Main differences from the original source files

par_ini.d

```
##########################################################
##   parameters for COSMOS code          ##########
##   ver1.00 by Chulmoon Yoo             ##########
##########################################################
999999          # maximum step of the main loop
400.            # maximum time to evolve
3               # tab number of the bufer grids
10.             # amp
-60             # minimum grid number of x =-nmax-1
60              # maximum grid number of x =imax/2-1
0               # minimum grid number of y
60              # maximum grid number of y
0               # minimum grid number of z
60              # maximum grid number of z
-1.             # minimum coordinate of x
1.              # maximum coordinate of x
0.              # minimum coordinate of y
1.              # maximum coordinate of y
0.              # minimum coordinate of z
1.              # maximum coordinate of z
```

```
##########################################################
##   parameters for COSMOS code          #########
##   ver1.00 by Chulmoon Yoo             #########
##########################################################
999999          # maximum step of the main loop
0.25            # maximum time to evolve
3               # tab number of the bufer grids
0.              # amp
-40             # minimum grid number of x =-nmax-1
40              # maximum grid number of x =imax/2-1
0               # minimum grid number of y
40              # maximum grid number of y
0               # minimum grid number of z
40              # maximum grid number of z
-1.             # minimum coordinate of x
1.              # maximum coordinate of x
0.              # minimum coordinate of y
1.              # maximum coordinate of y
0.              # minimum coordinate of z
1.              # maximum coordinate of z
```

finish time

scale-up coordinate
is not used 10. → 0.

number of grids 60 → 40

par_ini.d

```
33  ###################################################
34  ###  initial data parameter
35  ###################################################
36  0                   # 0:no continue 1:continue
37  ini_all.dat         # continue file
38  0.50                # amplitude
39  10.                 # wave number
40  10.                 # xi2 nonsphericity parameter 1
41  0.                  # xi3 nonsphericity parameter 2
42  0.                  # w3  alignment angle
43  0.                  # amplitude for the scalar field
44  10.                 # wave number for the scalar field
45  15.                 # xi2s
46  0.                  # xi3s
47  50.0                # Hubble
```

```
33  ###################################################
34  ###  initial data parameter
35  ###################################################
36  0                   # 0:no continue 1:continue
37  ini_all.dat         # continue file
38  0.01                # amplitude
39  10.                 # wave number
40  10.                 # xi2 nonsphericity parameter 1
41  0.                  # xi3 nonsphericity parameter 2
42  0.                  # w3  alignment angle
43  0.                  # amplitude for the scalar field
44  10.                 # wave number for the scalar field
45  15.                 # xi2s
46  0.                  # xi3s
47  2.0                 # Hubble
```

initial amplitude for the perturbation

not used in sample_pert

initial Hubble parameter = 2/L

```
57  ###################################################
58  ###  parameters for output
59  ###################################################
60  0.5             #1st part print interval boundary time
61  0.5             #2nd part
62  100.            #changing time for print interval
```

```
57  ###################################################
58  ###  parameters for output
59  ###################################################
60  0.25            #1st part print interval boundary time
61  0.5             #2nd part
62  100.            #changing time for print interval
```

output interval setting

cosmos.cpp

```
267    //setting for bools start
268    fld=true;                    // fluid evolution -> true/false
269    scl=true;                    // scalar evolution -> true/false
270    cuev=true;                   // curvature evaluation -> true/false
```

```
381    else
382    {
383        cout << "no continue" << endl;
384
385        //initial data setting start
386        //fmv->set_initial_scalar(mus,kks,xi2s,xi3s);
387        //#pragma omp barrier
388        fmv->initial_nonsph(mu,kk,xi2,xi3,xi2s,xi3s,w3);
389        // fmv->initial(mu);
390        #pragma omp barrier
391        printpack(fmv0,ln,pk,pl,filex,filey,filez,filex0z,filexy0);
392        //initial data setting end
393
394        //printpack(fmv0,ln,pk,pl,filex,filey,filez,filex0z,filexy0);
395    }
396    //reading continue or setting initial date end
```

```
267    //setting for bools start
268    fld=true;                    // fluid evolution -> true/false
269    scl=false;                   // scalar evolution -> true/false
270    cuev=false;                  // curvature evaluation -> true/false
```

no scalar field and curvature calculation

```
383        cout << "no continue" << endl;
384
385        //initial data setting start
386        //fmv->set_initial_scalar(mus,kks,xi2s,xi3s);
387        //#pragma omp barrier
388        //fmv->initial_nonsph(mu,kk,xi2,xi3,xi2s,xi3s,w3);
389        fmv->initial(mu);
390        #pragma omp barrier
391        printpack(fmv0,ln,pk,pl,filex,filey,filez,filex0z,filexy0);
392        //initial data setting end
393
394        //printpack(fmv0,ln,pk,pl,filex,filey,filez,filex0z,filexy0);
395    }
396    //reading continue or setting initial date end
```

initial data setting function changed

cosmos_initial_pert.cpp

initial data setting function “void initial(double mu)”
is defined in cosmos_initial_pert.cpp

cosmos_bssn.cpp

```
1602        ////////////////////////////
1603        // Gauge
1604        ////////////////////////////
1605
1606        //modified 1+log
1607        falpha=-etaa*(ek_p+2./(1.+fluidw)/tt)*alpha_p;
1608
1609        //synchronous
1610        //falpha=0.;
1611
1612        //modified harmonic
1613        //falpha=-(ek_p-get_bv(lui,kui,jui,20))*pow(al
1614
1615        //Gamma driver
1616        fbx=etabb*get_bv(l,k,j,4);
1617        fby=etabb*get_bv(l,k,j,5);
1618        fbz=etabb*get_bv(l,k,j,6);
1619
1620        //fbbx=fzgx -etab*get_bv(l,k,j,4);
1621        //fbby=fzgy -etab*get_bv(l,k,j,5);
1622        //fbbz=fzgz -etab*get_bv(l,k,j,6);
1623
1624        //for Lattice Uni
1625        fbbx=fzgx -2./(1.+fluidw)/tt*get_bv(l,k,j,4);
1626        fbby=fzgy -2./(1.+fluidw)/tt*get_bv(l,k,j,5);
1627        fbbz=fzgz -2./(1.+fluidw)/tt*get_bv(l,k,j,6);
1628
1629        //zero shift gauge
1630        //fbx=0.;
1631        //fby=0.;
1632        //fbz=0.;
1633        //fbbx=0.;
1634        //fbby=0.;
1635        //fbbz=0.;
```

gauge condition changed
to the synchronous gauge

```
1608
1609        //synchronous
1610        falpha=0.;
1611
1612        //modified harmonic
1613        //falpha=-(ek_p-get_bv(lui,kui,jui,20))*pow(alpha
1614
1615        //Gamma driver
1616        // fbx=etabb*get_bv(l,k,j,4);
1617        // fby=etabb*get_bv(l,k,j,5);
1618        // fbz=etabb*get_bv(l,k,j,6);
1619
1620        //fbbx=fzgx -etab*get_bv(l,k,j,4);
1621        //fbby=fzgy -etab*get_bv(l,k,j,5);
1622        //fbbz=fzgz -etab*get_bv(l,k,j,6);
1623
1624        //for Lattice Uni
1625        // fbbx=fzgx -2./(1.+fluidw)/tt*get_bv(l,k,j,4);
1626        // fbby=fzgy -2./(1.+fluidw)/tt*get_bv(l,k,j,5);
1627        // fbbz=fzgz -2./(1.+fluidw)/tt*get_bv(l,k,j,6);
1628
1629        //zero shift gauge
1630        fbx=0.;
1631        fby=0.;
1632        fbz=0.;
1633        fbbx=0.;
1634        fbby=0.;
1635        fbbz=0.;
```

makefile

```
33  # source file
34  SRC = $(PROG).cpp cosmos_bssn.cpp cosmos_initial.cpp cosmos_output.cpp cosmos_boundary.cpp cosmos_ahf.cpp cosmos_ipol.cpp
    cosmos_fluid.cpp cosmos_fmr.cpp
35  OBJS = $(SRC:%.$(LANG)=%.o)
```

```
36  # source file
37  SRC = $(PROG).cpp cosmos_bssn.cpp ../cosmos_initial.cpp cosmos_initial_pert.cpp ../cosmos_output.cpp ../cosmos_boundary.
    cpp ../cosmos_ahf.cpp ../cosmos_ipol.cpp ../cosmos_fluid.cpp ../cosmos_fmr.cpp
38  OBJS = $(SRC:%.$(LANG)=%.o)
```

- cosmos.cpp and cosmos_bssn.cpp is used instead of the original ../cosmos.cpp and ../cosmos_bssn.cpp

- cosmos_initial_pert.cpp is added to the list