Numerical Relativity 2023-2024

(bruno.giacomazzo@unimib.it)

Homework 2
(May 15 2024)

1 Sod Shock Tube Problem [max 2 pages]

Use the Einstein Toolkit to solve the Sod Riemann problem using three different resolutions. Compare with the exact solution (at least for the rest-mass density ρ) and discuss your results.

The parameter file is `notebooks/Einstein_Toolkit_Tutorials/Sod_1d.par`.

2 TOV Evolution [max 2 pages]

Use the Einstein Toolkit to study the evolution of the maximum of the rest-mass density ρ of a stable TOV solution. You can do one of the following studies:

1. use 3 different resolutions;

2. introduce a perturbation in pressure and then evolve the system with 3 different resolutions;

3. change the grid setup (domain size and/or number of refinement levels).

The parameter file is `notebooks/Einstein_Toolkit_Tutorials/TOV_example.par`.

In all cases discuss your results, focusing in particular on the evolution of the maximum of the rest-mass density.

3   Einstein Toolkit Parameters [max 4 pages]

Explain the meaning of these parameters:

1. `MoL::ODE_Method = "rk4"`

2. `GRHydro::recon_method = "ppm"`

3. `GRHydro::riemann_solver = "Marquina"`

Explain also the meaning of this block of parameters:

```
ML_BSSN::harmonicN        = 1      # 1+log
ML_BSSN::harmonicF        = 2.0    # 1+log
ML_BSSN::ShiftGammaCoeff  = 0.75   #this is 3/4
ML_BSSN::BetaDriver       = 2.66   #common choices are 1/M or 1/2M
```

Figures do not count toward the maximum number of page limit. Use an A4 page format and a font size of at least 11.

Note: in order to get admitted to the oral exam you are requested to submit the answers to all these questions as a single pdf document via email at least two weeks before the oral exam.