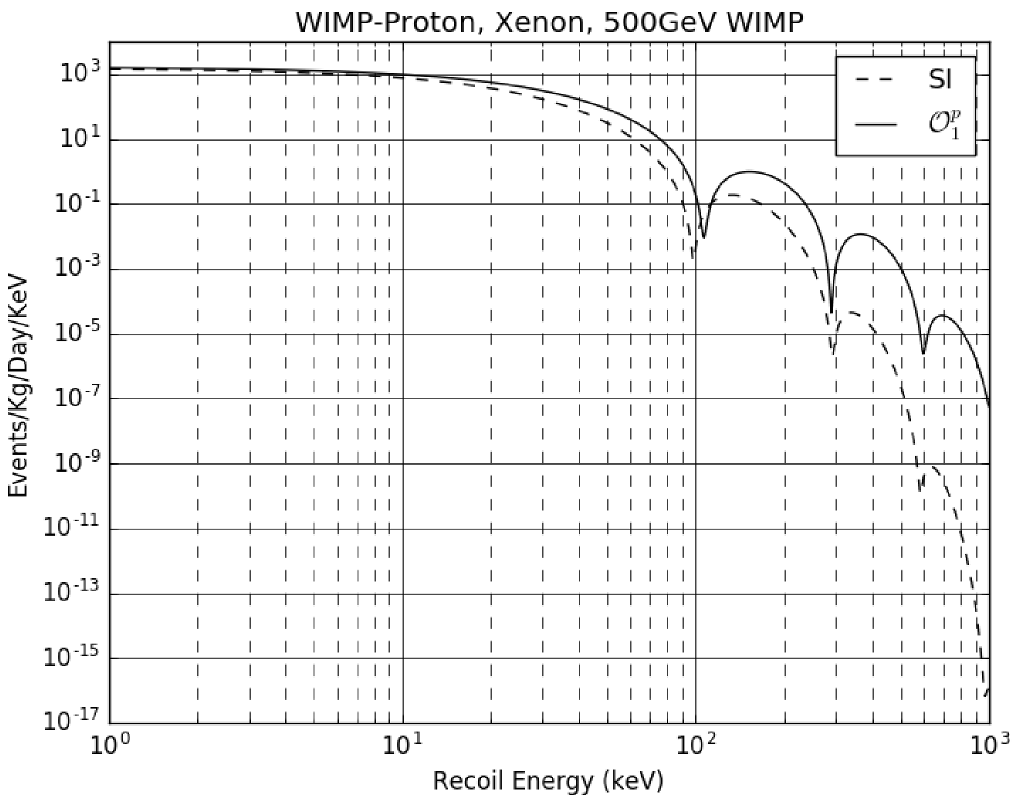
SI Spectra

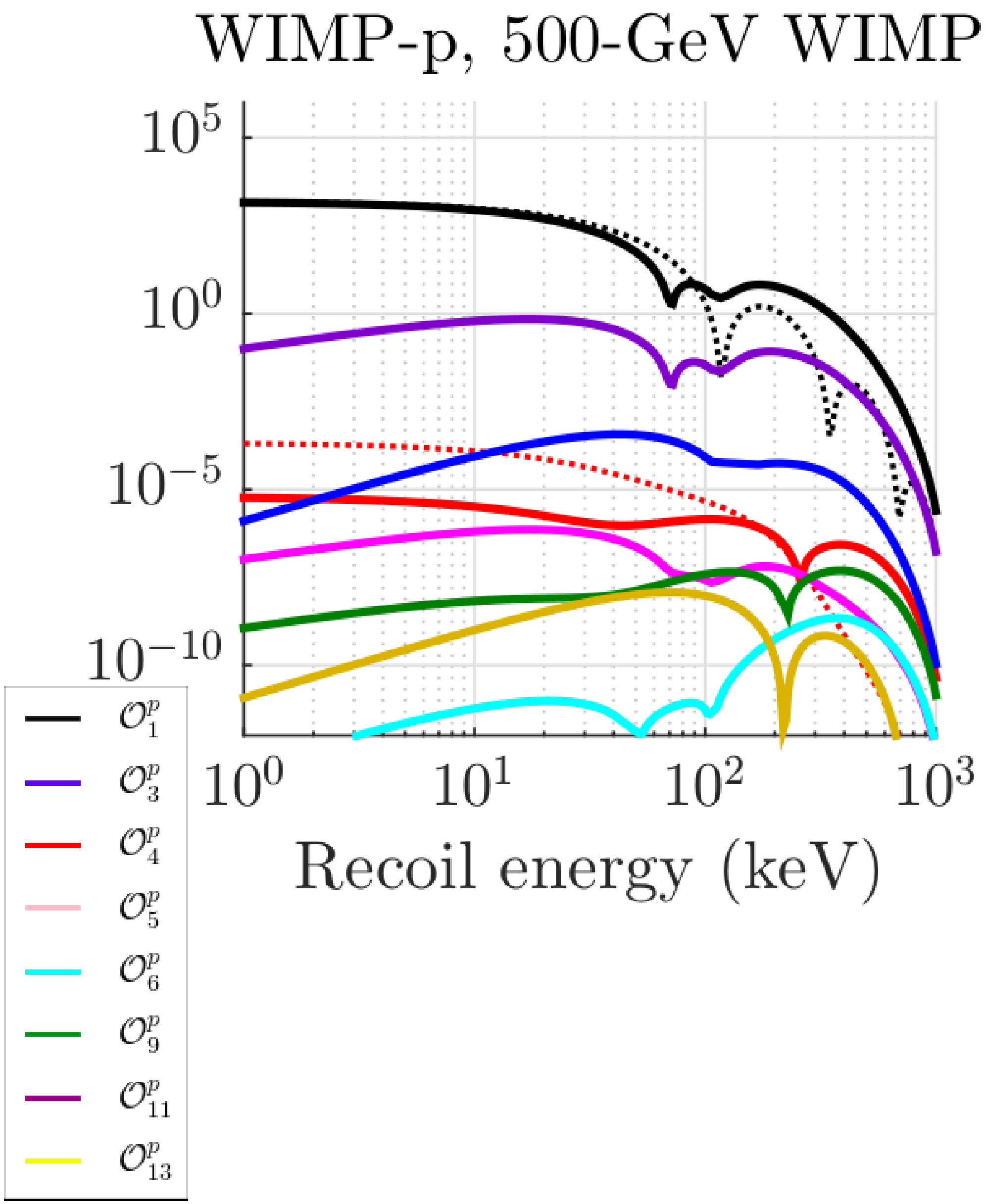
- Generated standard SI spectra using the Mathematica package
- Results are equally as lumpy as operator 1 spectra generated by Mathematica code, although the shapes of the curves are somewhat different.

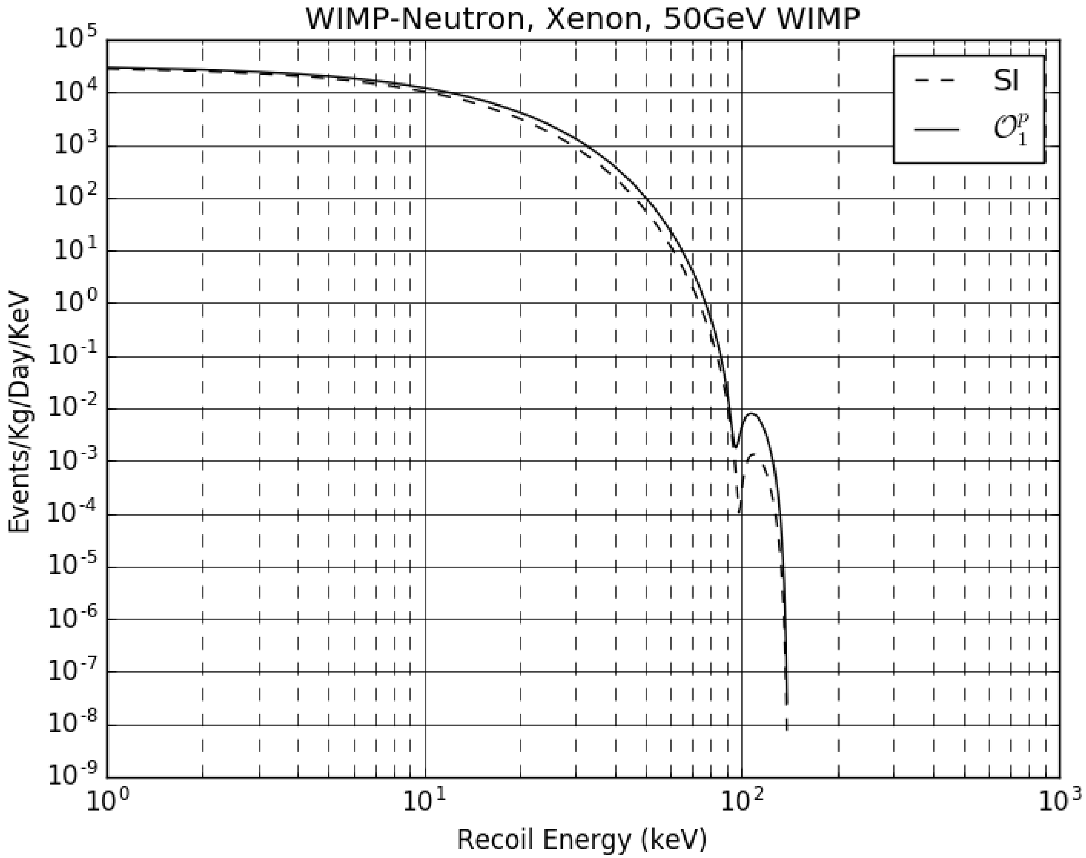


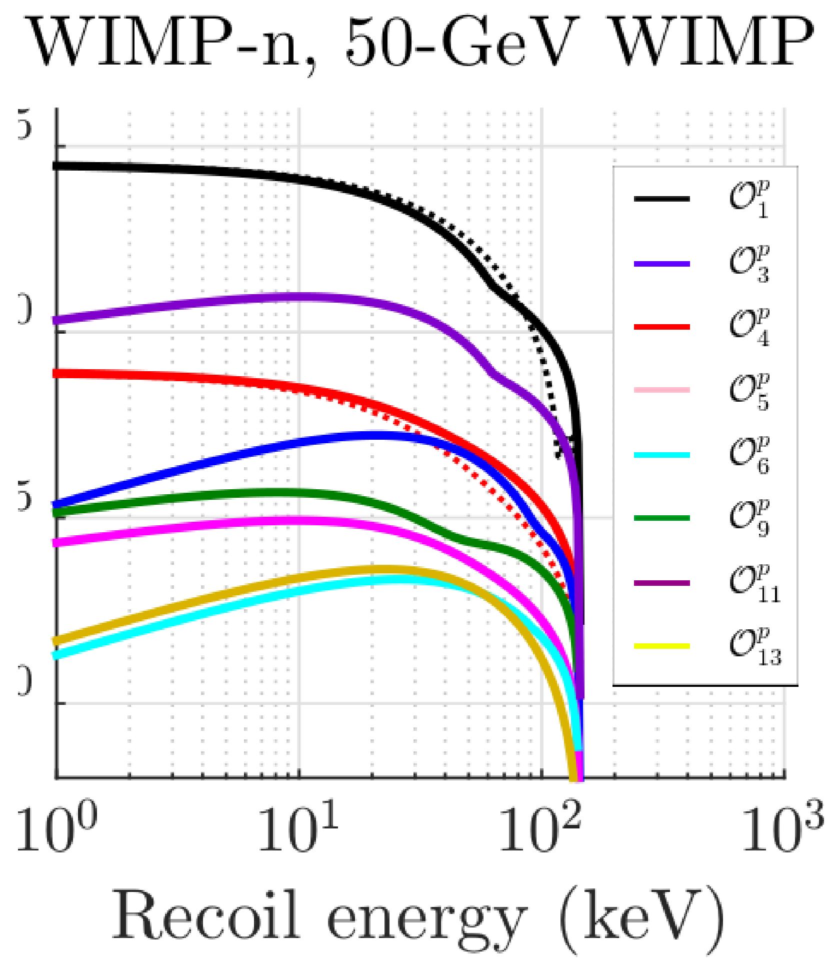


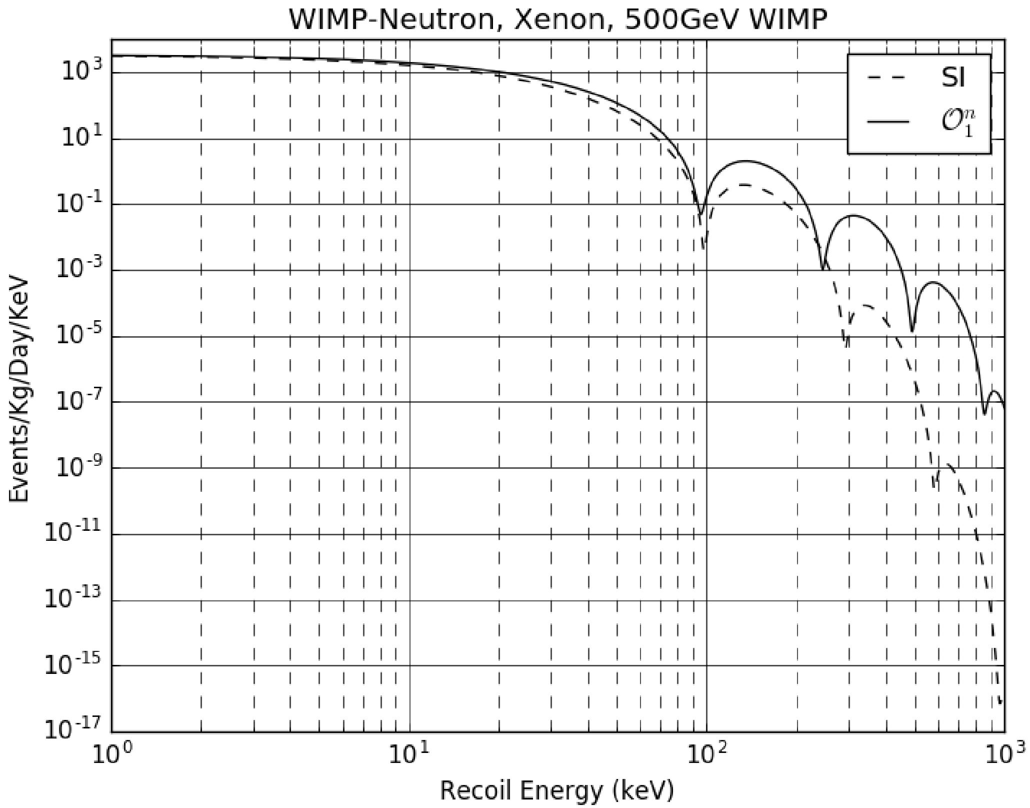
Note: I scaled the SI and O1 spectra so that they would have the same y-intercept.

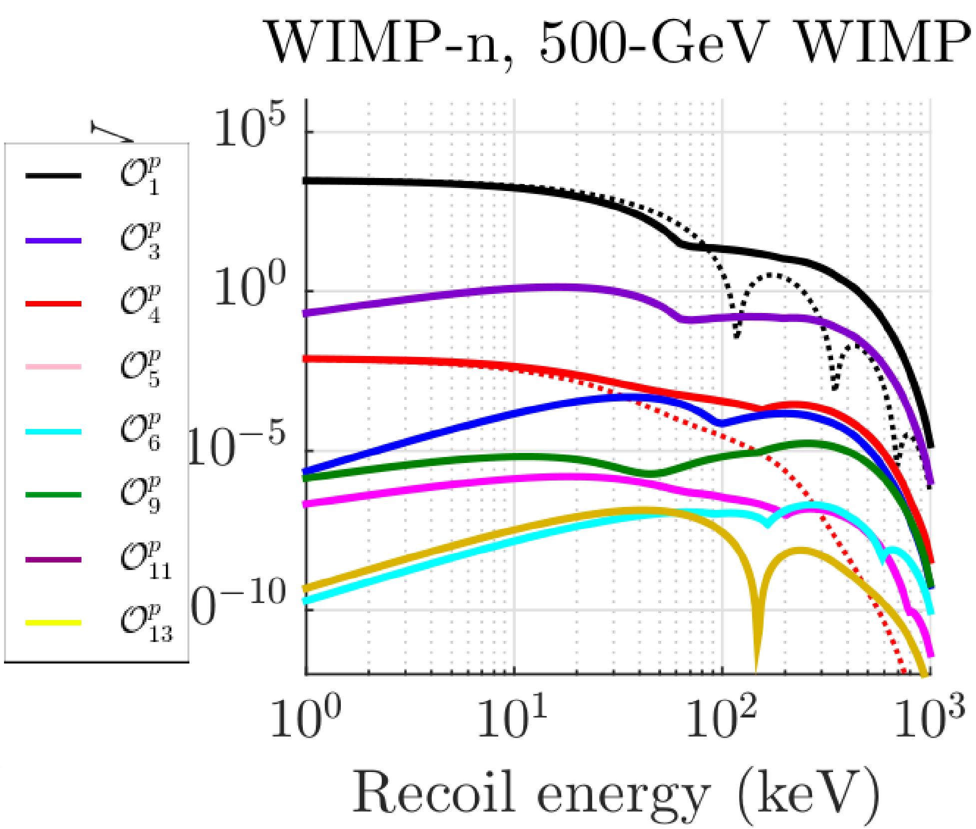

WIMP-Proton, Xenon, 500GeV WIMP
Events/Kg/Day/KeV
Recoil Energy (keV)
SI
$\mathcal{O}_1^p$
10^3
10^1
10^{-1}
10^{-3}
10^{-5}
10^{-7}
10^{-9}
10^{-11}
10^{-13}
10^{-15}
10^{-17}
10^0
10^1
10^2
10^3

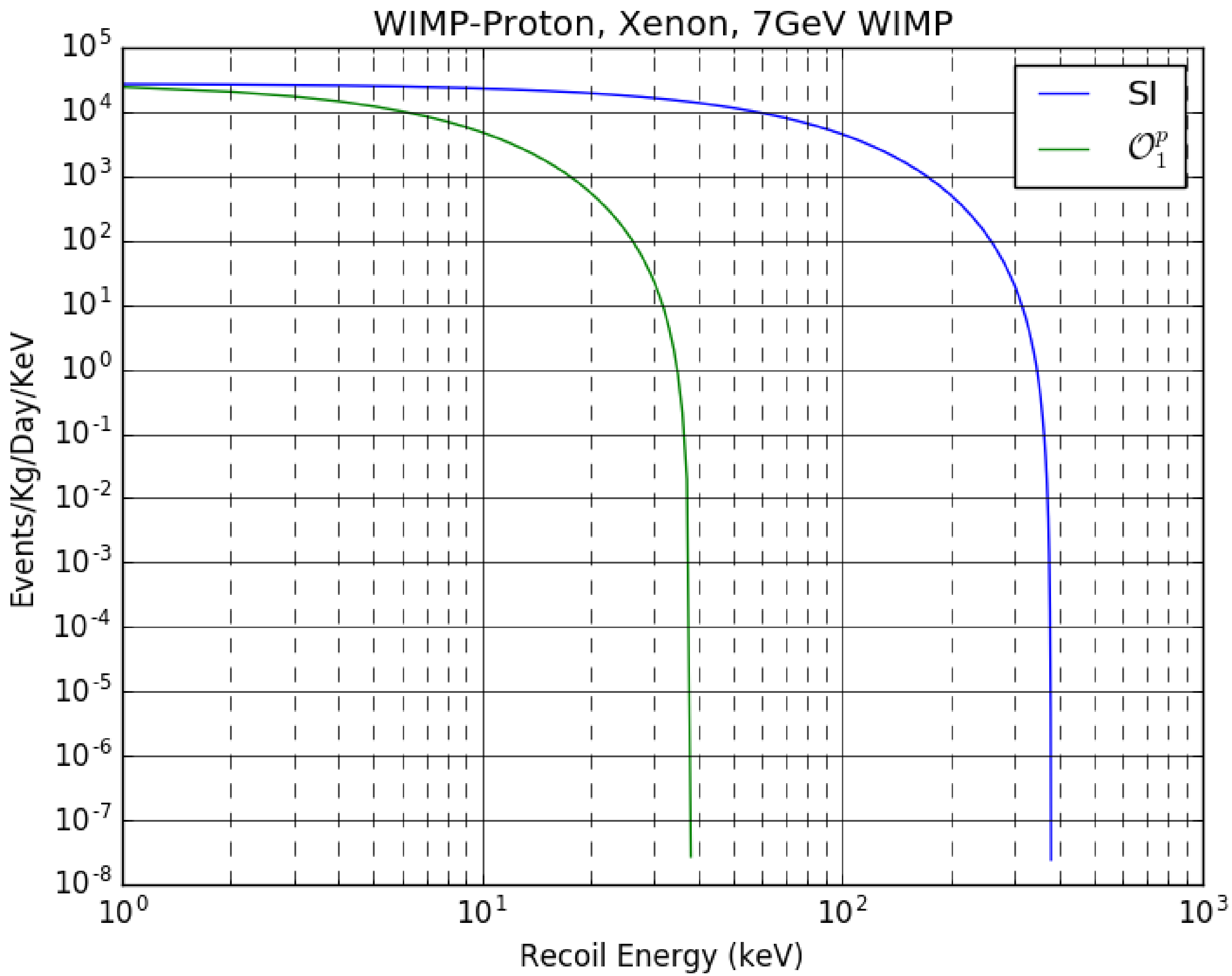

WIMP-p, 500-GeV WIMP
10^5
10^0
10^{-5}
10^{-10}
10^0
10^1
10^2
10^3
Recoil energy (keV)
$\mathcal{O}_1^p$
$\mathcal{O}_3^p$
$\mathcal{O}_4^p$
$\mathcal{O}_5^p$
$\mathcal{O}_6^p$
$\mathcal{O}_9^p$
$\mathcal{O}_{11}^p$
$\mathcal{O}_{13}^p$


WIMP-Neutron, Xenon, 50GeV WIMP
Events/Kg/Day/KeV
Recoil Energy (keV)
SI
$\mathcal{O}_1^p$
10^5
10^4
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^0
10^1
10^2
10^3


WIMP-n, 50-GeV WIMP
$\mathcal{O}_1^p$
$\mathcal{O}_3^p$
$\mathcal{O}_4^p$
$\mathcal{O}_5^p$
$\mathcal{O}_6^p$
$\mathcal{O}_9^p$
$\mathcal{O}_{11}^p$
$\mathcal{O}_{13}^p$
10^0
10^1
10^2
10^3
Recoil energy (keV)


WIMP-Neutron, Xenon, 500GeV WIMP
SI
$\mathcal{O}_1^n$
Events/Kg/Day/KeV
Recoil Energy (keV)

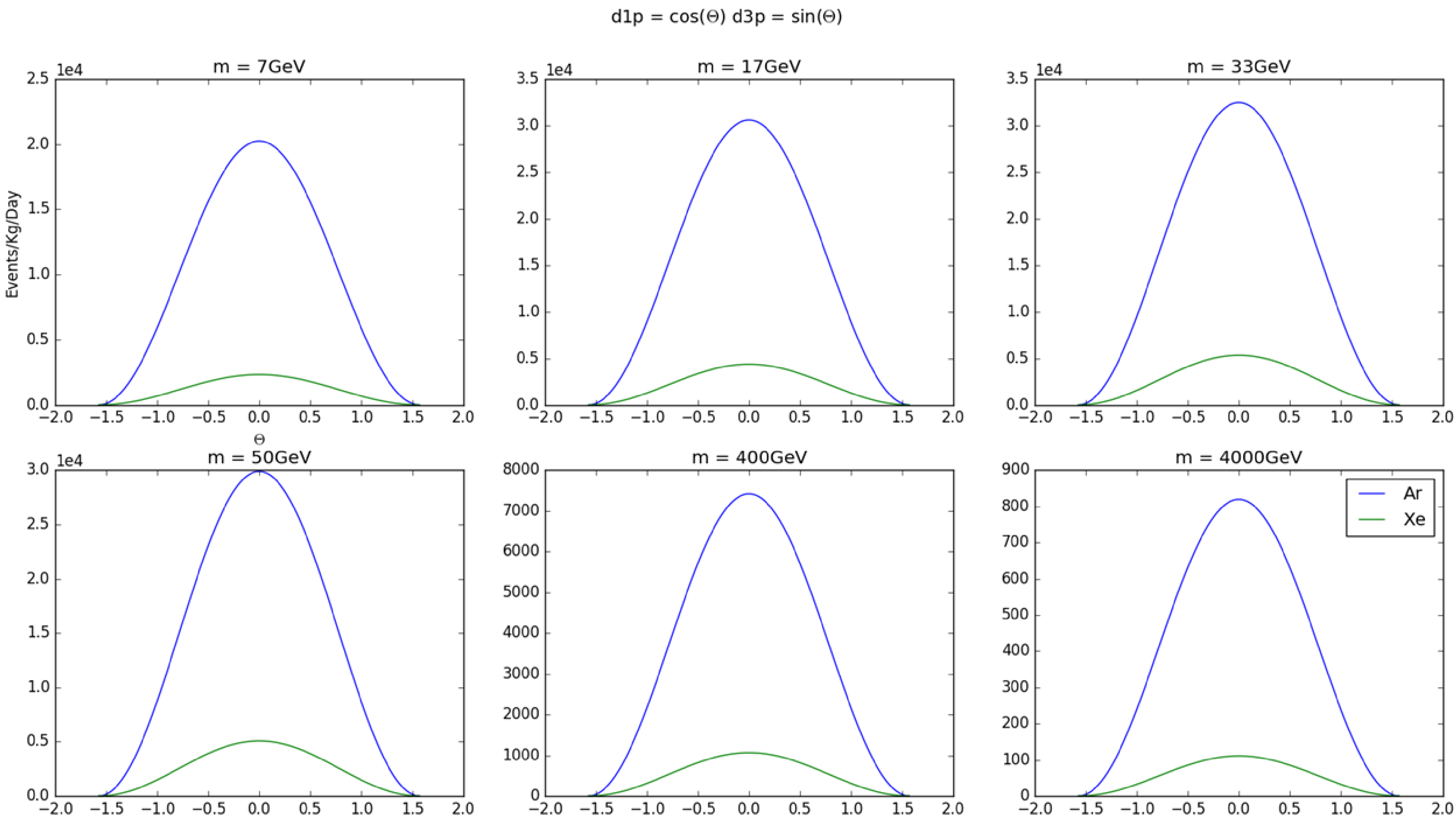

WIMP-n, 500-GeV WIMP
$\mathcal{O}_1^p$
$\mathcal{O}_3^p$
$\mathcal{O}_4^p$
$\mathcal{O}_5^p$
$\mathcal{O}_6^p$
$\mathcal{O}_9^p$
$\mathcal{O}_{11}^p$
$\mathcal{O}_{13}^p$
Recoil energy (keV)



WIMP-Proton, Xenon, 7GeV WIMP
SI
$\mathcal{O}_1^p$
Events/Kg/Day/KeV
Recoil Energy (keV)
10^5
10^4
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^0
10^1
10^2
10^3

Argon confusion update

- Plotted “heat maps” for more values of WIMP mass.
- It does seem that the event rate for Argon is largest around the mass of Argon, which is expected.



d1p = cos(Θ) d3p = sin(Θ)
m = 7GeV
m = 17GeV
m = 33GeV
m = 50GeV
m = 400GeV
m = 4000GeV
1e4
Events/Kg/Day
Θ
Ar
Xe

In the near future

- Start learning statistical techniques used for generating PLRs.
- Continue working with Calvin to sort out density matrix confusion.