WIMP Limits
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This week

Figure out what is going on in the code, WIMP limit

Syntax of blueice

Play with different parameters

Numerical Analysis

General idea of the code

Use blueice to create 1) likelihood function and 2) its interval to find the roots by using Brent's method and the roots will be plotted in the limit graph as the cross-section.

For likelihood function: 1) adds two rate parameters: WIMP recoil, electron recoil 2) adds 1 shape parameter: WIMP mass

(why is the WIMP recoil rate parameter = 0 to make a discovery?)

Problem

- Set cross section = 1e^-45, wimp interaction = SD, got an error.

```
~/Desktop/blueice/blueice/inference.py in one_parameter_interval(lf, target, bound, confidence_level, kind, bestfit_r
outine, t_ppf, **kwargs)
    376             return brentq(t, bound, global_best, args=[1 - confidence_level])
    377         elif kind == 'upper':
--> 378             return brentq(t, global_best, bound, args=[confidence_level])
    379
    380

/anaconda3/lib/python3.7/site-packages/scipy/optimize/zeros.py in brentq(f, a, b, args, xtol, rtol, maxiter, full_out
put, disp)
    508     if rtol < _rtol:
    509         raise ValueError("rtol too small (%g < %g)" % (rtol, _rtol))
--> 510     r = _zeros._brentq(f,a,b,xtol,rtol,maxiter,args,full_output,disp)
    511     return results_c(full_output, r)
    512

ValueError: f(a) and f(b) must have different signs
```

Interpretation of the syntax

- one_parameter_interval(lf, target, bound, confidence_level, kind, bestfit_routine, t_ppf, **kwargs)

- Set a confidence_level(100%) interval of kind(a range of WIMP mass) on the parameter target(WIMP rate multiplier) of likelihood function

lf = likelihood function

target = WIMP rate multiplier

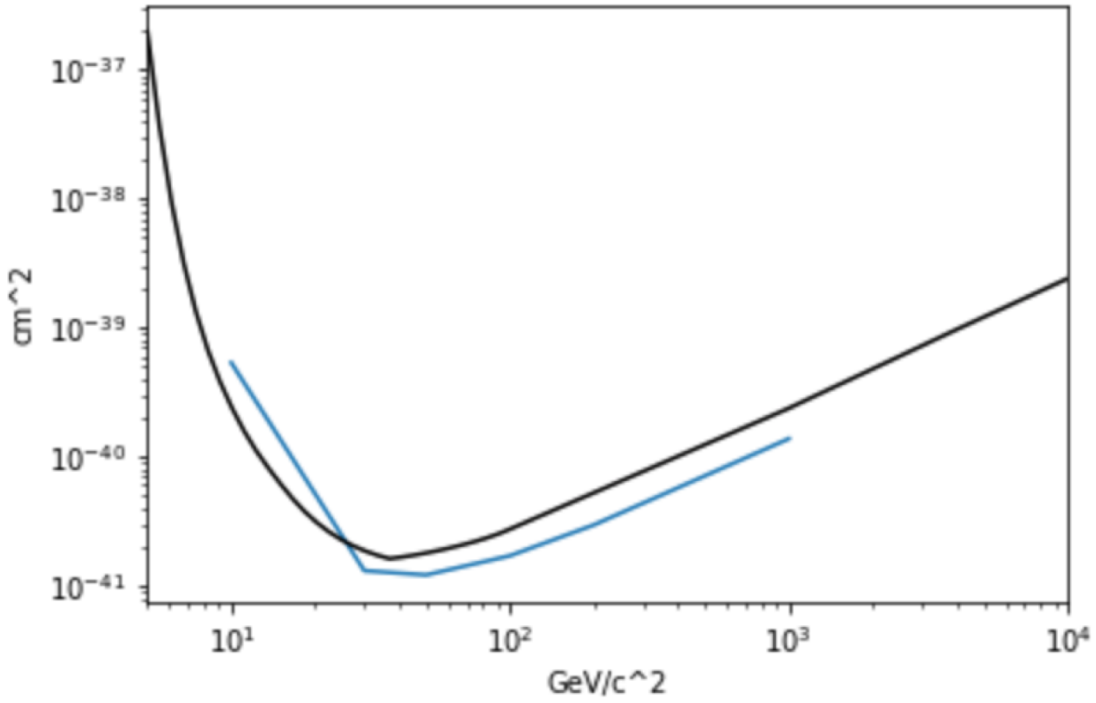
bound = 10

kind = WIMP mass

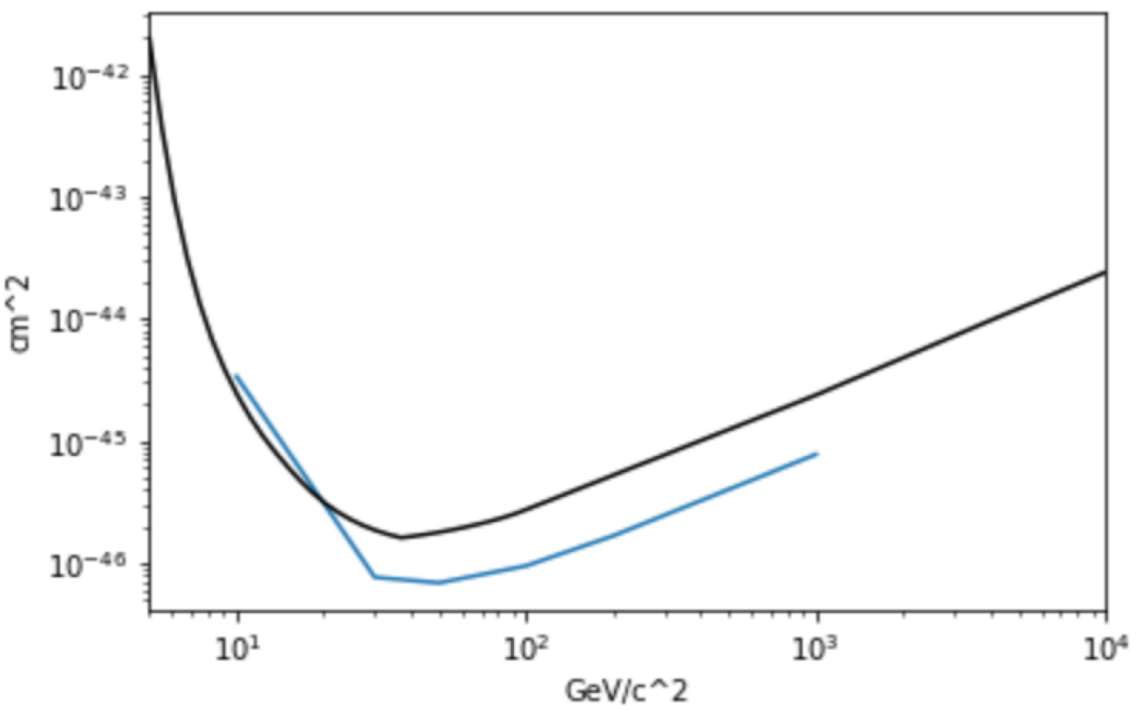
What I think…..

- Using Brent's method to find roots of the function and it requires f(a) and f(b) have different signs.
- Brent's Method: iteration of (bisection method + secant method)(I could make a slide on this method, if anyone is interested…..)
- When set CS to 1e^-45, the likelihood is too small, and the function curve is around zero-axis.
- Solution: increase the likelihood by decreasing the WIMP energy in the macro ---> No Effect
- Does it worth to dig more into it?

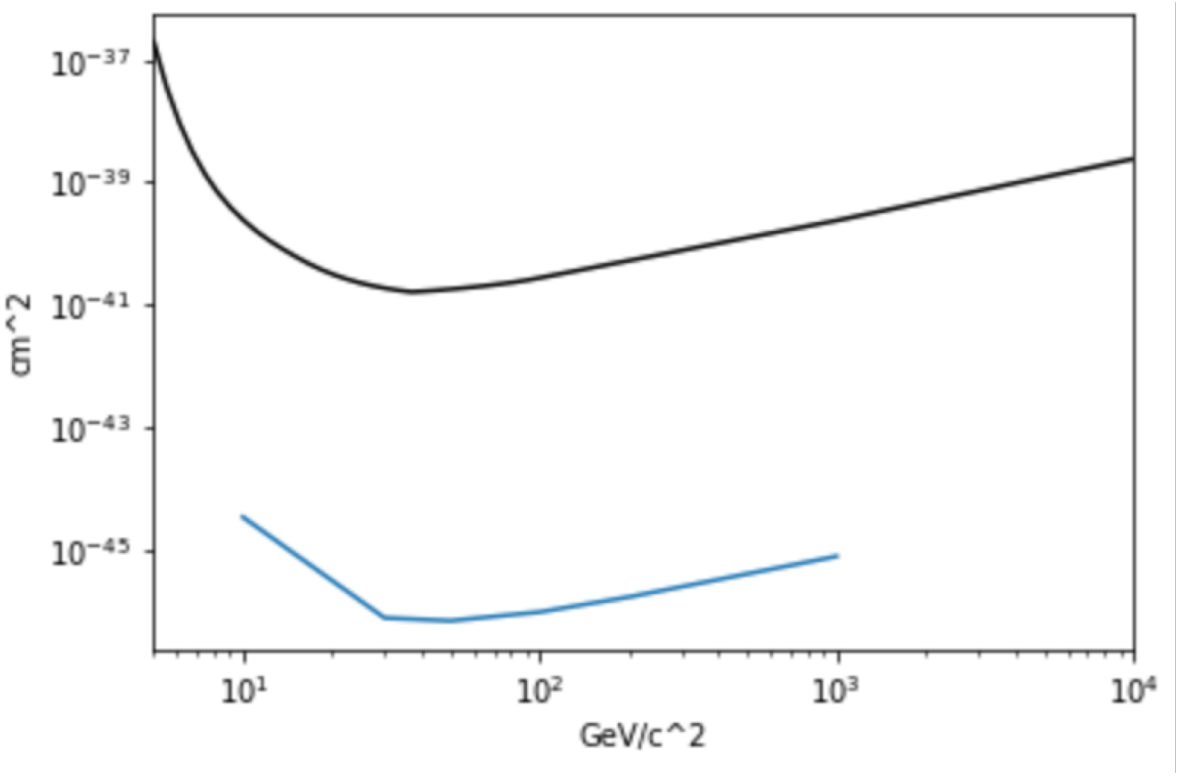
Cross-section: 1e^-40
WIMP Interaction:
SD_n_central (spin dependent)



Cross section: 1e^-45
WIMP Interaction: SI
(spin independent)



Cross-section: 1e^-40
WIMP Interaction: SI

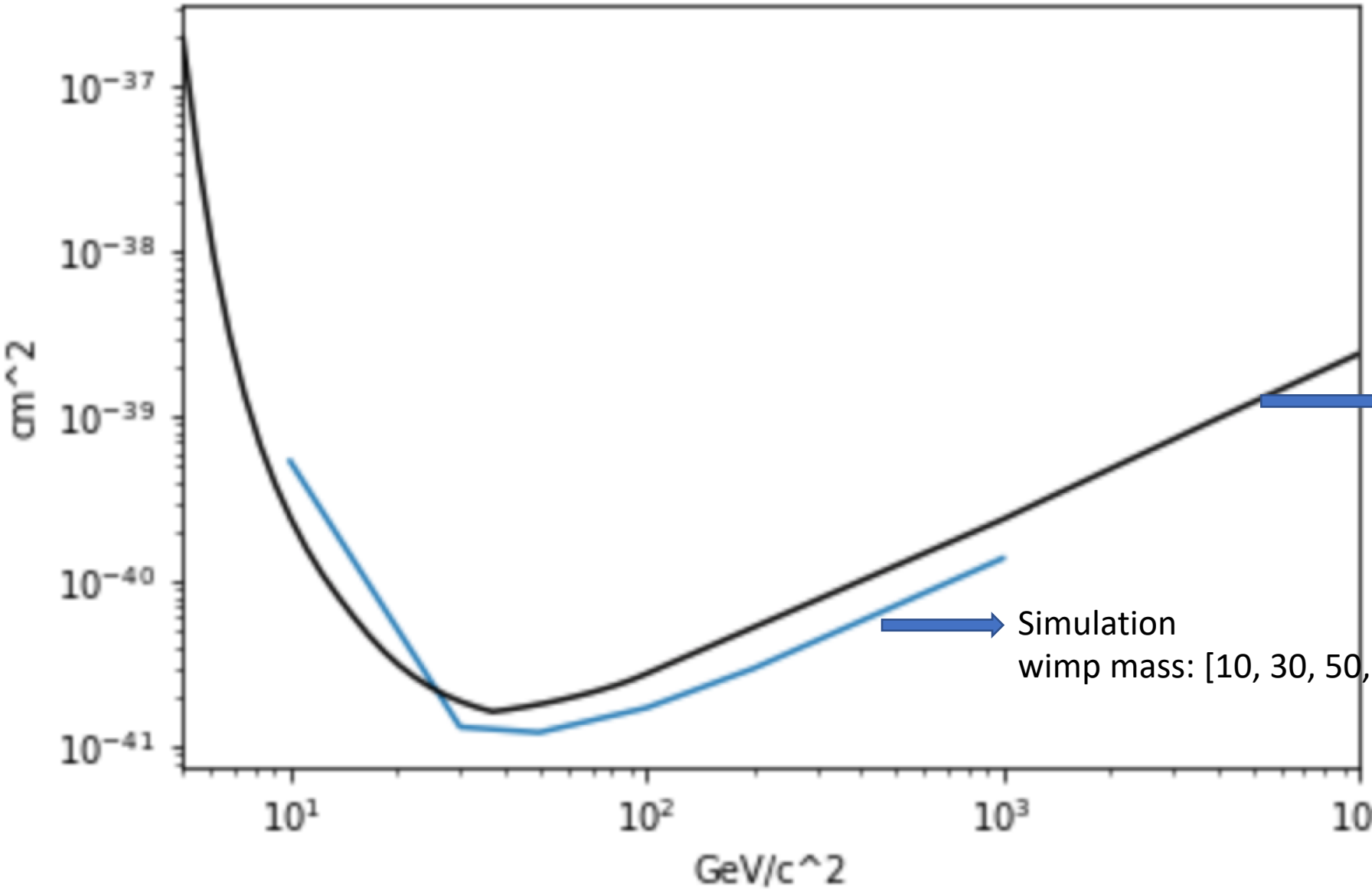


Next Week

- Analyze the simulation Macro
- Any remaining/new problems from this meeting

Macro(Xenon1T)

- Set Sources: energy distribution: er_background + nr_background(cnns and radiogenic neutrons) + 50Gev 10^-45 WIMP(nr)
- Set parameters



Model?

Simulation
wimp mass: [10, 30, 50, 100, 200, 1000] GeV

Info for the black line

5 GeV	10 GeV	10^2 GeV	10^3 GeV	10^4 GeV
1.98e^-37 cm^2	2.37e^-40 cm^2	2.75e^-41 cm^2	2.38e^-40 cm^2	2.41e^-39 cm^2

Base model(Xenon 1T)

- WIMP Parameters:

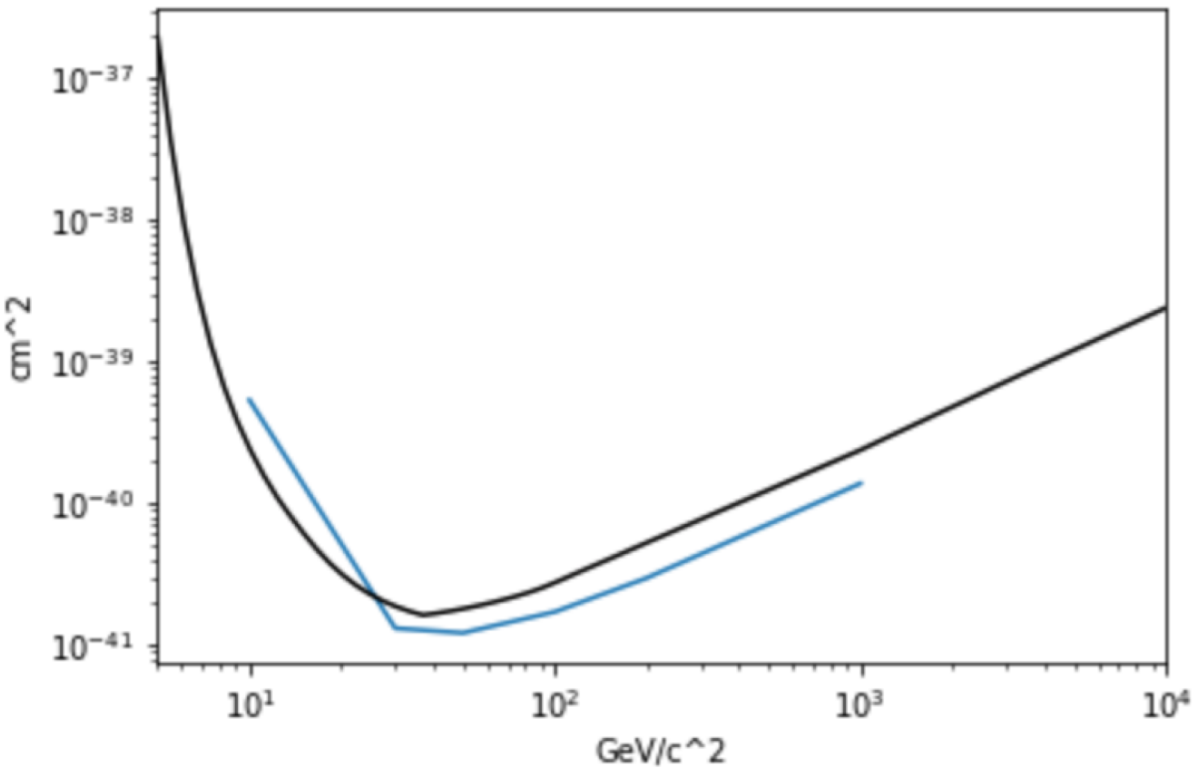
Detection	Sigma_nucleon	Wimp mass	NR cutoff	ER cutoff	WIMP interaction
Elastic NR	1e^-45 cm^2 → 10 e^-40 cm^2	50 Gev/c^2	1 keV	0.18keV	SI → SD_n_central

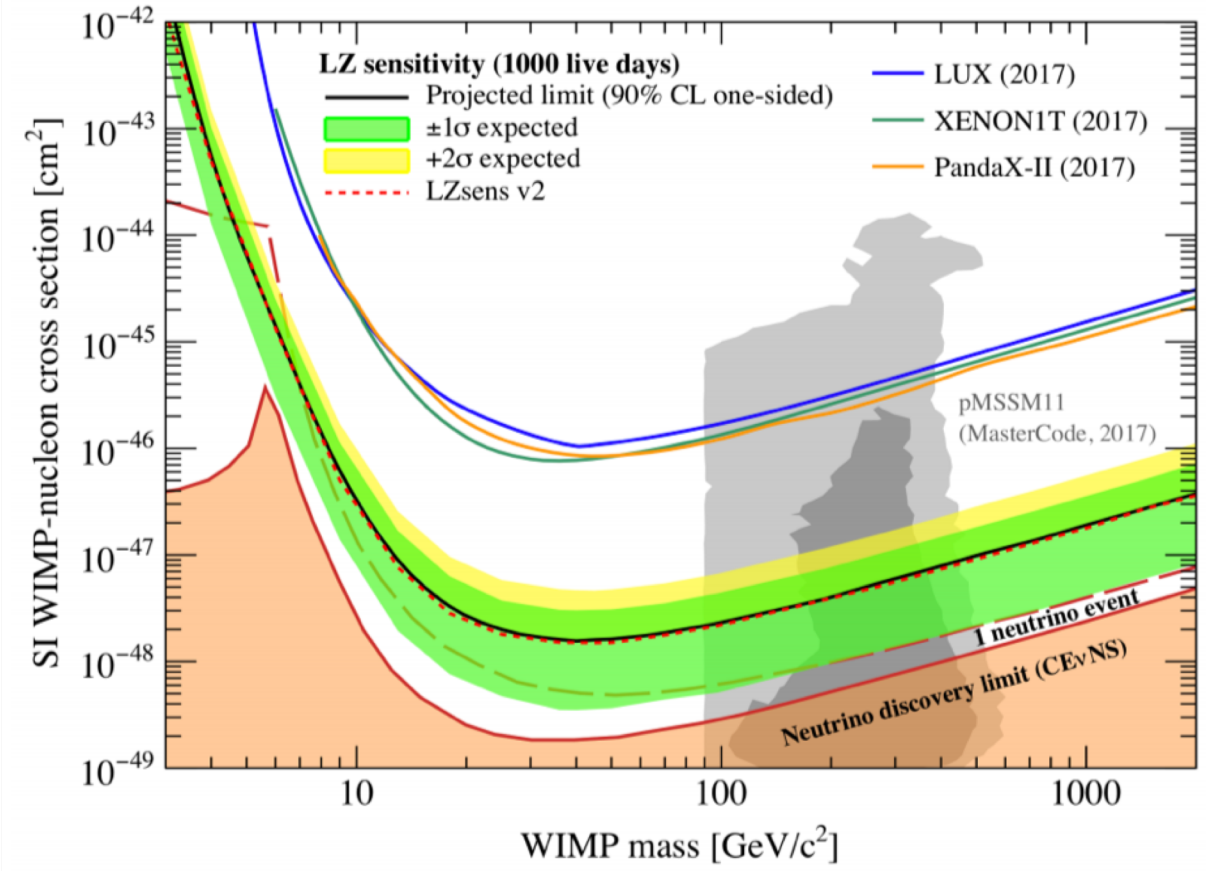
- Detector parameters:

Fiducial mass	Electron lifetime	Drift velocity
1042 kg	452 us	1.44 m/ms

Pdf_sampling_multiplier:1->0.1

Wimp limits curve





Questions?

- What other parameters do I need to know/change?