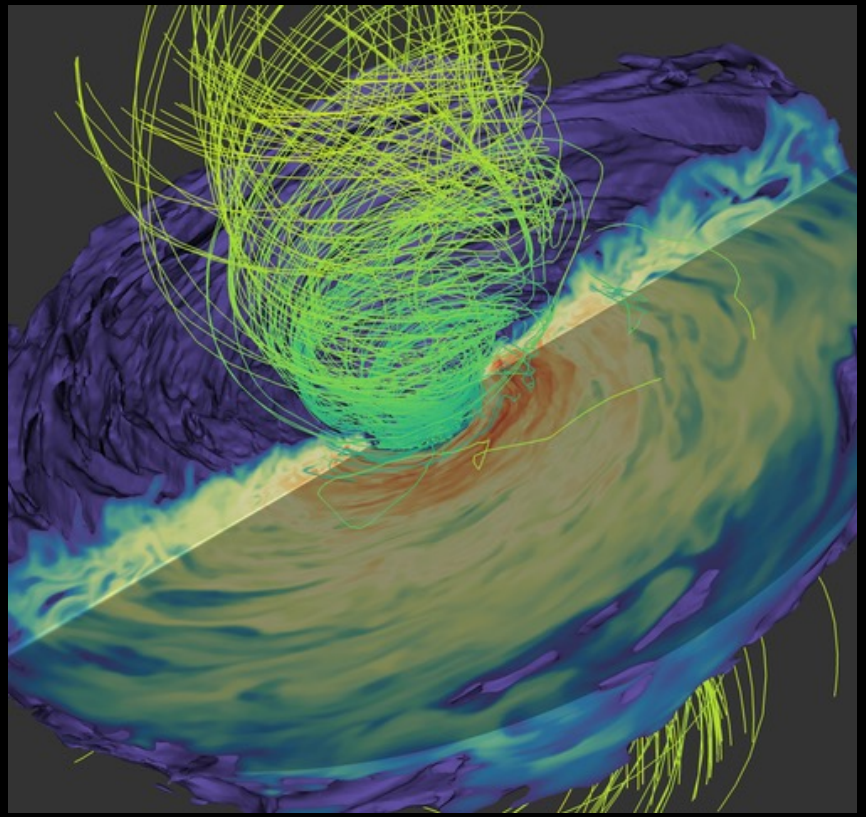
The Future of Scientific Computing in Source Modeling and Simulation.

Transients 2020

Kavli-IAU Workshop

3-7 February 2020 – Cape Town



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Multi-Physics, Multi-scale Simulations

Simulations of MMA sources are inherently multi-physics, multi-scale problems. Long, accurate, GRMHD simulations in 3d are required to guide and interpret MM**λ**, MMA observations.

In many cases, GW and EM signals depends on the complex coupling among:

- Dynamical GR-MHD
- Nuclear and Neutrino Physics
- Radiation transport (photons + neutrinos)
- R-processes/nucleosynthesis

Inherently 3d problems that cannot be easily captured by Analytical Models:

- Fluid and MHD instabilities
- multi-D structure
- multi-spatial scales

- To solve these problems we need multi-domain expertise, and sustained collaborative software development, but most funding still comes from individual PI, short-term, grants.
- Workforce training and retention is also a related bottleneck.
- Public, coordinated, data repository to share simulation products with the larger scientific community and observers are needed.

Cyberinfrastructure Challenges:

Successful Simulations require very advanced numerical algorithms, which translates into in hundred thousands lines of code!

The Advent of Supercomputers
Pioneering efforts on supercomputers at Livermore Natl Lab and NCSA by Larry Smarr in the 1970s and 80s.
Thanks to NSF support!

- Performing large simulations in a reasonable amount of time today is only possible on the largest petascale/exascale supercomputers (fast processors with peak petaflops performance, excellent interconnect, lots of memory per node);
- However, there are now software bottlenecks due data exchange between processors and inefficiencies due to load-unbalances.
- Mid-scale (local) facilities are also required for code development and testing and to perform a huge range of analysis projects.

XSEDE

BLUE WATERS
SUSTAINED PETASCALE COMPUTING
ILLINOIS
NCSA | National Center for Supercomputing Applications

FRONTERA
TACC
TEXAS ADVANCED COMPUTING CENTER

Discussion:

- Theory and simulations are key to the interpretation of observations of binary compact MMA sources.
- The demand for high-fidelity physical models will only increase as more exciting discoveries are made.
- The promise of MMA can be realized only if sufficient, sustained and community cyberinfrastructure is available!
  - Scalable software Infrastructure
  - Peta/Exascale Supercomputers
  - Workforce training and retention

White Papers: Kollmeier+2020, Allen+2020, Chang+2020

Growing Convergence Research