N-body simulations with Gadget-2

Simulation of large scale structure

Fourth report

Pálfi Mária

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Scientific Modelling Computer Lab

1 Introduction

Gadget-2 is a freely available code for cosmological simulations [1]. I have read this name several times in scientific papers, and it is marginally connected to my research, so I would like to understand it and see how it works. I hope, this will help me when I use similar codes and packages.

Before this week I have already installed Gadget-2, the Gadgetviewer and made videos about the collision of galaxies, then I installed packages that can generate initial conditions for the large scale structure simulation: N-GenIC and 2LPTic. These are detailed in the previous reports. Last week I started the large scale structure simulation, and I could generate a glass and initial condition from this glass with N-GenIC.

In this report I describe my progress in this week. In section 2 I tell what was wrong with running of the simulation last week. Section 3 describes the installation of the pygadgetreader I used to read the snapshots to Python. Section 4 contains the visualization of the simulation. I summarize my work in section 5.

2 Simulation of large scale structure

In cosmology the study of large scale structures is a very important task. The simulations can be compared with the observations, thus we can give the cosmological parameters. The Gadget can help with these simulations [2].

In the previous weeks I installed two initial condition generator: the first order N-GenIC based on Zeldovich approximation [3] and the second order 2LPTic Lagrangian Perturbation Theory [4] and made a glass with Gadget-2. The glass can satisfy the cosmological principles, the isotropy and the homogenity, which is essential in cosmological simulations. There are some (dark matter) particle, when we make glass, we turn on an anti-gravity. If we made the initial condition from a grid, the isotropy would not be true.

After that I created initial condition from this glass with N-GenIC. Then I tried to start a cosmological simulation with Gadget, but it did not work then. The mistake was that the boxsize parameter was not the same in the parameterfile creating the initial conditions (*ics.param*) and the parameterfile of the Gadget-2 simulation (*lss2.param*).

I set the following parameters in the parameterfile of Gadget-2:

- TimeBegin 0.0008975124
- TimeMax 1.0
- BoxSize 150000.0

and in the parameterfile of the initial condition generator:

- Nmesh 100
- Nsample 100
- Box 150000.0
- TileFac 2
- Redshift 1000

I did not change the other parameters. The result is shown in Figure 1 visualized by Gadgetviewer. I also made a video from the saved snapshots with the help of an online video maker [5]. I uploaded it to the github repository I made for this course [6].

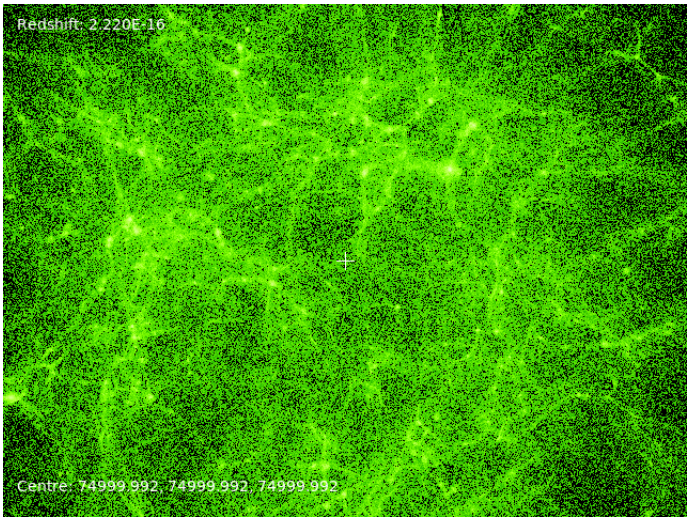

Figure 1: The result of the large scale structure simulation visualised by Gadgetviewer.

3 Pygadgetreader

To make nicer plots with Python I installed pygadgetreader according to [7].

I note here that I could not use the functions of this package with

```
from pygadgetreader import *
```

which was advises in the readme.md file, but using

```
from pygadgetreader import readgadget as gr
```

4 Visualisation

In this section I would like to include some plots I made with matplotlib.pyplot and mpl_toolkits.mplot3d.

First I saved the positions of the dark matter particles from the last snapshot with gr.readsnap(), then I made a 3D plot about the result (Figure 2), but in this case we cannot see well the structure because it is projected in 2D. I also plotted the y-positions as the function of x-positions of the large scale structure (Figure 3), but here again we might see the different depths in the same plane. Therefore I would like to create pictures from a given 'z' depth (a slice of the snapshot) in the next week.

I would like to compare the initial conditions and the glass, so I plotted to one picture them. In Figure 4 one can see that the glass is smaller than the initial condition, so I plotted to another picture the region where we can compare them (Figure 5).

5 Discussion, following steps

In this week I could run the large scale structure simulation and made some plots with the help of the pygadgetreader.

In the next week I would like to make some nicer plots, and plots about a given slice of the resulted snapshot and compare it with some observational result.

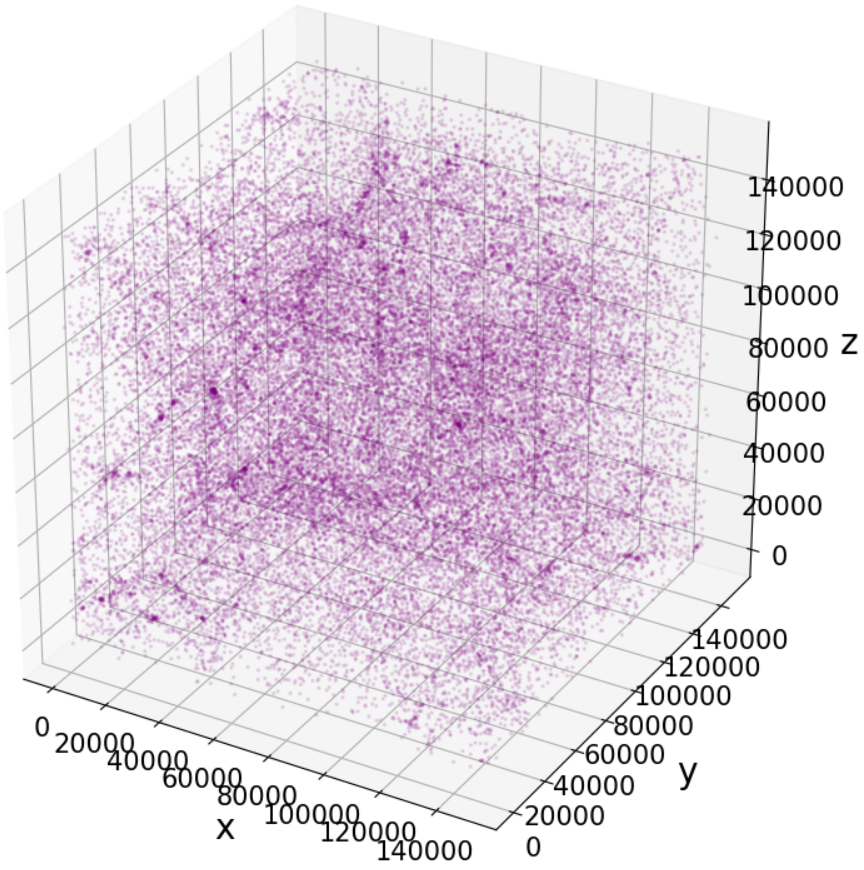

Figure 2: A 3D plot about the large scale structure. I plotted here every 200th particle.

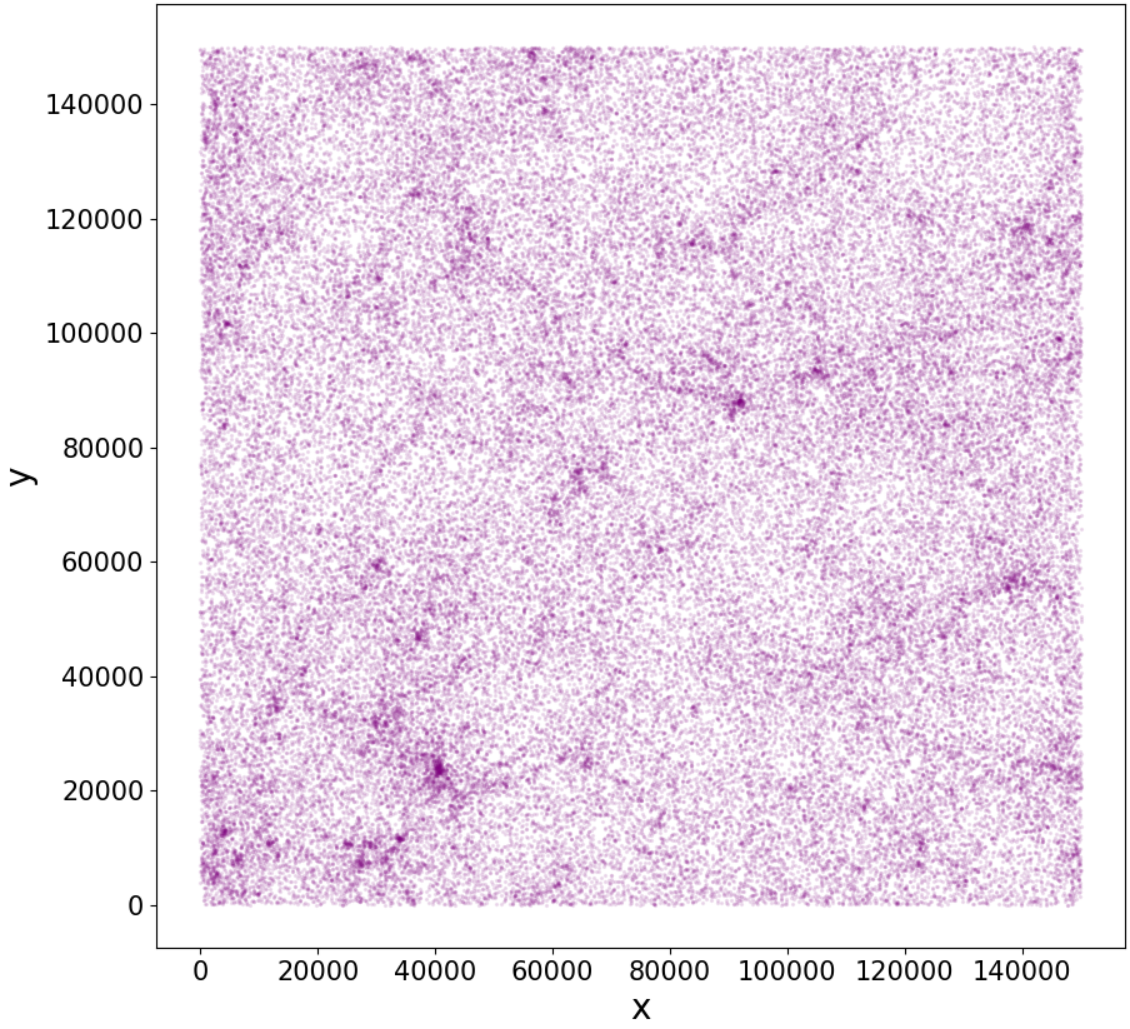

Figure 3: A 2D plot about the large scale structure. I plotted here every 100th particle.

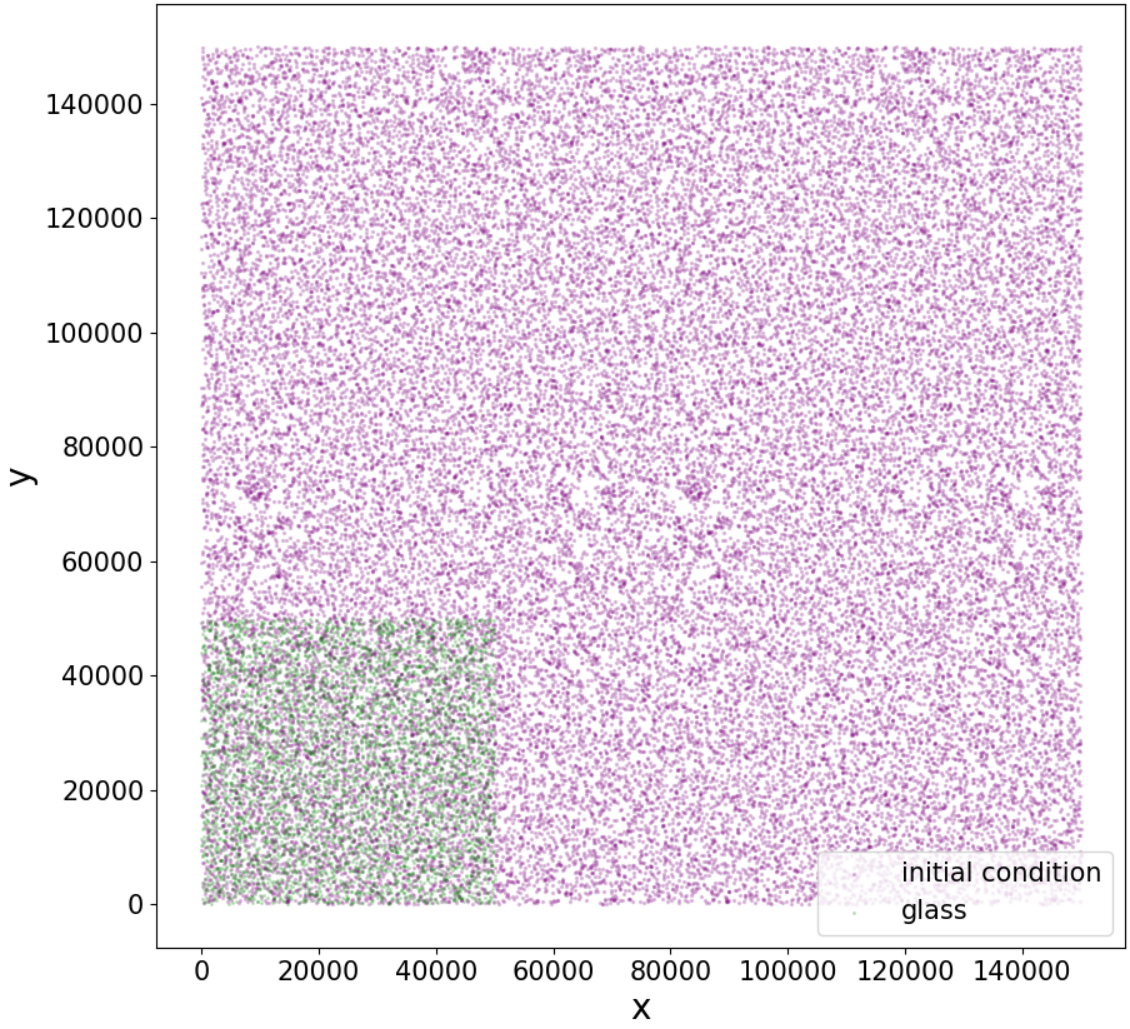

Figure 4: The position of the particles in the glass (green dots) and in the initial condition (purple dots). I plotted here every 200th particle.

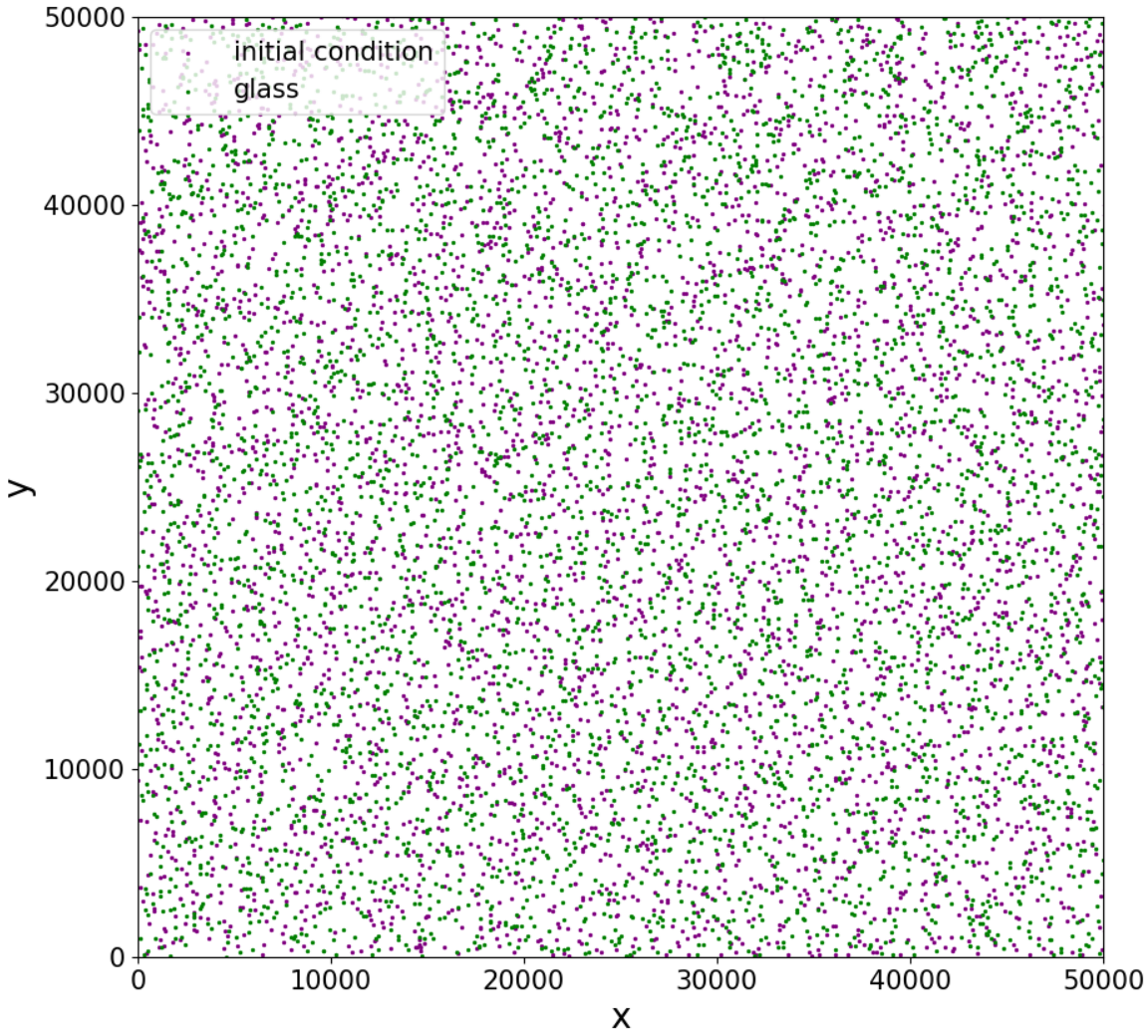

Figure 5: The position of the particles in the glass (green dots) and in the initial condition (purple dots) plotted in the region where we can compare them. I plotted here every 200th particle.

References

[1] https://wwwmpa.mpa-garching.mpg.de/gadget/

[2] https://wwwmpa.mpa-garching.mpg.de/galform/millennium/

[3] Springel, V., White, S. D. M., Jenkins, A., Frenk, C. S., et al. 2005, Nature 435, 629–636

[4] Crocce, M., Pueblas, S., Scoccimarro R., 2006, MNRAS 373, 369–381

[5] https://ezgif.com/apng-maker

[6] https://github.com/MariaPalfi/Scientific-modelling-lab/blob/master/lss_evol.gif

[7] https://bitbucket.org/rthompson/pygadgetreader/src/default/