Cholla: A New Code for Astrophysical Hydrodynamics

Evan Schneider and Brant Robertson
University of Arizona

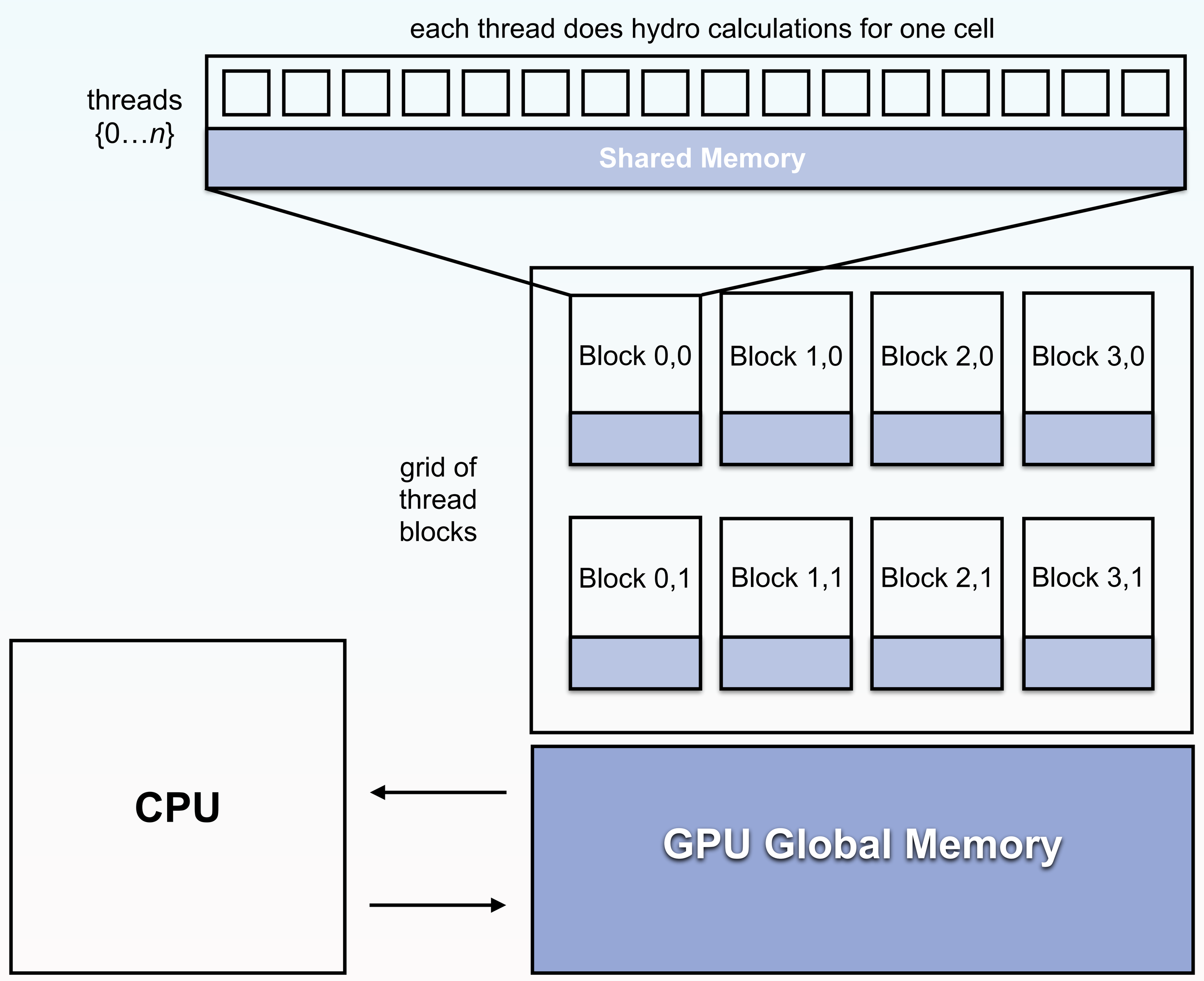
Introduction

CHOLLA stands for Computational Hydrodynamics On paraLLel Architectures.

Despite increasingly powerful CPUs, many astrophysical simulations remain bound by computational expense. Problems requiring static mesh hydrodynamics calculations often fall within this category. To improve upon this situation, we have developed *Cholla*, a code that takes full advantage of newer, extremely parallel GPU-based computer architectures. Using GPUs allows us to perform high resolution simulations quickly (and for a fraction of the cost of CPU-based methods).

We are currently using *Cholla* to probe questions about galactic outflows as well as ISM turbulence. We plan to make the code public soon.

GPU-based = Fast hydrodynamics



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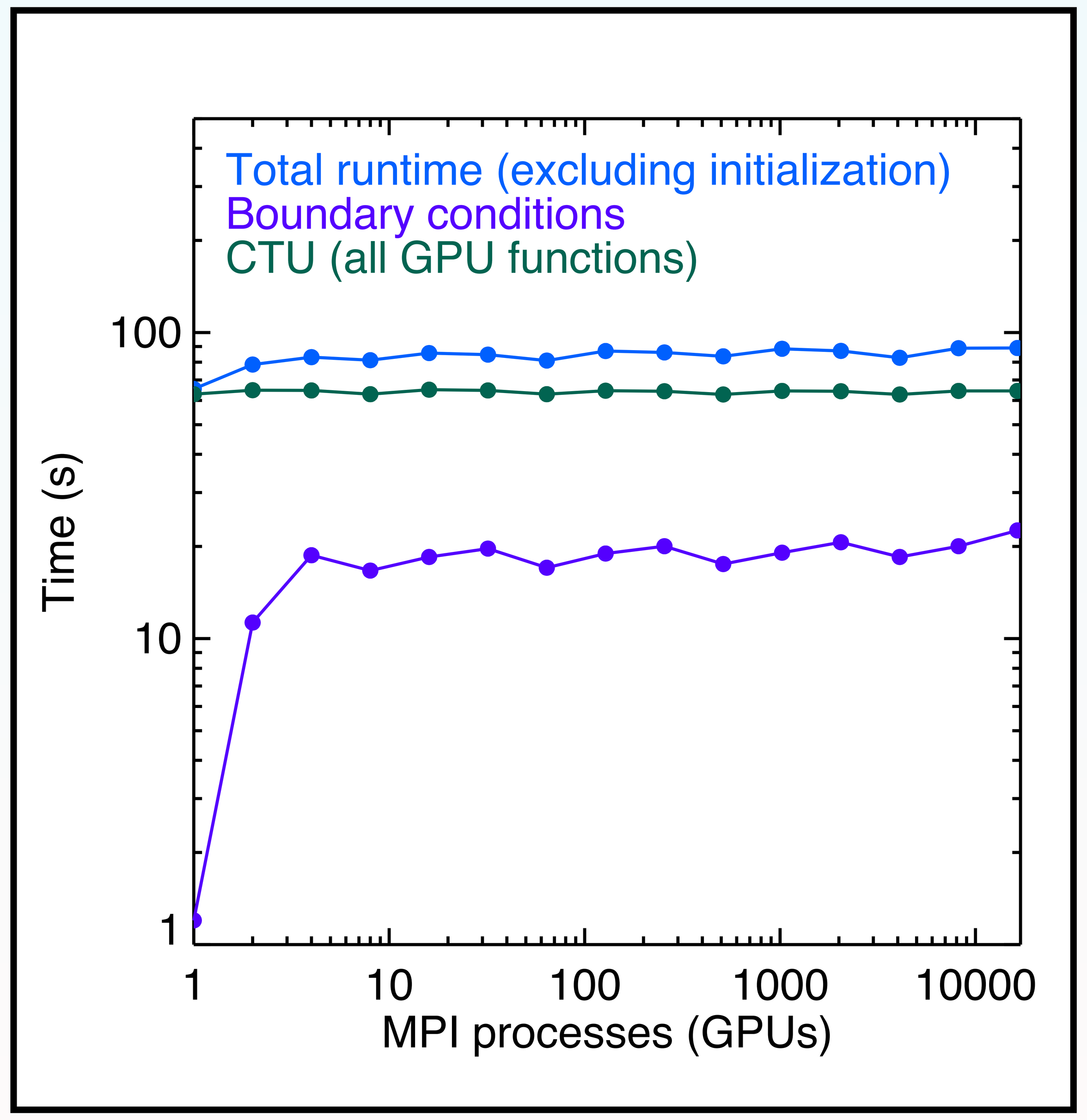
Code Specifics

- *Cholla* is a new three-dimensional hydrodynamics code that harnesses the power of GPUs to accelerate astrophysical simulations.
- Details: static mesh Eulerian code, unsplit Corner Transport Upwind integrator (Gardiner & Stone, 2008) or Van Leer predictor-corrector scheme (Stone & Gardiner, 2009), exact and Roe Riemann solvers, up to third-order spatial reconstruction with several slope limiting options, and optically thin radiative cooling.
- *Cholla* is fast (5 - 20 million cell updates per GPU second), MPI parallelized, and shows demonstrated scaling to > 16000 GPUs.

Weak Scaling on *Titan*

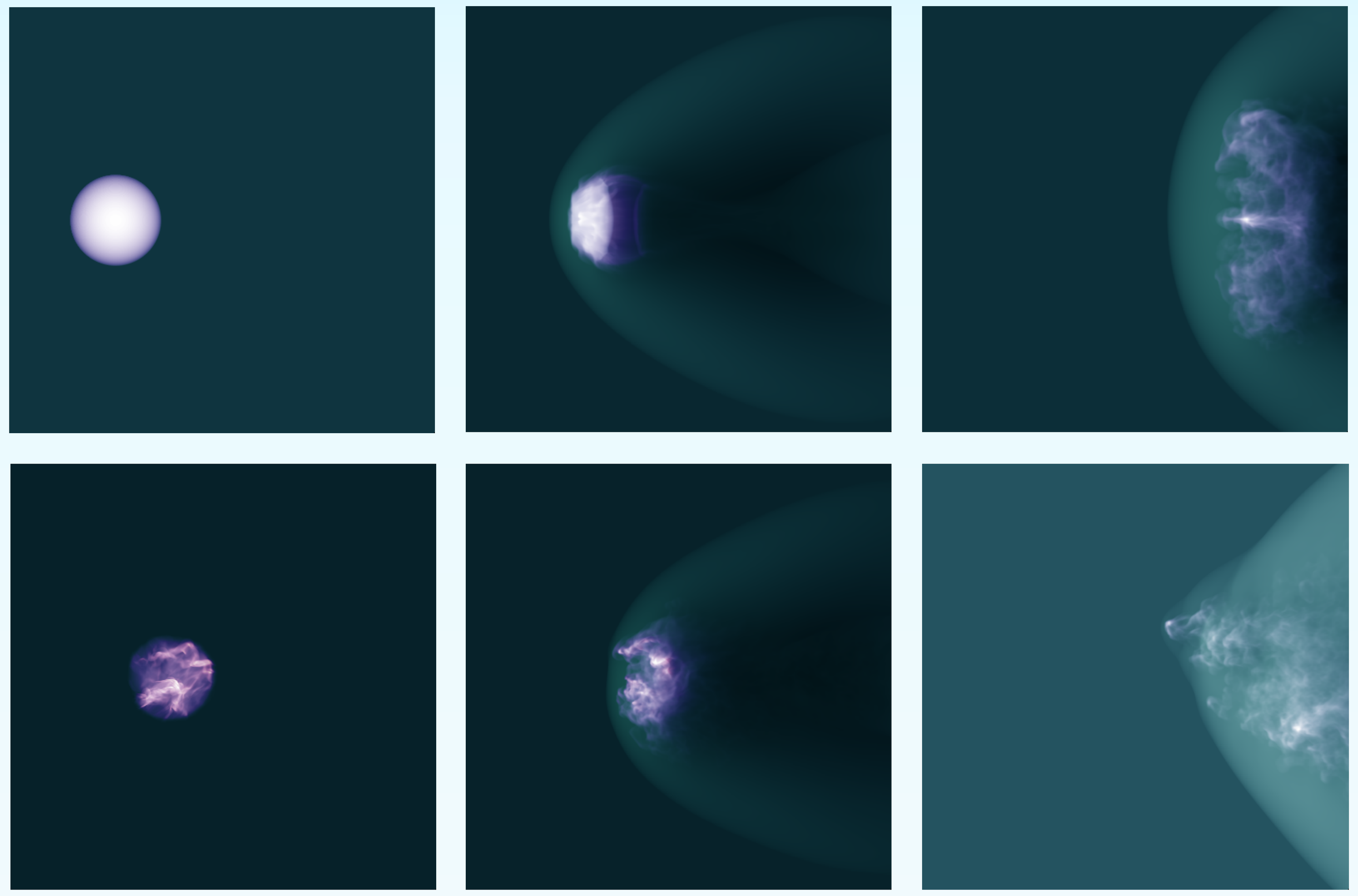


Titan is the flagship supercomputer at Oak Ridge National Laboratory, with 18,688 GPU-equipped compute nodes.

In preliminary tests, *Cholla* achieves nearly ideal weak scaling on tests with up to 8192^3 (550 billion) cells.

Cloud-Wind Interactions

What happens if clouds are not treated as constant density, uniform spheres?



- Most numerical studies of galactic outflows have modeled the cool gas as constant density, spherical clouds (e.g. Scannapieco et al., 2015).
- We test a more realistic model in which the cool clouds start with a lognormal density structure as a result of their turbulent nature.
- We demonstrate that turbulent clouds get disrupted and dissipate much more quickly than spheres with equivalent mass and mean density.

References:

Schneider, Evan E. & Robertson, Brant E. (2015). Cholla: A New Massively-Parallel Hydrodynamics Code For Astrophysical Simulation. *The Astrophysical Journal Supplement*, 217(2), 24-58.