AST 384C: Computational Astrophysics

HW 3 (due by 5pm central time on Friday, April 4)

Complete the following questions by submitting (documented) code and any accompanying answers / plots in a github repository. Email me the repository link once you've committed your solutions. Make sure to clearly document your code; when in doubt, over-explain!

1. **using KTrees**

   Set up a code that can generate (uniform) random postions in 3D for a set of N equal-mass particles in the range [0, 100] in each dimesion. Make sure to use a random number generator with a seed state that you can specify so that these initial positions are repeatable exactly.

   calculate the acceleration of every particle assuming vacuum boundary conditions (i.e., you don't have to worry about periodic boundaries or anything like that) both directly and using a KDTree for $N \in 10^{3,4,5,6}$. How does the timing scale for each method? Do your calculations depend on the method you used?

2. **hydro solvers**

   Download and set up pyro on your computer. Even if you install it via `pip`, I recommend cloning the repo as well so that you can easily access the files.

   Play around with it and have a look at the code – especially riemann.py, which will really help you understand how the Riemann problem is implemented and solved.

   - Run the Kelvin-Helmholtz tests for the 4 hydro solvers exactly as in the code guide.
   - Now repeat this with a relative velocity of ± 10 instead of 1. Describe the differences, if any, and their origin, relative to the $u = \pm 1$ case.