University of Rochester

Physics & Astronomy

Meeting Notes on Colliding Flows

Last Updated: December 22, 2014

1 12-18-2014 3:00pm, Vista Collaboratory

1.1 Meeting Summary

Did a brief review of the figures in Jonathan's paper (the column density maps, spectra, and mass weighted density versus pressure plots) while occasionally bringing up the figures currently made for the $\beta = 10$ with shear angle $= 0$ case. The figures discussed are listed on a wikipage whose link is in the footnote below. The figures include, column density maps, projected streamlines, β and β^{-1}-maps, B vs. n plots, and power spectra. We know that with our current runs, which have a weak field, that the presence of a field will inhibit collapse. We should also anticipate that the cores that will form also have lower mass. Overall we simply reviewed the 2013 paper and looked at material for the first out of our four runs.

1.2 $\beta = 10$, Shear angle $= 0$

In our study we're referencing Jonathan's paper, *The Effects of Inhomogeneities within Colliding Flows on the Formation and Evolution of Molecular Clouds* [1]. He did a clumpy versus smooth flows study. Our results should correspond with his smooth runs. Some things we immediately notice while looking at his spectra:

- No big humps occurring during the initial conditions.
- Looking for collapse generated by gravity that is illustrates in both kinetic and gravitational spectra.

For our spectra:

- The gravitational and magnetic pressure have similar slopes.
- Need v^2 power spectra. Would also be helpful to throw

  $$\lambda^2 = \frac{1}{k^2}$$

  onto the plot. Also need to adjust the domain and range for the initial condition frames.
- Note that we have some k' that is normalized for the box, where $k' = kl$, where l is the length of the box.
- Power dies off because we have no more scales to base power off of. We see the amount of power drop over time for the gravitational energy (see table on wikipage of when different sinks form)[1].

[1] https://astrobear.pas.rochester.edu/trac/wiki/u/madams/CollidingFlowsFigures

When looking at his column density maps (CDMs) and comparing with ours ($\beta = 10$, Shear angle = 0):

- Our bounds match Jonathan's after doing some dimensional analysis. However the actual plots we have do not match his. We need to reconsider the units for what we're visualizing.
- Jonathan's units go something like $\frac{\text{particles}}{\text{cm}^2}$. However it seems we are plotting something like $\frac{\text{particles}}{\text{cm}^3}$, so we will have to account for the length scale of the box. In other words, $\frac{\text{particles}}{\text{cm}^2} l$, where l is the length scale in units of pc. Ultimately we want everything to be on the same scale of 10^{18}.

Regarding our morphology and sink evolution observed in the CDMs:

- Rings: magnetic fields confining the flows. The field lines are forced to corrugate (looking down the barrel on the CDM). Is this effect real?
- "Splashing": Perhaps field lines enhance the NTSI?
- In Jonathan's simulation he has approximately 26 sinks by 27.2 Myr, where as our simulation has 4 by that time.

Regarding the projected streamlines on CDMs:

- Black background with the black streamlines on the mass2 CDM projections cause some visualization issues.
- The idea of "projected" streamlines seems strange, might want to consider looking at 3D plots of streamlines. (Consider the simulations used for Vista Presentations). However we might want to drop off the number of field lines around the edges of the simulation box. Perhaps consider zooming in on the known filament regions to see the streamlines? (Two new potential visualization figures here..)
- Usage of polarization maps?

On the magnetic field versus density plots (B vs. n), a form of pdfs.

- They have the "mass weighted density versus pressure" (mwdvp) superimposed on the magnetic field versus density plots. Both pdfs are based on the notion of binning. However for these mwdvps are based on the about of mass for some given density and pressure. When doing post processing on the HDF5 files, you get two pdfs: volume weighted density and mass weighted density. The vwdvp are based on the number of cells, or volume. For these B vs. n plots we have chosen to use mass.

- Each plot has the 10K, ram pressure, magnetic pressure and the nvp curve plotted over it. Can see as time goes on the material is being brought close to the nap line and runs up it. This implies that those cells are seeing gravitational collapse.

- From these plots we hope to derive a sense of what cores are gravitationally or thermally bounded. Can they tell us if the fields keep the gravitational collapse from happening?

- If we see magnetic pressure above ram pressure we have gravitationally bound fields. There for we have less population up the nvp curve.

- The stuff with lower thermal pressure (the ring structures we see in the CDMs) is thought to be below the cooling curve.

- The mwdvp plot obscures the B vs n plot in the sense that we cannot see if there are these two "orange islands" that connect. Are these two islands why we don't have as much collapse as in Jonathan's paper?

  - Perhaps to be good to see these plots without the mwdvp but with a contour map instead.
  - A distinct population of particles for $\beta^{-1} > 1$ where the kinetic energy is still strong refers to the cells making up the ring – confined by the ram pressure.
  - The ram pressure generates the splashing or mass motion (more kinetic energy).
  - Observing cooling instabilities.
  - Is it possible to make a B vs. n plot for the area just inside of the ring?

- What are these cells that create this spraying affect at the top of the nvp curve in the B vs. n at later times?

On the β and β^{-1} maps. Note that β is the ratio between the thermal and magnetic pressure respectively. So by plotting inverse β we are actually observing how strong the magnetic field is.

- With the red we see what is strong field. This field can be ram pressure dominated or gravitational confinement. The strong field could potentially be due to just the splashing and not the cores.

- Referring back to the B vs. n plots, things that are above the mwdvp will have $\beta^{-1} > 1$. Which regions have super-kinetic energy?

References

[1] Carroll-Nellenback, Frank, Heitsch (2013). The Effects of Inhomogeneities within Colliding Flows on the Formation and Evolution of Molecular Clouds. http://arxiv.org/pdf/1304.1367v2.pdf