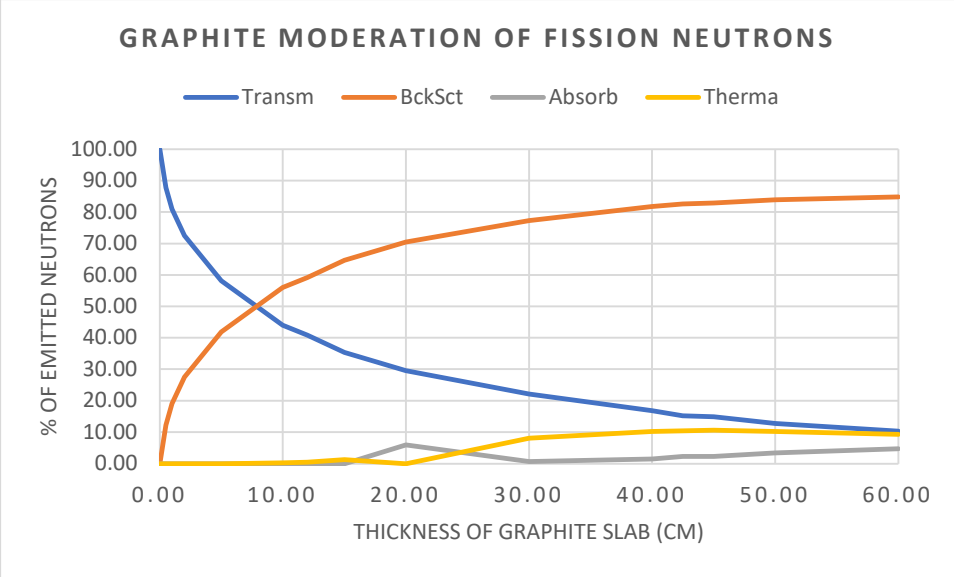
Andrew Cohen
Phys 250
11/26/20

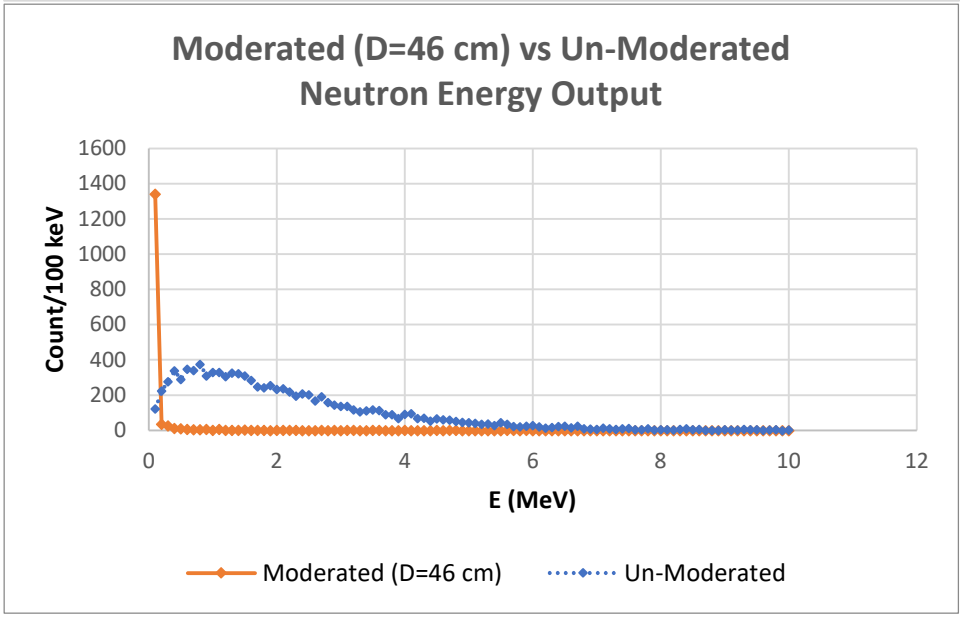
HW 5 Writeup

Using the simplified geometry of the infinite slab of graphite yielded an optimal graphite thickness of 46 cm. This can be seen in the graph below that shows that maximum percentage of thermalized neutrons occurring at D=46 cm. I also plotted the energies of the neutrons below to verify that the graphite moderator was performing its proper function. From the book *Physics of the Manhattan Project*, the correct answer is a spacing of 21 cm – this however is for a square lattice of Uranium pseudo-sphere, or "slugs", not the infinite slab we approximated.

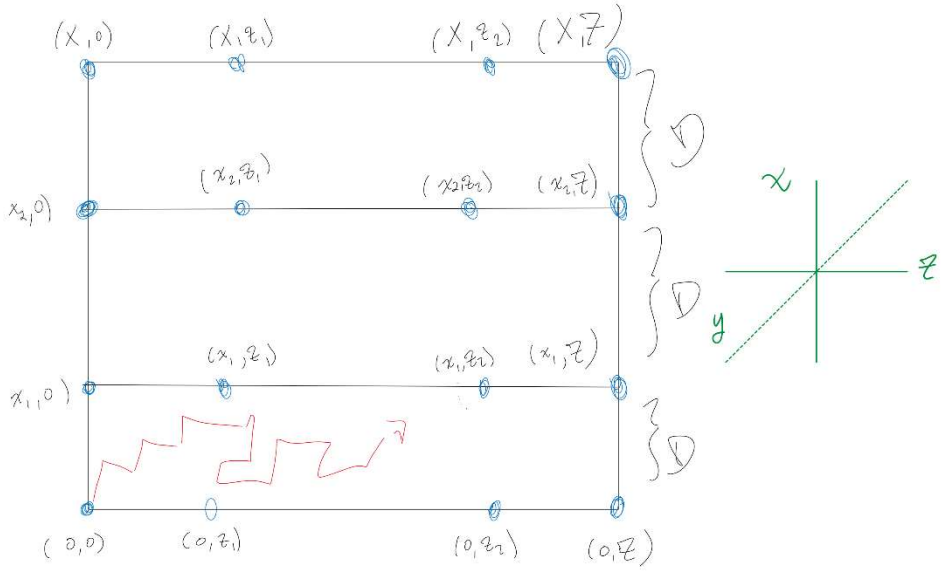
The tallies of the Transmitted, Backscattered, Absorbed, and Thermalized neutrons are plotted as a function of graphite thickness D.



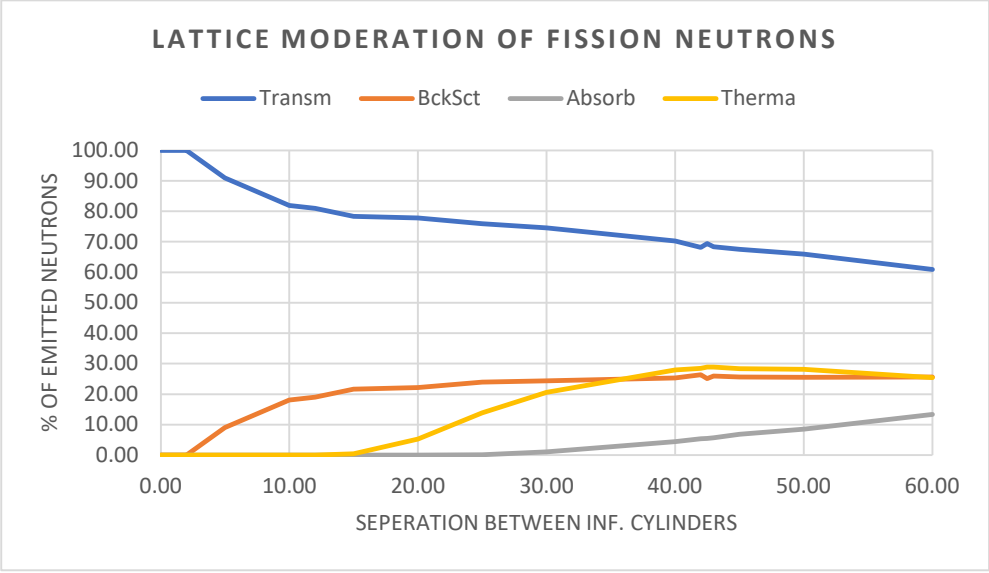
The neutron energies for D = 46 cm was plotted (orange) to verify that my optimal distance was in fact based on proper neutron moderation. The blue data are the unmoderated energies.



Given the approximations we made in our geometry, I sought to explore whether our simulation could be improved through a slight modification. Thus, I then coded the same simulation but instead of an infinite graphite slab I utilized a square lattice of infinitely tall uranium cylinders of defined radius (4.1275 cm) surrounded by graphite. The radii information was found in the paper *Piles of piles: An inter-country comparison of nuclear pile development during World War II*. I also included a condition that if a neutron reaches the boundary of the lattice and has yet to be terminated, it reappears on the other side of the lattice thus simulating infinite lattice next to each other. The square lattice design is pictured below.



The results are tabulated in the plot. The shows that the optimal spacing distance D for this geometric configuration is 42.5 cm – an improved result from the original geometry but not quite the progression I was hoping to receive.



Although this result is disappointing, it is not that surprising. My geometry was still simplified – advancing to a truly three-dimensional simulation with spheres instead of cylinders would improve the result. Furthermore, other effects such as the cross-sectional presence of boron have significant effects on the calculations of the system. I could also attempt other methods of determining the optimal spacing such as the reaction rate method. These are problems I hope to investigate in the future… maybe after I learn COMSOL.