N-body simulations with Gadget-2

Installation of Gadget-2

First report

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1 Introduction

Gadget-2 is a smoothed particle hydrodynamics (or SPH) code, frequently used in astrophyscics and hidrodynamical simulations. [1] I have read this name several times in scientific papers, and it is marginally connected to my research. During my project I am going to run some N body simulation related to astrophysics and cosmology, e.g. collision of galaxies, large scale structure of the Universe, non-Newtonian gravitation.

In this report I describe how I installed the Gadget-2 and tried to run a simple program in the previous days.

2 Task

For the first some day my task was to download and to install the gadget-2 code, then running a test program according to the website [2].

3 Solution and results

3.1 Installation

I downloaded the necessary .tar.gz packages for the

- GNU Scientific Library (GSL),
- fast Fourier transform (FFTW),
- and the Gadget 2.0.7.

Then I unpacked and installed them according to [2]. I had to have a Massage Passing Interface (MPI) library. I downloaded mpich-3.3.2 (stable release) from [3] and installed by following the steps of its installation guide [4]. Here I note, that the test commands like

```
mpiexec -f machinefile -n <number> hostname
```

do not work, because the option -f does not exist. The checking if the MPI works is shown on picture 1, where I ran an example code which calculate the value of pi.

My directory containing all the packages needed to run Gadget-2 is shown on picture 2.

```
marika@Otletesgep:~/Gadget$ mpiexec -n 4 ./mpich-3.3.2/examples/cpi
Process 0 of 4 is on Otletesgep
Process 2 of 4 is on Otletesgep
Process 3 of 4 is on Otletesgep
Process 1 of 4 is on Otletesgep
pi is approximately 3.1415926544231239, Error is 0.0000000008333307
wall clock time = 0.000269
marika@Otletesgep:~/Gadget$
```

Figure 1: Test running: calculation of pi.

```
marika@Otletesgep:~/Gadget$ ls
fftw-2.1.5          gadgetviewer-1.0.10      gtk+-2.0.0          mpich-install
fftw-2.1.5.tar      gadgetviewer-1.0.10.tar  gtk+-2.0.0.tar.gz
Gadget-2.0.7        gsl-1.9                  mpich-3.3.2
gadget-2.0.7.tar    gsl-1.9.tar              mpich-3.3.2.tar.gz
marika@Otletesgep:~/Gadget$
```

Figure 2: Gadget directory. gtk+ and gadgetviewer is necessary for seeing the results of the test run (see section 4).

3.2 Running the first program

Then I have tried to run the galaxy collision test according to [2]. I made the *galaxy* directory and gave the directory path in *galaxy.param*. The command

```
mpirun -np 2 ./Gadget2 ./parameterfiles/galaxy.param
```

and the output are shown on picture 3 and 4. It can be seen that my installations were successful, the test program runs in order.

After that I would like to see the results of the program, so I looked into the *galaxy* directory which is shown in picture 5.

4 Discussion, following steps

To sum up my installation and test program running was successful, but I did not yet make a video like at [2]. I find gadgetviewer [5] to see the snapshots, but I have not installed yet correctly. So the next week I would like to see the snapshots, make the video about the galaxy collision and start a new task if I will have enough time.

```
marika@Otletesgep:~/Gadget/Gadget-2.0.7/Gadget2$ mpirun -np 2 ./Gadget2 ./parameterfiles/galaxy.param

This is Gadget, version `2.0'.

Running on 2 processors.

Allocated 25 MByte communication buffer per processor.

Communication buffer has room for 504122 particles in gravity computation
Communication buffer has room for 204800 particles in density computation
Communication buffer has room for 163840 particles in hydro computation
Communication buffer has room for 163840 particles in domain decomposition


Hubble (internal units) = 0.1
G (internal units) = 43007.1
UnitMass_in_g = 1.989e+43
UnitTime_in_s = 3.08568e+16
UnitVelocity_in_cm_per_s = 100000
UnitDensity_in_cgs = 6.76991e-22
UnitEnergy_in_cgs = 1.989e+53


Allocated 2.91824 MByte for particle storage. 68


reading file `/home/marika/Gadget/Gadget-2.0.7/ICs/galaxy_littleendian.dat' on task=0 (contains 60000 particles.)
distributing this file to tasks 0-1
Type 0 (gas):          0  (tot=     0000000000) masstab=0
Type 1 (halo):     40000  (tot=     0000040000) masstab=0.00104634
Type 2 (disk):     20000  (tot=     0000020000) masstab=0.00023252
Type 3 (bulge):        0  (tot=     0000000000) masstab=0
Type 4 (stars):        0  (tot=     0000000000) masstab=0
Type 5 (bndry):        0  (tot=     0000000000) masstab=0

reading done.
Total number of particles :  0000060000

allocated 0.0762939 Mbyte for ngb search.

Allocated 3.30359 MByte for BH-tree. 64
```

Figure 3: Running the galaxy collision test command.

```
Begin Step 2018, Time: 2.99854, Systemstep: 0.00146484
domain decomposition...
NTopleaves= 260
work-load balance=1.28243   memory-balance=1.4686
exchange of 0000000141 particles
domain decomposition done.
begin Peano-Hilbert order...
Peano-Hilbert done.
Start force computation...
Tree construction.
Tree construction done.
Begin tree force.
tree is done.
force computation done.

writing snapshot file...
done with snapshot.

There is no valid time for a further snapshot file.

Begin Step 2019, Time: 3, Systemstep: 0.00146484
domain decomposition...
NTopleaves= 260
work-load balance=1.28136   memory-balance=1.46837
exchange of 0000000181 particles
domain decomposition done.
begin Peano-Hilbert order...
Peano-Hilbert done.
Start force computation...
Tree construction.
Tree construction done.
Begin tree force.
tree is done.
force computation done.

writing snapshot file...
done with snapshot.
```

Figure 4: The end of the output of running the galaxy collision.

```
marika@Otletesgep:~/Gadget/Gadget-2.0.7/Gadget2/galaxy$ l
cpu.txt                 restart.0      snapshot_000  snapshot_004  timings.txt
energy.txt              restart.0.bak  snapshot_001  snapshot_005
info.txt                restart.1      snapshot_002  snapshot_006
parameters-usedvalues   restart.1.bak  snapshot_003  snapshot_007
marika@Otletesgep:~/Gadget/Gadget-2.0.7/Gadget2/galaxy$
```

Figure 5: The *galaxy* directory with the resulted files.

References

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

[2] https://astrobites.org/2011/04/02/installing-and-running-gadget-2/

[3] https://www.mpich.org/downloads/

[4] https://www.mpich.org/static/downloads/3.3.2/mpich-3.3.2-installguide.pdf

[5] https://github.com/jchelly/gadgetviewer