

Ph22 Lab4

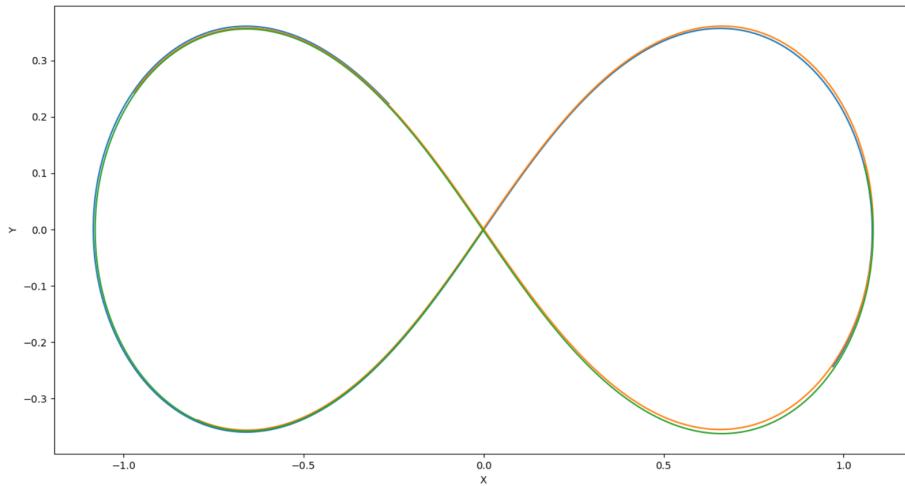
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1 N-Body Simulation

1.1 Testing on Figure 8 Orbit

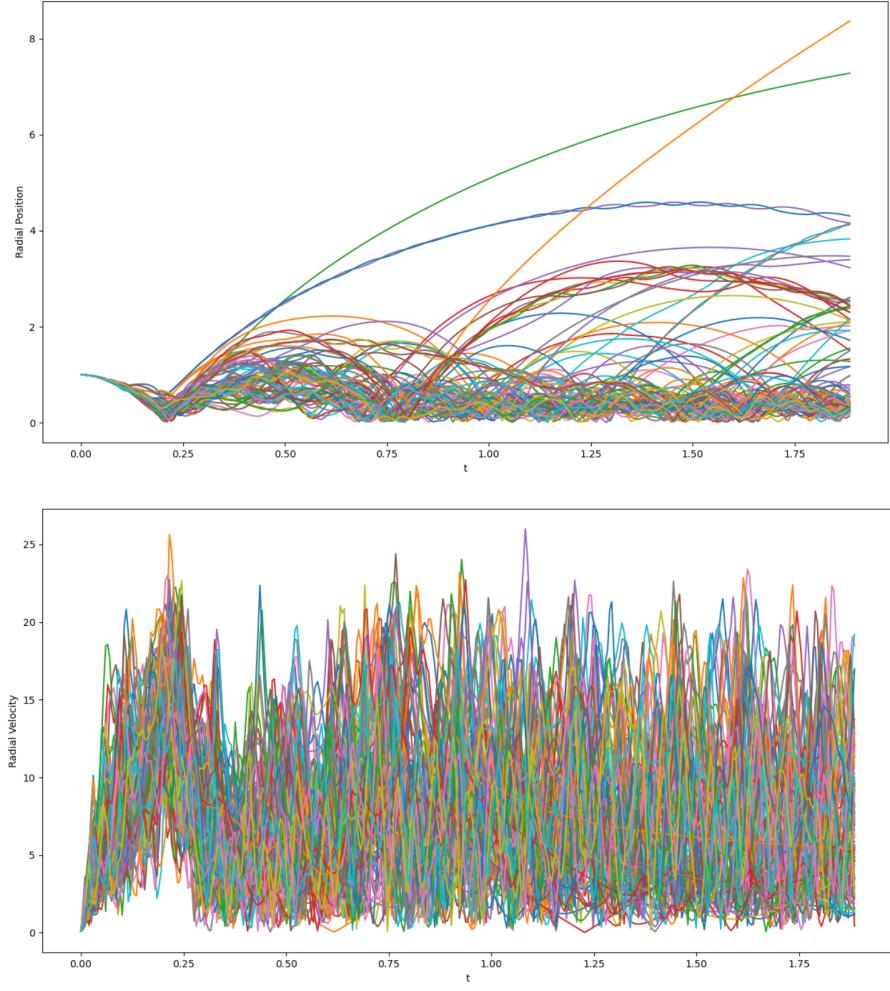
We test the N-body simulation on the 3-body figure 8 orbit with initial conditions specified in the previous lab. The following is the output:



1.2 100 Body Simulation: $v_0 = 0.1$

1.2.1 Distributed on ring

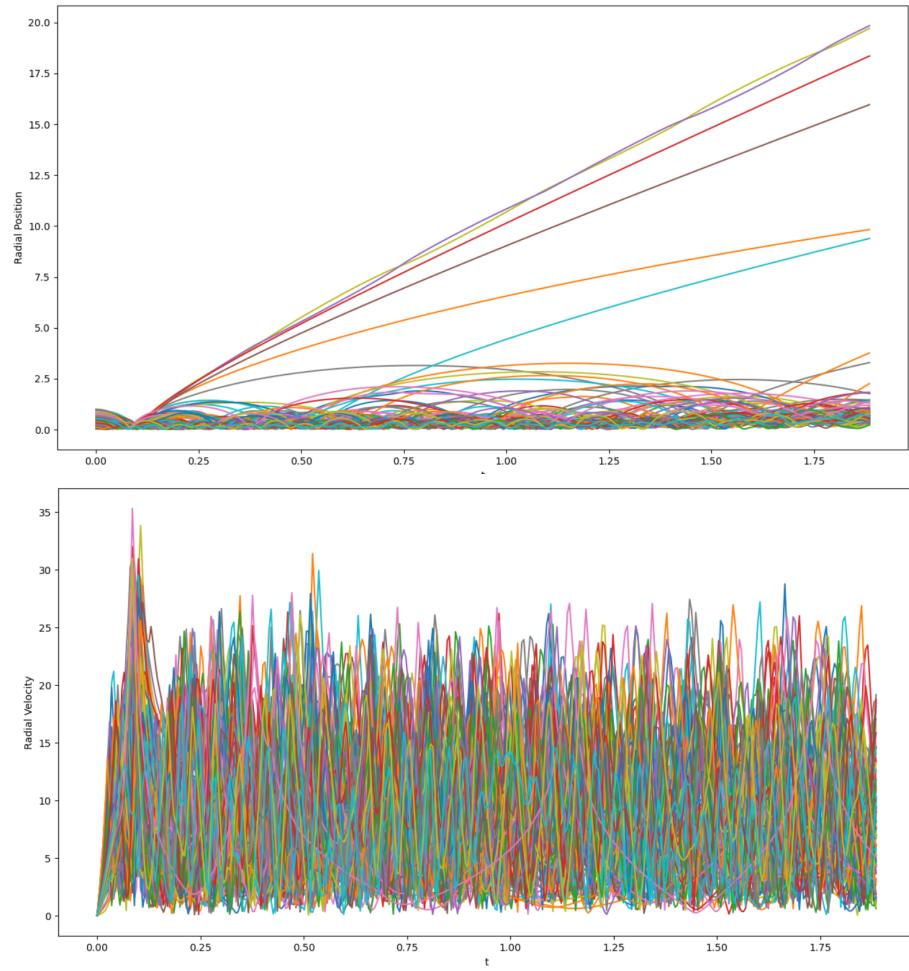
We run the simulation for $N = 100$ with unit masses and unit G spread randomly across the unit circle in the x-y plane. Initial velocities were given random directions with magnitude $v_0 = 0.1$, and the simulation was run for $3t_{orb}$ with $\Delta t = 0.005$. The other parameters used were specified in the lab notes. The radial position and radial velocity versus time plots are shown below.



1.2.2 Distributed within ring

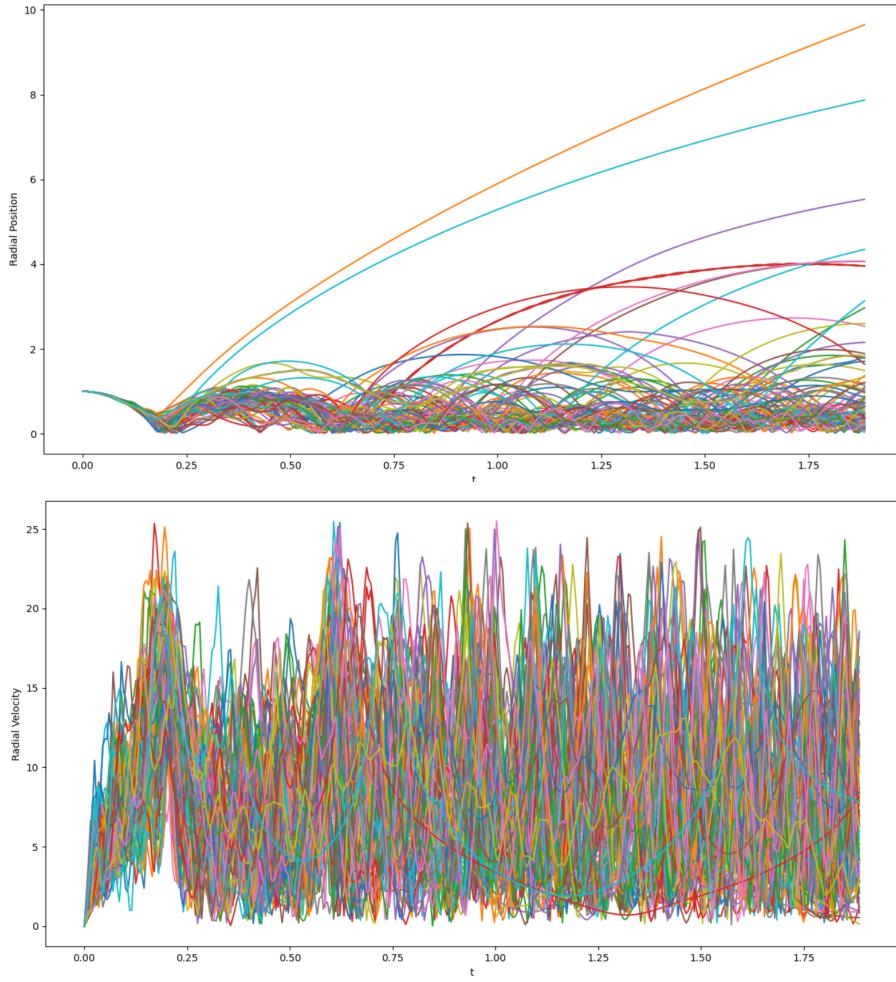
Below are the same plots but with the initial conditions modified so that the particles are randomly distributed within the ring of radius 1. The initial ve-

locities were modified so that they were 1 order of magnitude lower than their initial radial distance.



1.3 100 Body Simulation: $v_0 = 0$

We run the simulation with the same exact parameters and randomly generated positions on the unit circle, except now with zero initial velocity. We notice more clustering around the center of mass. The following are the radial position and radial velocity versus time plots.



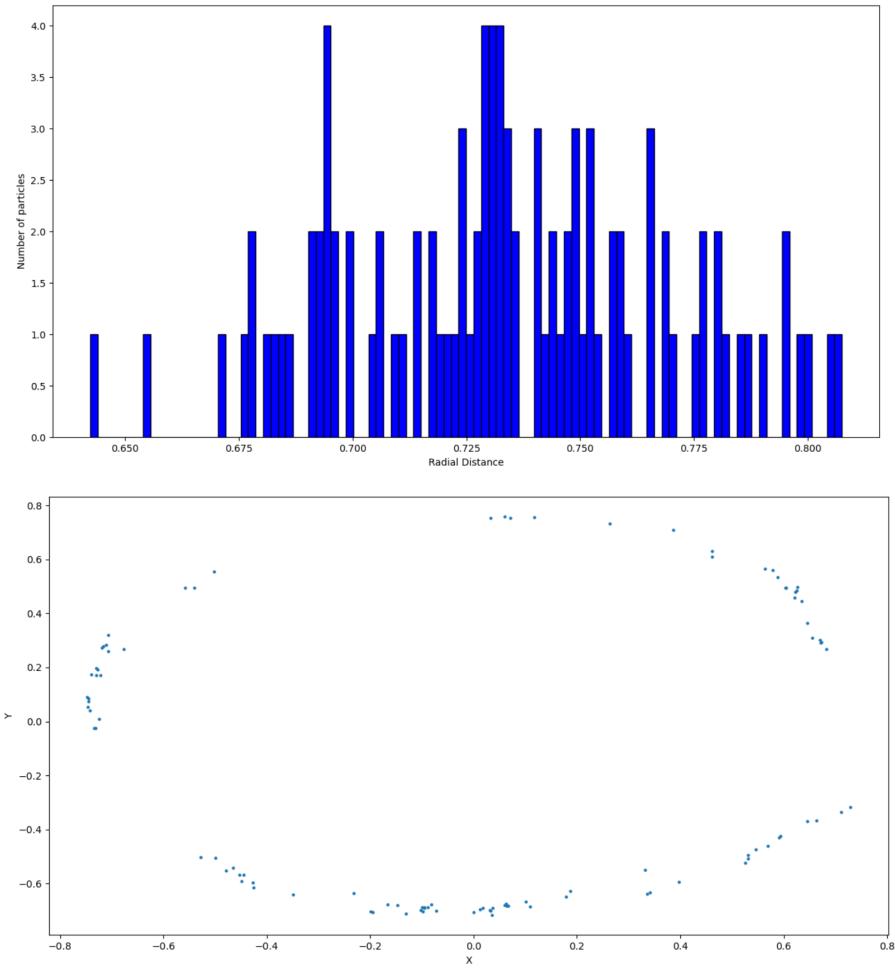
1.4 100-Body Simulation: Radial Distribution and Scatter Plots

1.4.1 Distributed on ring

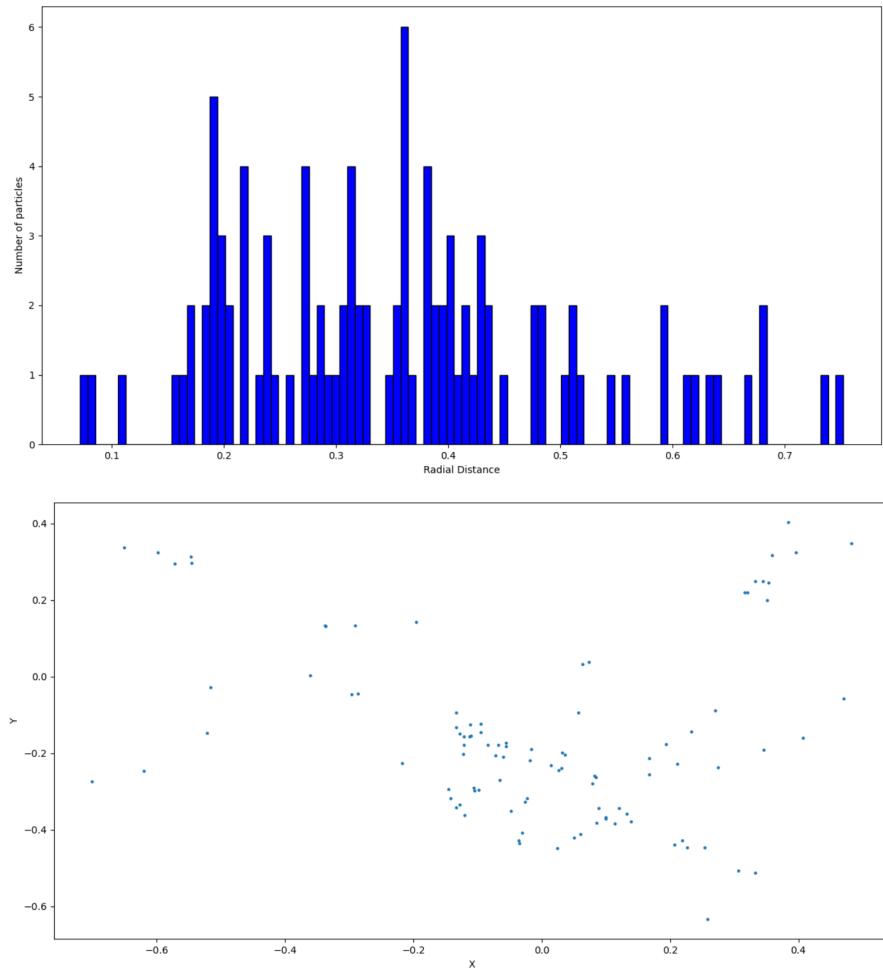
Below are plots of the distribution of radial position and plots of position in x-y plane for the bodies at times $\frac{1}{2}t_{relax}$, t_{relax} , $\frac{3}{2}t_{relax}$, $2t_{relax}$, where

$$t_{relax} \equiv \frac{N}{10 \log(N)} \sqrt{\frac{R^3}{GM}} \approx 0.217$$

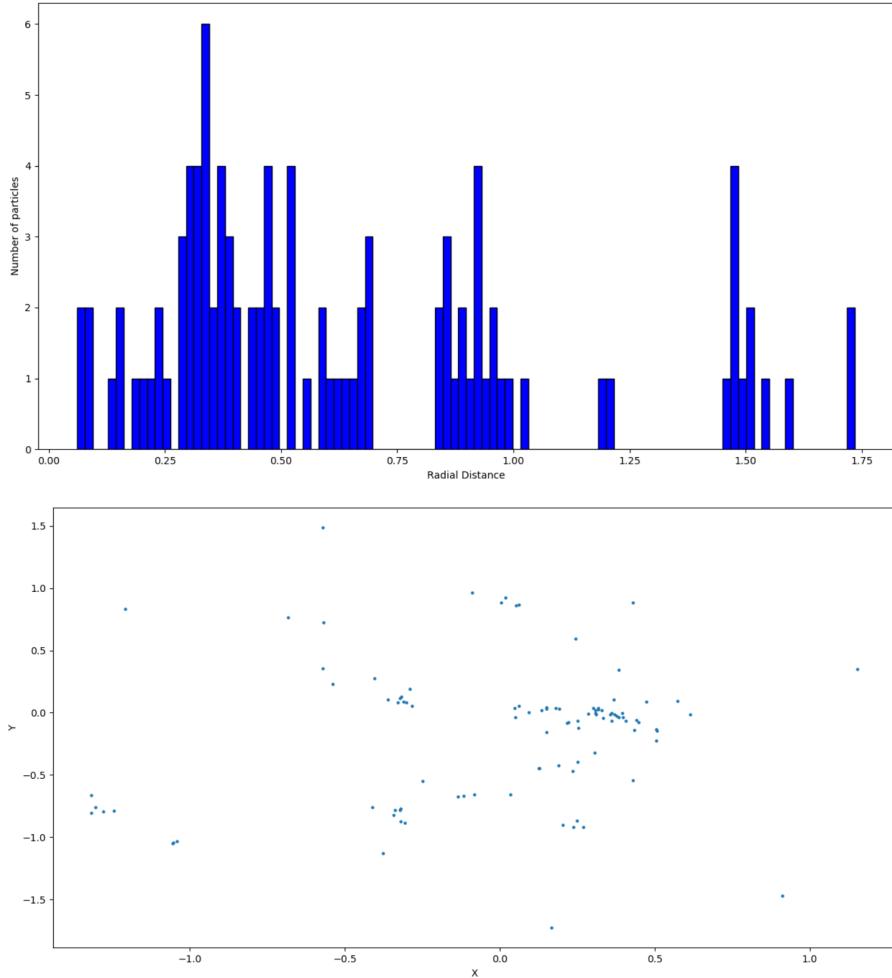
$$t = \frac{1}{2}t_{relax}$$



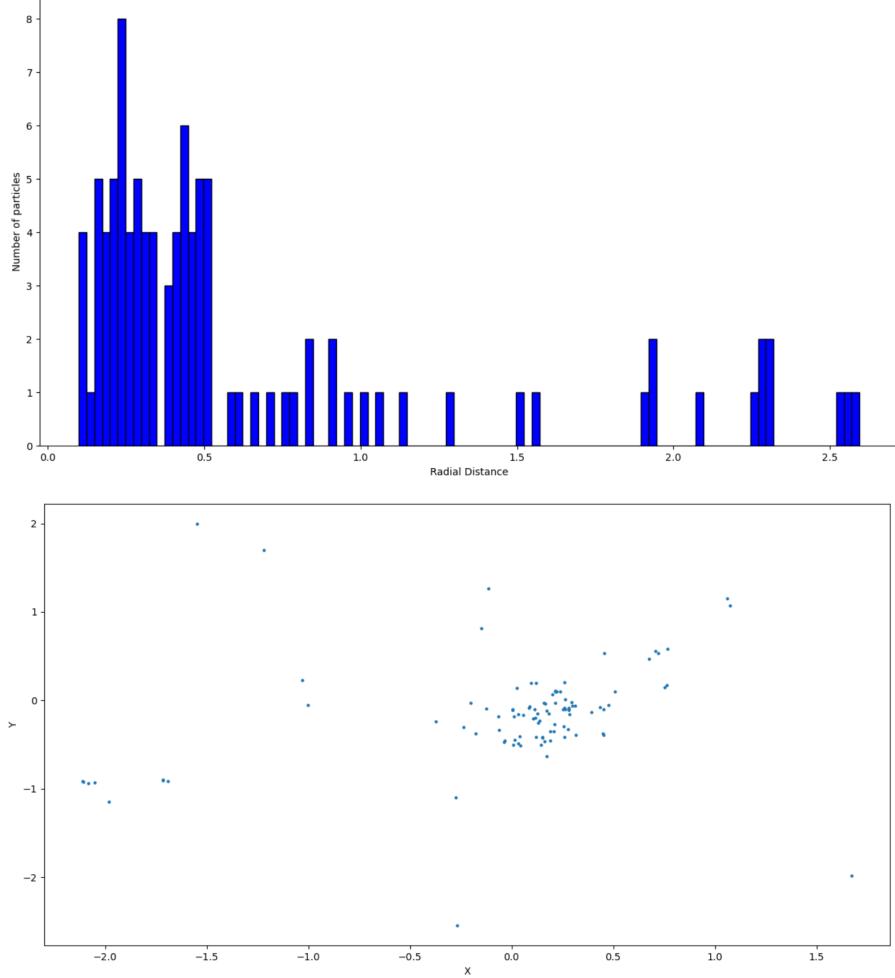
$t = t_{relax}$



$$t = \frac{3}{2} t_{relax}$$



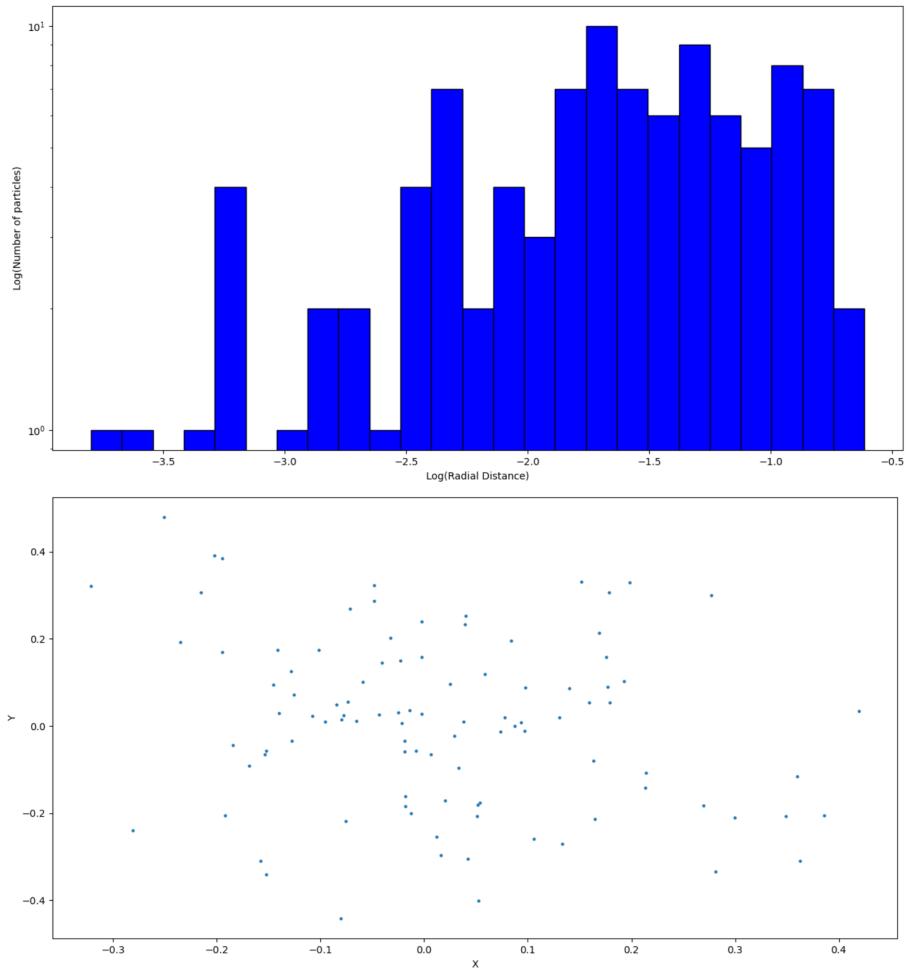
$$t = 2t_{relax}$$



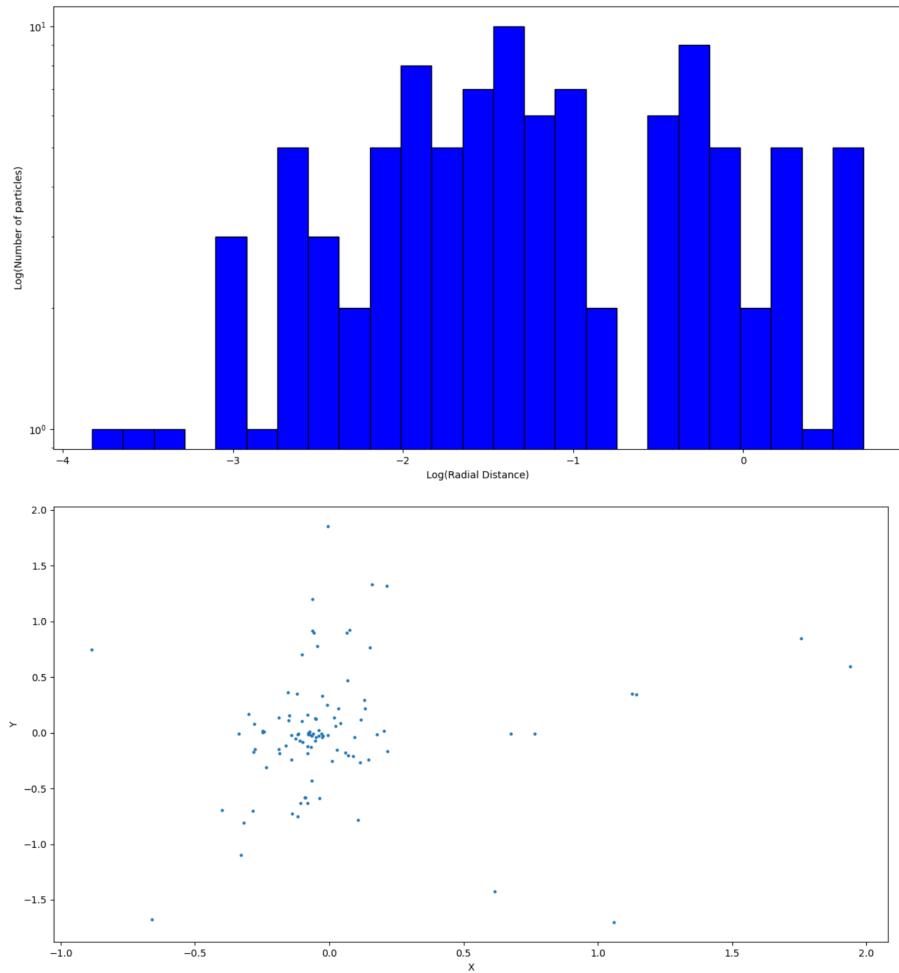
1.4.2 Distributed within ring

Below are the same plots but with the initial conditions modified so that the particles are randomly distributed within the ring of radius 1. The initial velocities were modified so that they were 1 order of magnitude lower than their initial radial distance. The radial distributions are now plotted in log-log.

$$t = \frac{1}{2}t_{relax}$$



$t = t_{relax}$



$$t = \frac{3}{2} t_{relax}$$

