MUSIC, iSS and UrQMD

Running hydro with MUSIC and late stages with iSS and UrQMD

Overview

Prepare MUSIC input

Running MUSIC

Piping MUSIC output to iSS

Converting iSS output to UrQMD

Hadron scattering with UrQMD

Overview

Prepare MUSIC input

Running MUSIC

Piping MUSIC output to iSS

Converting iSS output to UrQMD

Hadron scattering with UrQMD

Prepare MUSIC input

- Create an empty folder, e.g. music_run
- Create symbolic links (assuming the repo is cloned at your home)
  - `ln -s $HOME/hadrex-workshop-2021/sources/MUSIC/EOS music_run/EOS`
  - `ln -s $HOME/hadrex-workshop-2021/sources/MUSIC/tables music_run/tables`
- Create music input file
  - Copy from `<test_run_path>/music/event0/music_input`

Prepare MUSIC input

- Hydro simulations only
- Read Kompost IC
- Multiplicative IC factor
- Choose EOS
- Enable viscosity
- Enable shear viscosity
- Enable bulk viscosity

```
#Default parameters
mode 2
Initial_profile 9
s_factor 1.0

#Physics parameters
EOS_to_use 7
Viscosity_Flag_Yes_1_No_0 1
Include_Shear_Visc_Yes_1_No_0 1
Include_Bulk_Visc_Yes_1_No_0 1
Include_deltaf_bulk 1
T_dependent_Shear_to_S_ratio 1
Include_second_order_terms 1
Include_Rhob_Yes_1_No_0 0
use_eps_for_freeze_out 0
T_freeze 0.151

#Discretization parameters
boost_invariant 1
Delta_Tau 0.005
Y_grid_size_in_fm 28.0
X_grid_size_in_fm 28.0
Grid_size_in_y 280.0
Grid_size_in_x 280.0

#Output
output_evolution_data 0
output_evolution_every_N_timesteps 10

#Output
outputBinaryEvolution 1

#Misc parameters
Initial_time_tau_0 1.2
Initial_Distribution_input_filename /Path/to/IC.dat
EndOfData
```

Prepare MUSIC input

- Temperature dependant shear viscosity
- Include second order terms in hydrodynamics
- Choose freeze out based on energy or temperature
- Freeze out temperature
- Enable boost invariance (2D hydro)

```
#Default parameters
mode 2
Initial_profile 9
s_factor 1.0

#Physics parameters
EOS_to_use 7
Viscosity_Flag_Yes_1_No_0 1
Include_Shear_Visc_Yes_1_No_0 1
Include_Bulk_Visc_Yes_1_No_0 1
Include_deltaf_bulk 1
T_dependent_Shear_to_S_ratio 1
Include_second_order_terms 1
Include_Rhob_Yes_1_No_0 0
use_eps_for_freeze_out 0
T_freeze 0.151

#Discretization parameters
boost_invariant 1
Delta_Tau 0.005
Y_grid_size_in_fm 28.0
X_grid_size_in_fm 28.0
Grid_size_in_y 280.0
Grid_size_in_x 280.0

#Output
output_evolution_data 0
output_evolution_every_N_timesteps 10

#Output
outputBinaryEvolution 1

#Misc parameters
Initial_time_tau_0 1.2
Initial_Distribution_input_filename /Path/to/IC.dat
EndOfData
```

Prepare MUSIC input

Grid discretization setup

Setup of full evolution

Initial time of hydrodynamic evolution

Path to initial condition

Mandatory marker of end of parameters

```
#Default parameters
mode 2
Initial_profile 9
s_factor 1.0

#Physics parameters
EOS_to_use 7
Viscosity_Flag_Yes_1_No_0 1
Include_Shear_Visc_Yes_1_No_0 1
Include_Bulk_Visc_Yes_1_No_0 1
Include_deltaf_bulk 1
T_dependent_Shear_to_S_ratio 1
Include_second_order_terms 1
Include_Rhob_Yes_1_No_0 0
use_eps_for_freeze_out 0
T_freeze 0.151

#Discretization parameters
boost_invariant 1
Delta_Tau 0.005
Y_grid_size_in_fm 28.0
X_grid_size_in_fm 28.0
Grid_size_in_y 280.0
Grid_size_in_x 280.0

#Output
output_evolution_data 0
output_evolution_every_N_timesteps 10

#Output
outputBinaryEvolution 1

Initial_time_tau_0 1.2
Initial_Distribution_input_filename /Path/to/IC.dat
EndOfData
```

Prepare MUSIC input

- Get kompost ICs
  - Copy from `<test_run_path>/kompost/event0/EnergyMomentumTensor.dat.music_init_flowNonLinear_pimunuTransverse.txt`
- Update music_input file to point to the IC

Overview

~~Prepare MUSIC input~~

Running MUSIC

Piping MUSIC output to iSS

Converting iSS output to UrQMD

Hadron scattering with UrQMD

Running MUSIC

- Choose number of cores
  - Export OMP_NUM_THREADS=4
- Run hydro
  - `mpihydro music_input`
- Wait to finish.
  - 4 cores, 3.8 GHz, WSL box, b = 14.6 fm
  - Around 1 min

Running MUSIC

- Choose number of cores
  - Export OMP_NUM_CORES=4
- Run hydro
  - `mpihydro music_input`
- Wait to finish.
  - 4 cores, 3.8 GHz, WSL box, b = 14.6 fm
  - Around 1 min
- If it complains about freeze-out hypersurface reaching boundary, your results will be wrong
  - Lower normalization
  - Increase grid size
- At the end you must have the file `surface.dat`

Overview

~~Prepare MUSIC input~~

~~Running MUSIC~~

Piping MUSIC output to iSS

Converting iSS output to UrQMD

Hadron scattering with UrQMD

Piping MUSIC output to iSS

- Create an empty folder, e.g. `iss_run`
- Create symbolic links (assuming the repo is cloned at your home)
  - `ln -s $HOME/hadrex-wokshop-2021/sources/iSS/iSS_tables iss_run/iSS_tables`
- Inside iss_run, create folder `results`
- Copy `music_input` and `surface.dat` inside it
- Create iSS input file
  - Copy from `<test_run_path>/iss/input/iss_parameters.in`

Tweaks in the iSS_parameters.dat

- Hydro mode: 1 – boost invariant, 2 – 3D
- Turn_on_bulk/rhob/diff
- Include_deltaf_shear/bulk/diffusion
- y_LB/y_RB: Boundaries in rapidity
- y_LB/y_RB
- sample_up_to_desired_particle_number
- number_of_particles_needed
- randonSeed: -1 uses system clock

- Run with `iSS.e`

Overview

~~Prepare MUSIC input~~

~~Running MUSIC~~

~~Piping MUSIC output to iSS~~

Converting iSS output to UrQMD

Hadron scattering with UrQMD

Final Particle File Format - OSC1997A

- The first two lines of a OSC1997A file must be

```
OSC1997A
final_id_p_x
```

- The name of the code, version of the code, as well as the collision system are specified in one line:

```
code_name version (aproj, zproj)+(atarg, ztarg) refframe, ebeam, ntestpart
```

- The event header contains

```
event npart bimp phi
```

  - `Event`: event number
  - `npart`: number of particles in an event
  - `bimp`: impact parameter (not used)
  - `phi`: azimuthal angle (not used)

- There are `npart` number of lines each describes one particle in the format

```
ipart, id, px, py, pz, p0, mass, x, y, z, t
```

Converters from OSCAR and to OSCAR

- Conversion to UrQMD format:
  - `osc2u.e < OSCAR.DAT`
  - Outputs a .f14 file
- You may convert to the hadrex format with oscarToHadrex
  - `oscarToHadrex [oscarFileName] [trentoFileName] [hadrexfile.root]`
- You may convert from the hadrex format with hx2osc
  - `hx2osc [hadrexfile.root] [oscarFileName]`
- **Beware:** OSCAR is an ASCII file.
  - ASCII files tends to be large.
  - It is preferable to keep event records in a binary format, such as the hadrex format we use

Overview

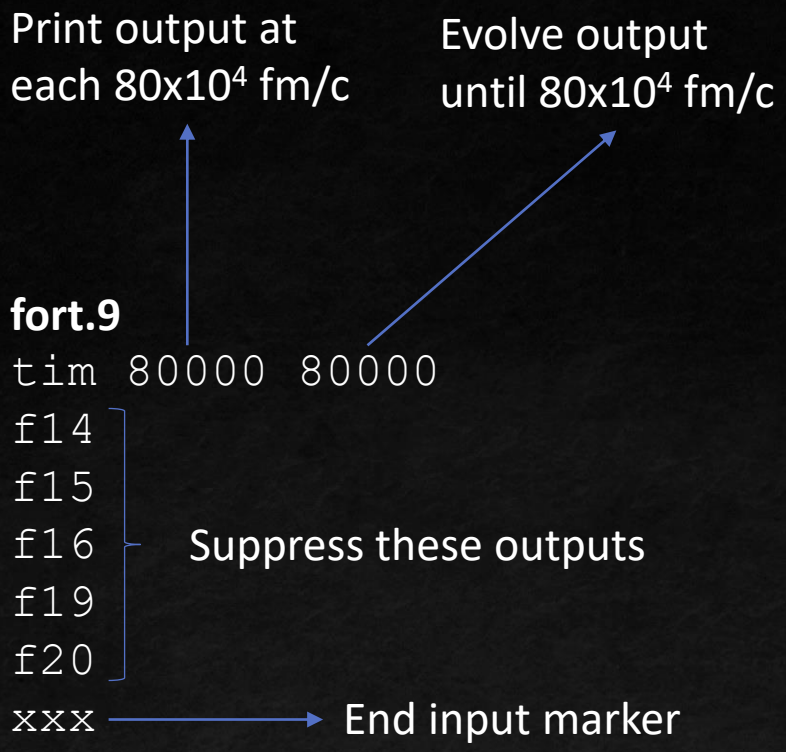
~~Prepare MUSIC input~~

~~Running MUSIC~~

~~Piping MUSIC output to iSS~~

~~Converting iSS output to UrQMD~~

Hadron scattering with UrQMD



Hadron scattering with UrQMD

- Create input file
  - For other options, see UrQMD manual
- Move fort.14 to fort.10
- Setup environment variables
  - export ftn09=fort.9
  - export ftn10=fort.10
- For decays only, set: `tim 0 0`
- Conversion to hadrex formats
  - `u2hadrex fort.13 fort.f15 <test_run_path>/trento/output/0.dat event0.root`

THANKS