Jan 30. Thu.

SU(3) Edge Effect Study

After figuring out how to solve SU(3) confining string yesterday, I immediately set up a edge effect study. To do this, I simulated the confining string picture on a grid of 10 by 10, for a charge separation of $R = 2, 3, \ldots 9$. Then I repeated the calculation on a grid of 20 by 20. (Note that all of these are computed to 400 loops.)

The result is shown below in figure 1.

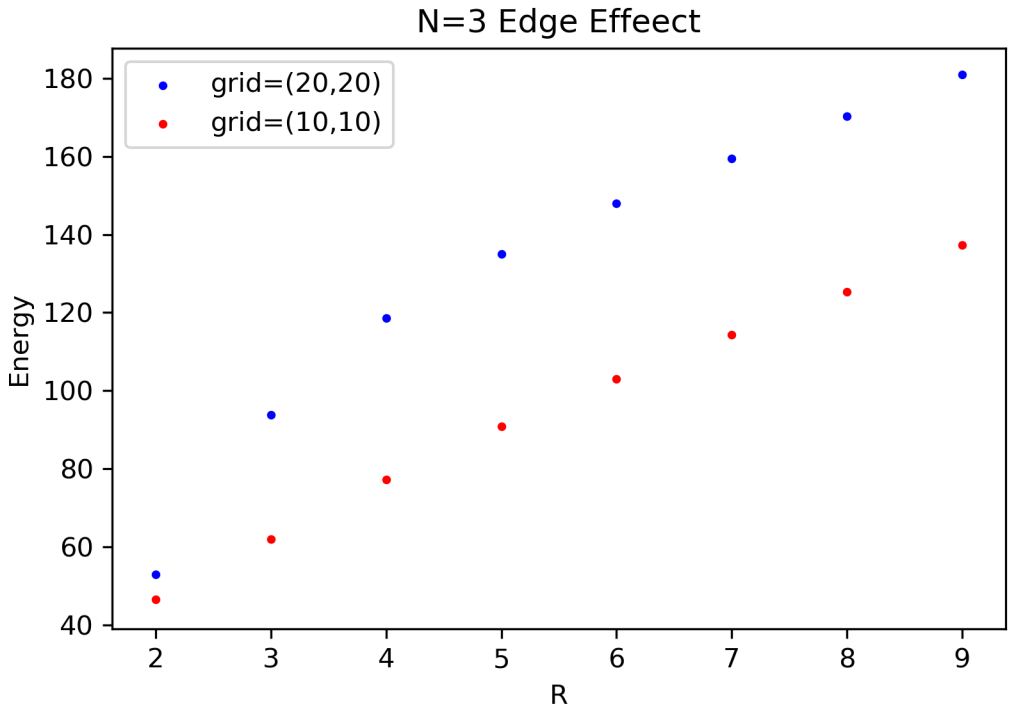

Figure 1: SU(3) Edge Effect

It is clear that the larger grid has an overall larger energy, due to the energy being an integral over all space, and there are just more space to be integrated for the larger grid. However, beside this energy difference, there is very little edge effect. Adding a constant to make the difference clear, see figure 2, it is clear that even close to the boundary, the energy basically agree. In particular, the slope of the energy as a function of separation completely agrees, as is clear from the diagrams.

Surprisingly, the only major difference between the two results are the low-separation energy. The "true" energy has a drop-off from the linear relation, while the small-grid result doesn't. However, this should

not change our result, as the slope of the graph are unaltered in any case.

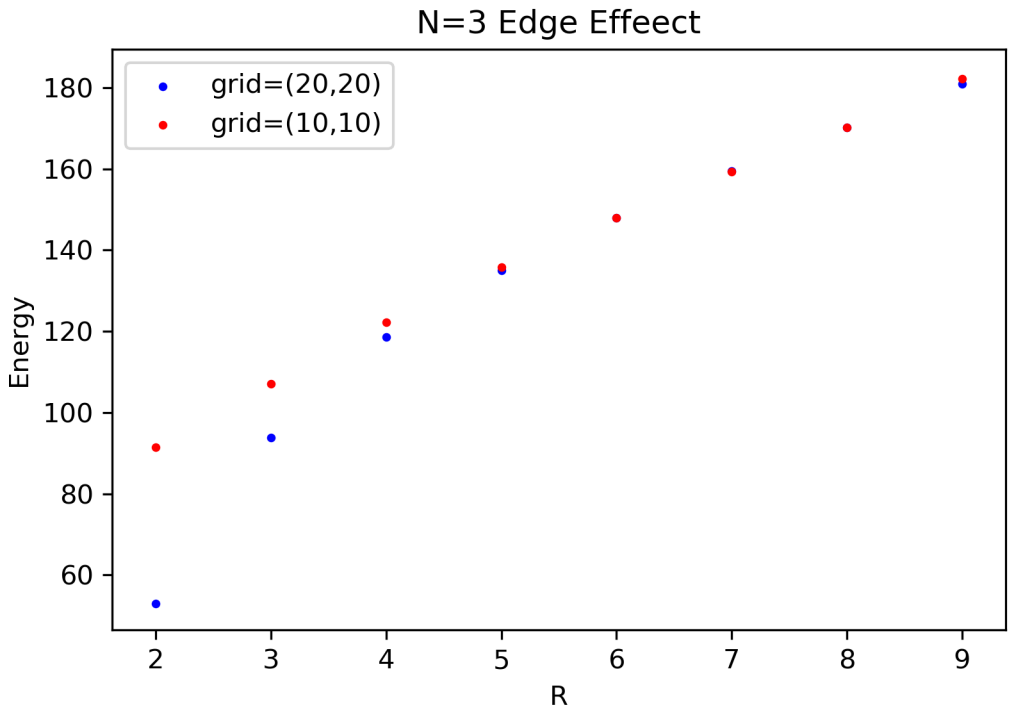

Figure 2: SU(3) Edge Effect shifted

This is overall a very good news for my project. First, it means that the prediction of the linearly rising potential is reproduced by my code. Second, in practice, the agreement implies that there is no need for us to consider edge effect. We just take the points that maitain linear relation and find the slope.

First Meeting with Erich & Explanation of No Edge Effect

After getting this nice edge effect result, I had my first official meeting with Erich on this project. I first spent most of the meeting explaining to him how I solved SU(3). In particular, I explained the monodromy (with 0, $\vec{w}_k$, and k=1 wall) I used to support the charges. We agreed that such configuration is always possible, for N-ality p, where we simply use $\vec{w}_p$, since the two upper and lower BPS walls are related by the $\mathbb{Z}_N$ symmetry and have the same energy.

I then went over the initial configuration using BPS. Erich agrees that this makes sense, but wants me to explore both $k = 2$ wall and starting with initial configuration that is not "guiding" the computer, i.e. try starting with constant initial conditions. I tried this before, and the result doesn't give double string, but in all cases, the time it took for convergence was just too long and I gave up. Perhaps I will study this later when my code gets efficient. Besides, exploring these would be a side-project.

Finally, Erich agreed that my result is consistent with an linearly rising potential. We also realized that in hindsight, it makes sense that a confining potential has no edge effect. After all, at far distance, a confining potential forces the flux out of the vacuum and confine it into flux tubes. So at the boundary,

there is very few flux left. In contrast, a non-confining theory, as we did over the summer by setting $W = 0$, experiences strong edge effect.

Next Steps: February List

I finished most of the points on the New-School-Year list, except for the optimization part. Over the next month, the goal is to optimize the code (carry over from last list), do one two more sanity checks, and start using a supercomputer to get overall results.

1. Optimize the code by using a shortcut equation of motion.
2. Optimize the code by exploiting Numpy to its fullest.
3. Optimize the code by running it on half grid.
4. Sanity check: run the same simulation for a range of separation for SU(3) with N-ality $p = 2$ to check that the slope is the same as the previous case.
5. Start using Supercomputer to solve the rest.
6. Sanity check: run a SU(4) edge effect study (using Supercomputer).

My goal is to finish the first 3 points (optimization) by February 9.

Finish point 4 and get started with the Supercomputer (hopefully with SU(4) result) by the end of Feb 16.

By March 1, I hope that I will have most of the results down.