N-body Project
Phys 512 Computational Physics

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1 Intro

I did the regular n-body project with two twists.

1. I used the 2-dimensional gravitational force. So the force goes like $\frac{1}{r}$ and the potential goes like $\log(r)$.

2. I have two different kinds of particles. They're labeled particles A and particles B. They act on each other according to the following sign table:

	A	B
A	-	-
B	-	+

So A particles attract A. B and A particles attract each other. B particles repel each other. This will only show up when simulating a lot of particles and in the extra GIFs I'm including.

2 GIFs

In order to recreate these calculations, you need to call an initial condition function which gives the information about all the particles.

For the first GIF of a stationary particle, use the one_in_middle() initial condition.

For the GIF of the orbiting particles, use the two_particles_circle() initial condition. G_A (the gravitational constant relevant to the particles orbiting) was set to 0.1. (It needs to be set to this for the velocity to be correct.)

For the hundred thousand particles periodic and non periodic, use the mixOfBoth(1000000,0,"good seed", 1000) initial conditions. Note, I made the seed a string instead of a number because I thought that would be more fun. There's a bool variable called periodic that controls whether or not it's periodic. The energy pretty much doubles when the particles collapse. This could be because of too large timesteps. It's a similar result for nonperiodic.

For the rk4, for each step, it gets the forces four times as often as the leapfrog method. This means I need to take a quarter the number of steps (400 to 100). To keep the same total time, I'll multiply the Δt by 4 (0.1 to 0.4).

Looking at the results of rk4 for periodic, the energy doubles also, which is the same as leapfrog. The conclusion is that they're about the same for conservation of energy.

Unfortunately I couldn't figure out how to implement rk4 with non periodic boundary conditions. You would have to somehow remove particles in between every step of rk4. I'll try to redeem myself by including two more plots showing off the A particles and B particles that I wrote.

3 Extra GIFs

I included a GIF called B_Particles_Only.gif. This is using the initial condition called mixOfBoth(0,30,"phys512", 1), witch G_B on -0.01 and delta t on 0.01. This causes the particles to spread apart.

And the grand finale is both kinds of particles together, which you can see in Extra_A_and_B.gif. This was called with mixOfBoth(100, 900, "phys512", 1). G_A = 0.005, G_AB = 0.005, G_B = -0.02. The time step was set at 0.05. The cyan particles are the A particles and the white are the B particles. You can see the A particles clump up while the B particles disperse. But you can also see the B particles collect around the A particles, since the force from the A particles can overpower the repulsiveness of the B particles.