FARGO3D Workshop (ITA 2021)

1 Default setups

1.1 Standard fargo setup

1. Compile the standard setup with `make SETUP=fargo` and run the fargo3d executable with `./fargo3d setups/fargo/fargo.par`. You may use the utilities provided in `plot_fargo.py` as a starting point. Compilation with `make view` enables live plotting with matplotlib during the simulation run.
   The default configuration simulates planet-disk interaction with a Jupiter-mass planet.

2. Now try to change the planet mass to e.g. $5M_{\mathrm{jup}}$ and $30M_{\mathrm{earth}}$ and see what happens (edit planets/jupiter.cfg). You can also add another planet and activate migration.

3. What happens if you modify the aspect ratio?

4. Is angular momentum conserved in the simulation?

1.2 Multifluid setup

1. Now switch to the `fargo_multifluid` setup. It includes three different dust species with Stokes numbers of 0.1, 1 and 10 (see `fargo_multifluid.par`). How does the dynamics change with the Stokes number?

2. What happens if you switch of dust feedback (in `condinit.c`)?

2 Accretion

With an internal torque G due to viscosity the conservation of angular momentum in the disk leads to:

$$r\frac{\partial}{\partial t}\left(r^2\Omega\Sigma\right) + \frac{\partial}{\partial r}\left(r^2\Omega\cdot r\Sigma v_r\right) = \frac{1}{2\pi}\frac{\partial G}{\partial r} \tag{1}$$

with $G = 2\pi\nu\Sigma r^3\frac{\mathrm{d}\Omega}{\mathrm{d}r}$.
The steady state solution for v_r can be found as follows:

$$r^2\Omega\cdot r\Sigma v_r - \nu\Sigma r^3\frac{\mathrm{d}\Omega}{\mathrm{d}r} = C \tag{2}$$

$$J\cdot r\,v_r + \frac{3}{2}\nu\Sigma r^2\Omega = C \tag{3}$$

$$J\cdot r\,v_r + \frac{3}{2}\nu\cdot J = C \tag{4}$$

$$rJ\left(v_r + \frac{3}{2}\frac{\nu}{r}\right) = C \tag{5}$$

where J is the angular momentum and C an integration constant. Setting C to zero we obtain the equilibrium radial gas velocity in a steady state accretion disk:

$$v_r = -\frac{3}{2}\frac{\nu}{r} \tag{6}$$

Now the tasks are:

- Implement a steady state accretion disk setup in fargo3d. Which geometry should we choose?
- How can we improve the solution? Implement powerlaw extrapolation boundary conditions.
- Try to use damping zones at the boundaries to stabilize the flow

3 β-Cooling and VSI