Friday July 10 - Astrophysics

Discussion Lead: Julian Krolik

Brainstorming Q&A:

1. Alessandra C.: Tsvi what do you think of polarization? Are there too many unknowns in the magnetic field structure to make that useful to constrain the structure of the ejecta (since polarization would depend on both)?
    a. Tsvi: The issue was addressed in 2005.01754 had clear analytic explanation of misinterpretations results of numerical simulations. But the referee wanted numerics ha ha ha. But the point is that polarization peaks at the moment that we see the jet from the side - namely at the peak of the afterglow so usually it doesn't give much additional information.
    b. Agniez: good tools available to measure polarization in jets in HARM. E.g. "iPole" [https://ui.adsabs.harvard.edu/abs/2018MNRAS.475...43M/abstract] on Github
    c. Alessandra [chat]: Could you point me to any references for the polarization in recent simulations if there are any?
2. Algorithm:
    a. Cipo: any comparison in terms of performance between IGM and MANGA? How do the GRHD+Voronoi mesh scale?
    b. Phil. To 0th order, haven't done performance comparisons. For one thing, it didn't have individual time-stepping -- hard to compare with SPH. Now do have multistepping, but still focusing on algorithm development
    c. Longer answer: MANGA Voronoi & SPH versions perform similarly in context of common envelopes (within 25%). But in case of sophisticated EOSs MANGA Voronoi is superior.
    d. But any grid code will generally outperform a moving-mesh one, due to extra work in later. But there are key advantages to MANGA approach: e.g. in situations where bodies are moving toward each other, bulk flow is much larger than internal fluid velocities. Hope that in future BNS evolutions, lack of advection will improve performance, as well as [???] and individual time-stepping.
    e. Julian: spoke about MHD and difficulties of doing derivatives. Phil: started implementing vector potential in MANGA, but not properly tested. Have tests [??]

with weak B-fields, but not strong. In another test, I wasn't getting the right magnetic energy spectrum -- needs to be revisited with students.

f. Julian: Zach spoke about advantages of staggered grids for B-fields in IGM. Phil: yes, but not easy to do with Voronai mesh. Zach: lower-order reconstruction methods (e.g., used with MANGA & other moving-mesh codes) with vector potential can actually behave *better* in shocky situations.
g. Beany: Could you take a Regge-calculus like approach with Delaunay & Voronai meshes for different things? Phil: something like this was tried by [Mocz et al (2016)]. Could associated multiple B-fields on faces, each associated with different interior cells. Could be looked at more … Delaunay tessellation may not be unique, but could perhaps get around with dual fix.
h. Vassili: could you elaborate on trouble with staggering? Phil: when faces are constantly changing, difficult to calculate the staggering necessary. V: don't you have to do this anyway? Phil: "cell-centered values" really "cell-averaged values". Have to assign values on faces from these. How do you account for face value evolution? One attempt did something Athena++ like in 2D, but didn't work very well [Mocz (2014)].
i. Julian: including radiation in CHANGA/MANGA? Use the same approach as in Athena code? Phil: multiple methods possible: M1 (has been tried). But trying fully time-dependent with slow-light approx. Implemented algo from latest Athena++, but not short characteristics (that needs "global solve" that assumes regular mesh; hard with unstructured mesh).
j. Julian: you mean time-dependent radiative transfer? (Phil: yes.) Julian: two versions of this -- time independent, and time-dependent. This is effectively still short-characteristics. This is an issue in regions with low optical depth: need ever-finer angular resolution. Phil: no way around this to my knowledge. Could do the "adaptive angle" method. Keep the same "angular budget", but varying actual angles.

3. BNS+postmerger:
    a. Cipo: any clue on refinement and simulation time required for a magnetized BNS, resulting in BH+disk, in order to see sGRB?
4. Julian: what's angular structure of jet -- power as function of angle? - The observed afterglow isn't very sensitive to the angular structure of the jet. (Tsvi)
5. Julian: Riccardo: what was the ratio of jet power to column density in two cases you showed?

    a. Don't have to hand. Power comes from core. When we don't see collimated outflow, we still get to the end of the simulation. Not clear if changing B-field produces better outflow of different obstacles. But still need BH for jet according to current results

6. Milton: what about EOS?
    a. Ric: currently only dealing with qualitative behavior. Next need to vary with other ingredients, e.g. neutrinos. After that can do systematic investigation to get real parameter values.

7. Ari: need longer delay time (~0.8 sec)
    a. Ric: What kind of wind choices were made? Magnetically driven put out much more material
    b. Ari: three different types: spherical, neutrino-driven (mentioned in previous talk), magnetized outflows (in Agniezska's sims). In latter, see different edge-shapes.
    c. Ric: can get polar pollution
    d. Agniez: see similar behavior across winds; Ari agree, with slight differences

Key References:

- Ian Hawke: On surface boundary conditions look at sections 6.5.1 and 7.1.3 of John Muddle's thesis at http://eprints.soton.ac.uk/375551/
- R Ciolfi: constraints on jet https://arxiv.org/abs/2004.10210
- Agniezska: iPole: https://ui.adsabs.harvard.edu/abs/2018MNRAS.475...43M/abstract
- R Ciolfi: other paper (in addition to "superluminal motion" paper) for the final 170817 jet structure: https://arxiv.org/abs/1808.00469
    - this one gives a constraint on the radio source size (source remained compact, also in favour of beamed jet)
    - However, this paper assumes it deals with light curves from a given jet structure (theta_J is fixed) (see arXiv 2005.01754) Without an extra constraint the light curve data on its own cannot determine the jet parameters.