AthenaPK

Philipp Grete

University of Hamburg

in (development) collaboration with
Forrest Glines and James Stone

Parthenon developer meeting

Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

Funded by the
European Union

AthenaPK – Overview

Applications (AthenaPK)

- Finite-volume (M)HD
- Cell-centered divergence cleaning

Parthenon interface

- Single package with `MultiStageDriver`
- `MeshData` where supported
- One large variable vector
- Explicit `ScratchPadMemory` use
- C++17 `constexpr if` in kernels
- Regression test infrastructure
- Lots of `Params` abuse
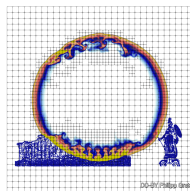
Application: Turbulence

Background

- 3D periodic, uniform grids

- May include cooling (optically thin) and diffusion processes

- Study energy dynamics $\Rightarrow$ requires high resolution

Implementation

- Turbulence driver (stochastic process in spectral space for force field in physical space)

- Custom, explicit Fourier transform using few modes
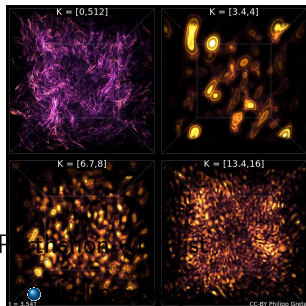
- Data compression

- Arbitrary "MeshData" (say like an array of acceleration vectors)

- Support for slices in outputs

Application: Cloud in wind

Background

- Supersonic ($M \approx 4$), weak magnetic fields ($\beta = 100$), high density contrast ($\rho_c / \rho_w = 1000$), with AMR

- Includes cooling, anisotropic thermal conduction

- Study cloud crushing/survival

Implementation

- RKL2 super timestepping (separate "driver" $\rightarrow$ just more tasks)

- first-order flux correction (iteratively, not guaranteed to work)

Parthenon wish list

- "fix" prolong/restriction

- Face-centered fields (for CT)
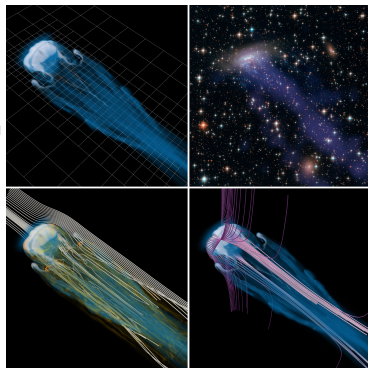
- FluxDiv subset of variables

- boundary exchange subset of variables
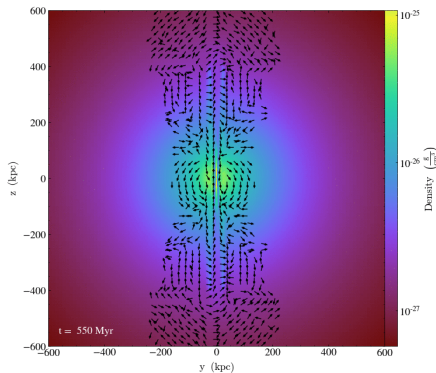
Application: AGN feedback

Background

- SMR with static potential
- Single AGN in the center
- All the previous physics, too
- Study AGN feeding, energy redistribution, magnetization, . . .

Implementation

- global reduction/kernel

Parthenon wish list

- adaptive time-stepping?
- use texture cache for cooling table (and interpolation)

Application: "HPC"

Background

- used in CFP benchmarking suite for upcoming cluster in Hamburg
- used in acceptance testing for Frontier

Parthenon wish list

- further opt./tests on AMD GPUs (and Intel)
- HostPinned versus Device memory
- optimized buffer filling kernels dep. on number of buffers
- "auto-tuning"