Turbulent mixing layer simulations

Radiative and non-radiative three-dimensional hydrodynamic turbulent mixing layer simulations run with the athena++ code framework.

When using these simulations in scientific works, please refer to and cite:

Fielding, Ostriker, Bryan, and Jermyn 2020, ApJL, 894, L24

doi: https://doi.org/10.3847/2041-8213/ab8d2c

As well as the CATS release paper (Burkhart et al. 2020), and the athena++ code paper (J. M. Stone et al. 2020)

The simulation outputs are in HDF5 format. There are 100 outputs per simulation. All of the simulation parameters can be found in the included athinput.XXX.sh files. Information regarding the code specific simulation parameters as well as useful analysis scripts can be found on the athena++ documentation page.

Two simulations are provided for use. These simulations are at the fiducial resolution of 128 cells per *L,* the stream-wise length of the box and characteristic scale of the mixing layer. For access to higher resolution versions of these simulations or other choices of parameters please reach out to Drummond Fielding directly.

One of the provided simulations has no radiative cooling (In the directory labeled *_tshtcool00_*) and the other has strong cooling such that the cooling time is ten times shorter than the mixing time (In the directory labeled *_tshtcool10_*). In all other respects the simulations are identical. The simulation domains are tall skinny boxes that are *L x L x 10L* in shape. The shear velocity is in the x direction and the gradient in the density and velocity is in the z direction. The resolution is highest in the central *L x L x 3L* outside of which the resolution rapidly decreases. These simulations have a density contrast of 100 (chi100) and relative velocity 10^-0.5 = 0.316 times smaller than the sound speed of the hot phase (i.e. a relative Mach number of ~0.3; Mach03). In code units the pressure $P = 1$, $v_{rel} = 0.41$, $L = 1$, and the density of the hot phase $n_{hot}= 1$. The x and y boundary conditions are periodic. The z boundary condition holds the density, pressure, and x velocity constant while maintaining a zero gradient condition for the y and z velocities. In the radiative simulations the hydro time-step is constrained to be less than 1/10th the shortest cooling time in the domain. There is an initial perturbation to the z velocity that is 4% the initial shear velocity. This perturbation has a sinusoid component with wavelength equal to the box size and a white noise component that is imposed at the grid scale. There is no explicit conduction or viscosity.

More detailed information on these simulations is available upon request or can be found in the primary reference. Visualizations of these simulations can be found at https://dfielding14.github.io/movies/.