

Art of Scientific Visualization

Introduction to VisIt



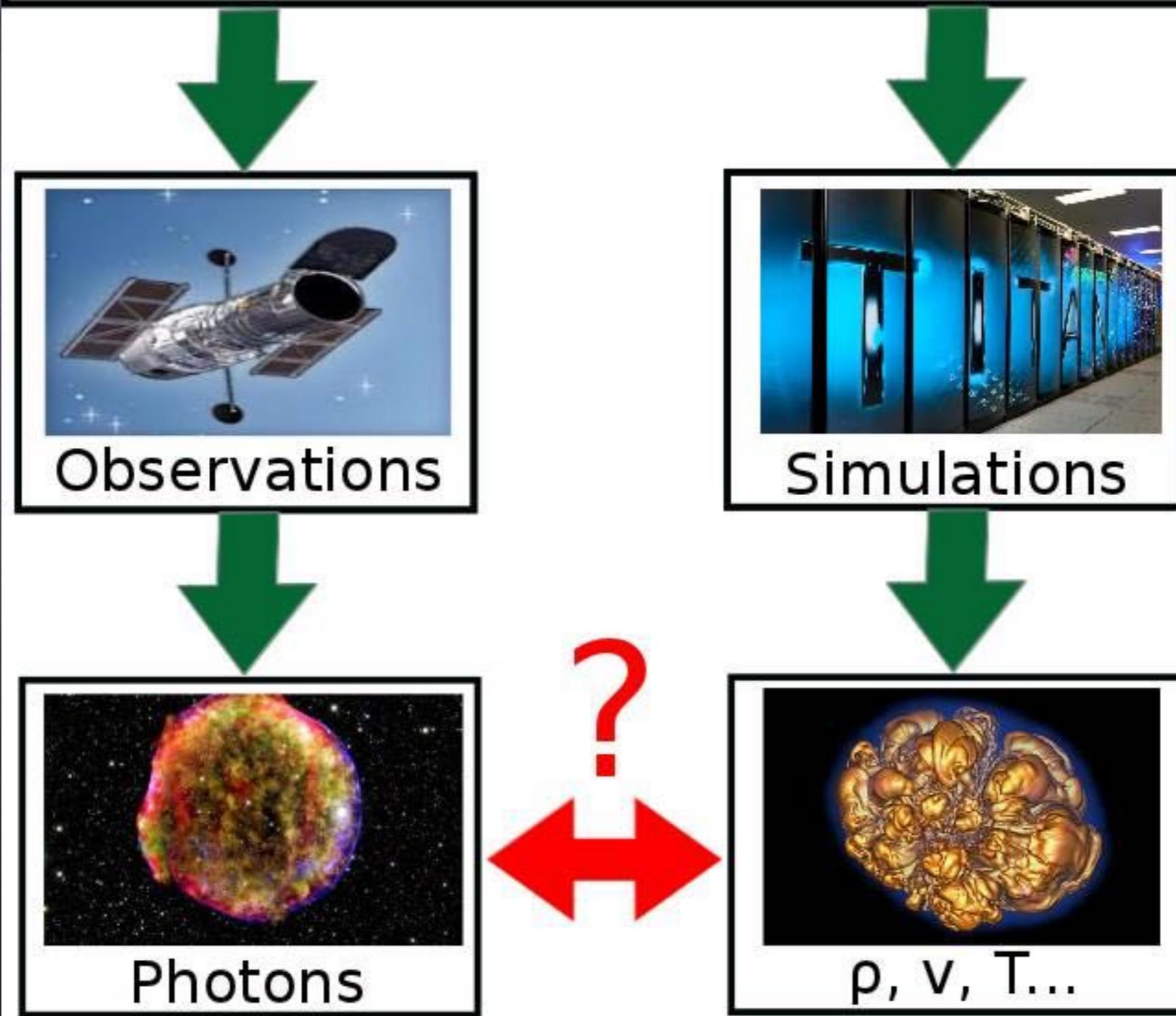
Ken Chen (陳科榮)

ASIAA

AFD School, NTHU, 09/04/2019

Astrophysical Research

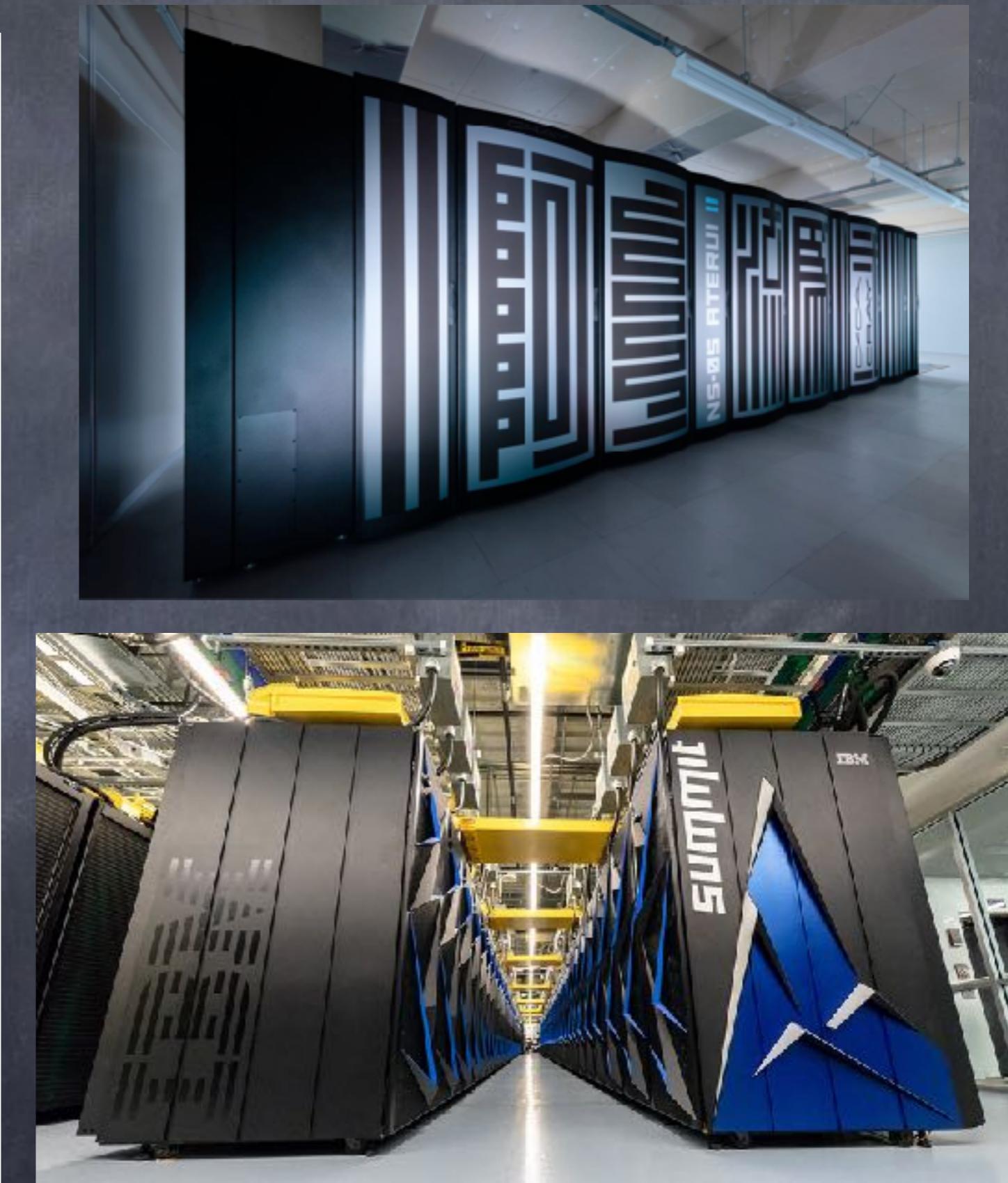
Astrophysical Explosions



Observer's Perspective

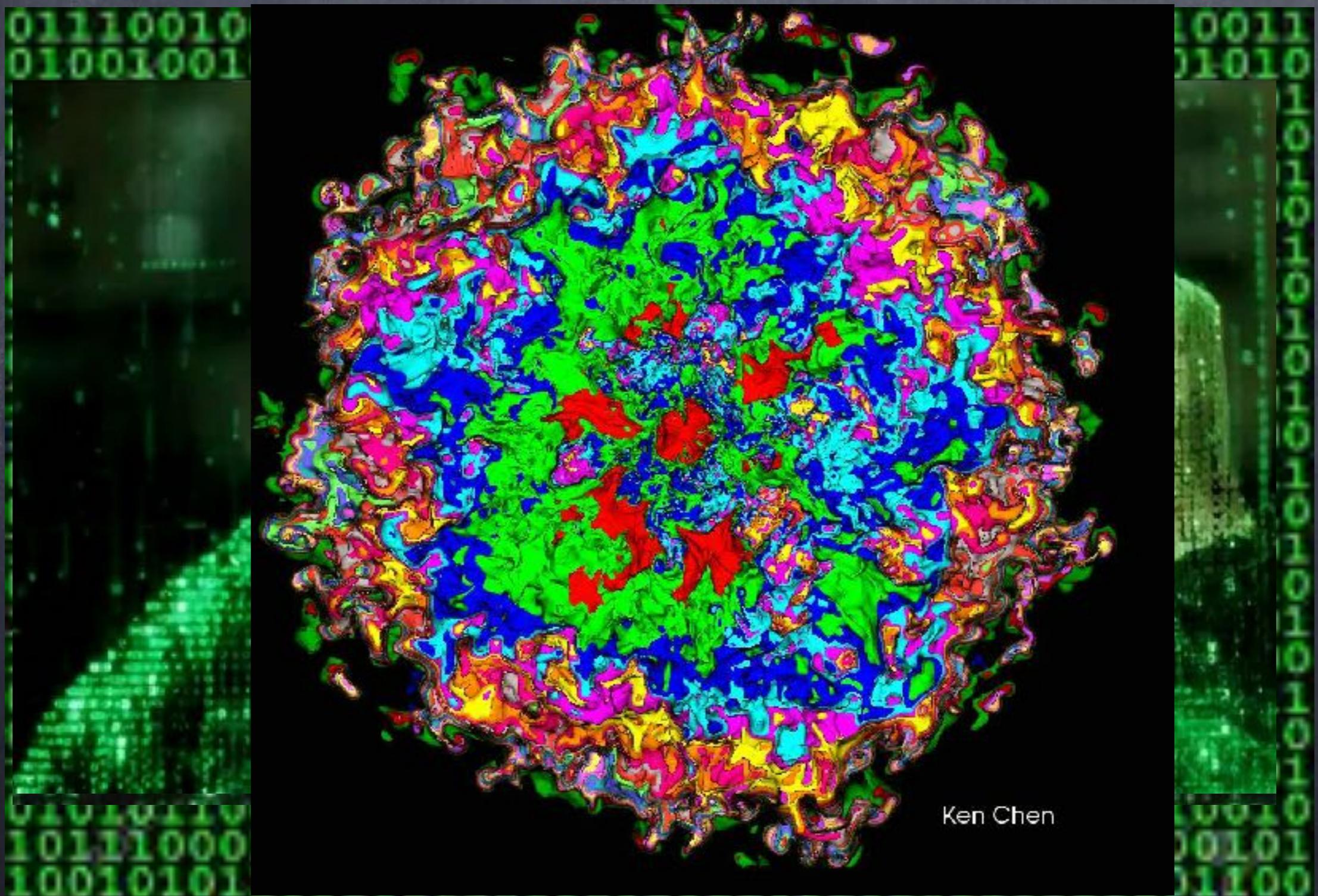


Telescopes for Theorists and Simulators

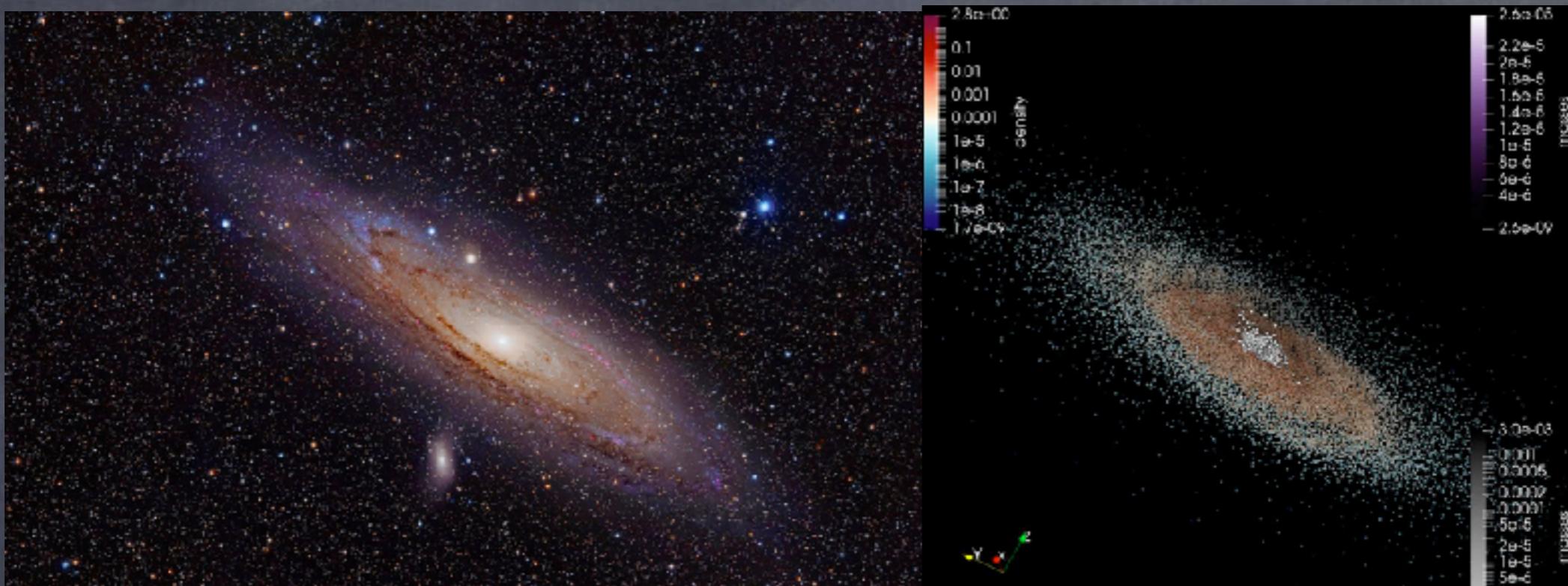


Visualization

a way to make the invisible visible



Simulations and Observations



Supernova Explosions



Nordhaus+ 2011

Cosmic Structure Formation

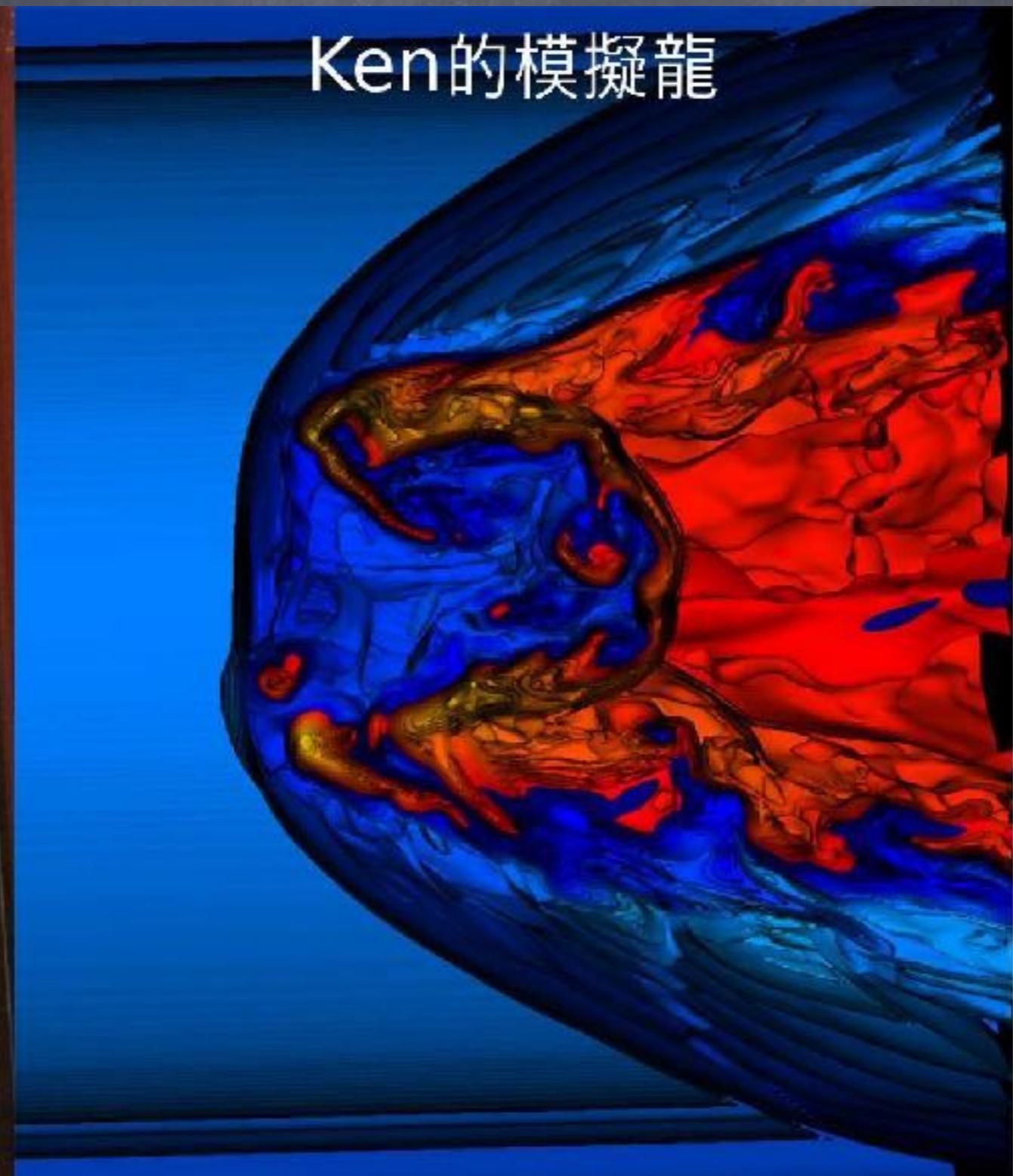
UCSC

Fun Stuff

淺草寺的神龍



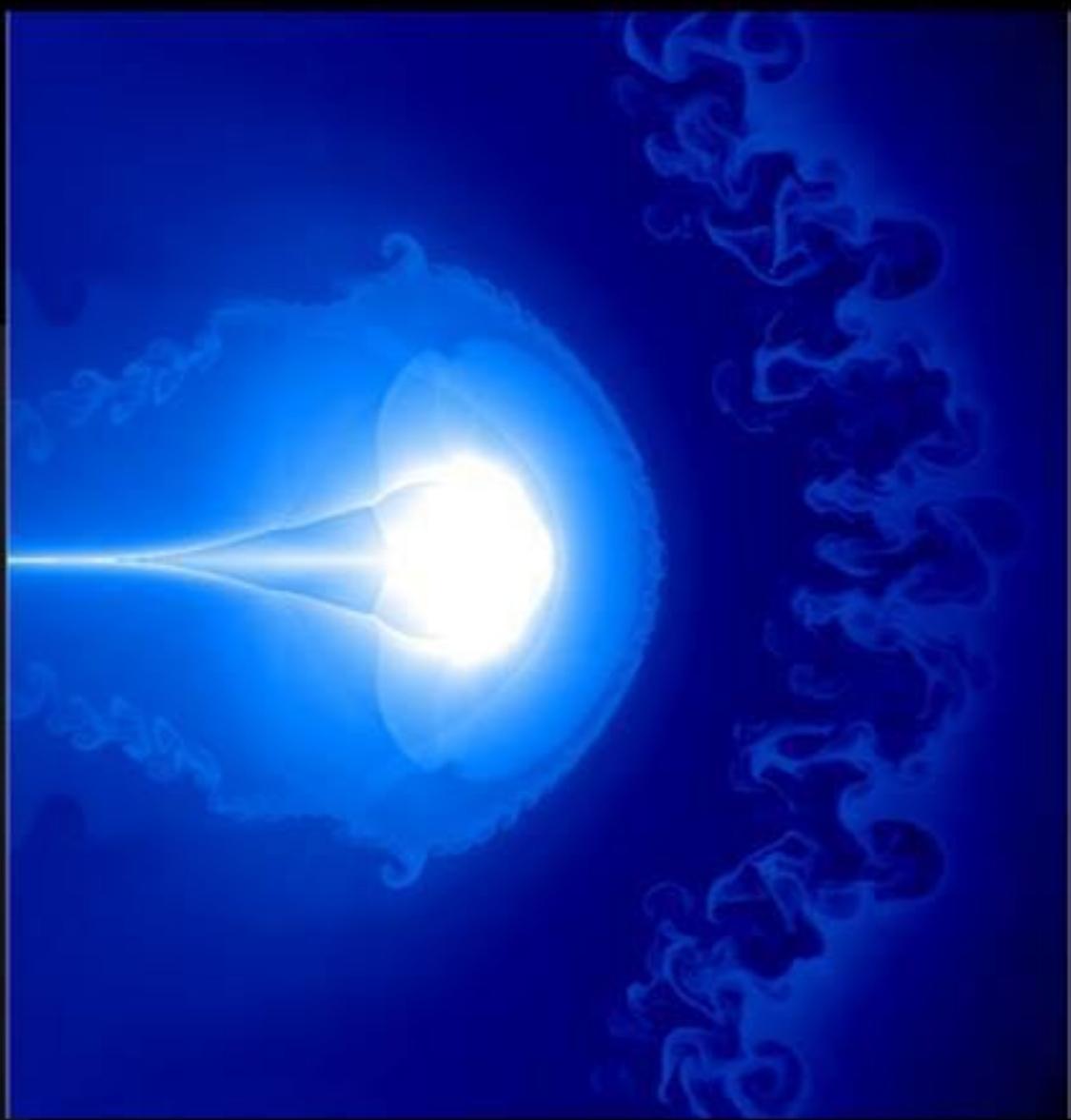
Ken的模擬龍



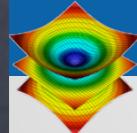
More Fun Stuff



CAPCOM

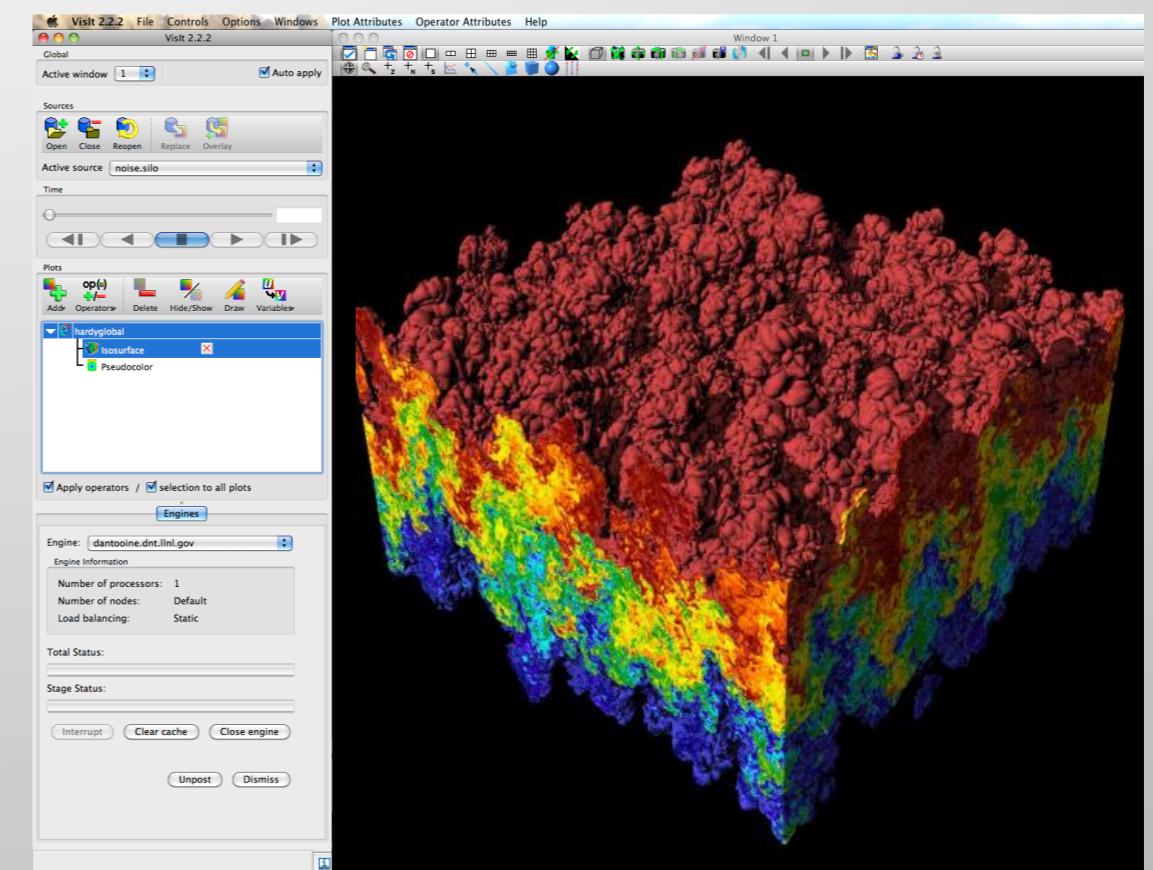


Ken Chen



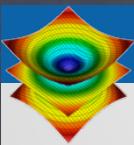
VisIt is an open source, turnkey application for data analysis and visualization of mesh-based data.

- Production end-user tool supporting scientific and engineering applications.
- Provides an infrastructure for parallel post-processing that scales from desktops to massive HPC clusters.
- Source released under a BSD style license.

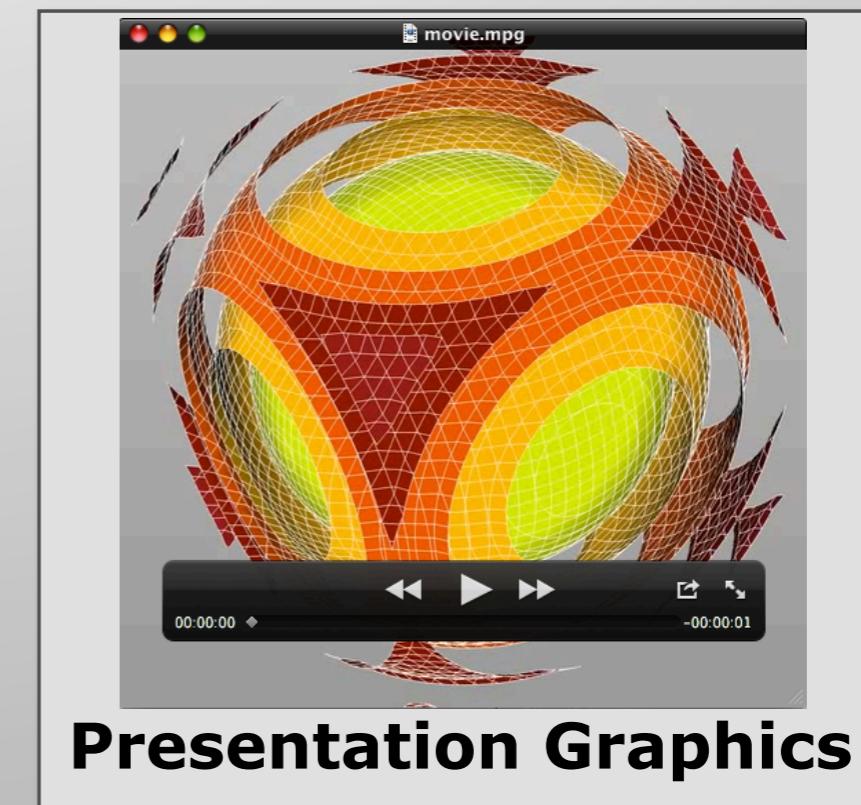
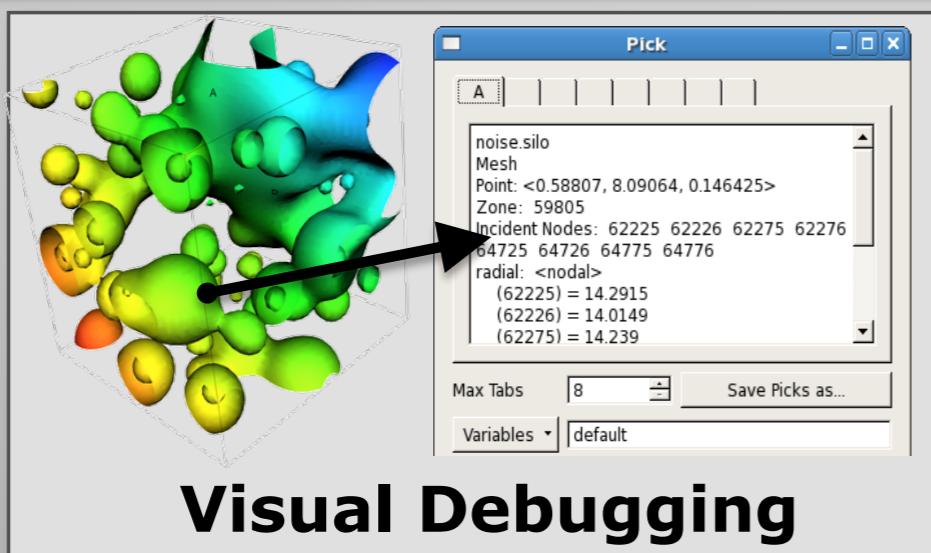
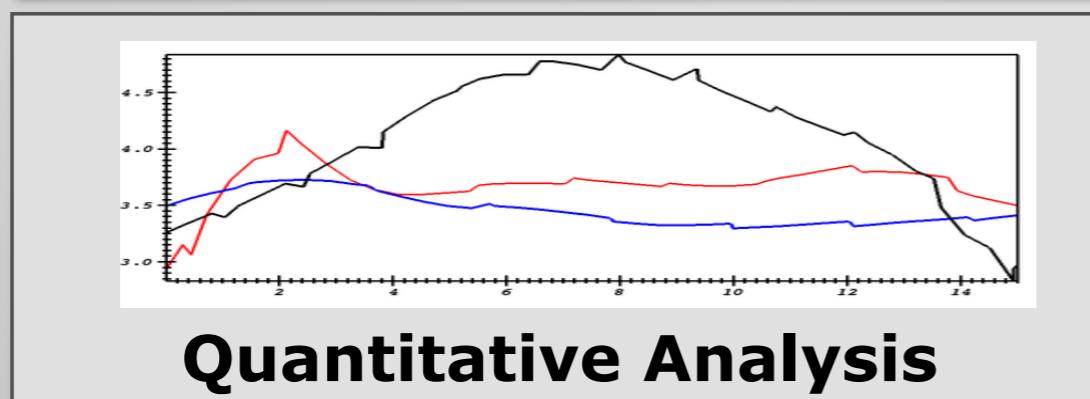
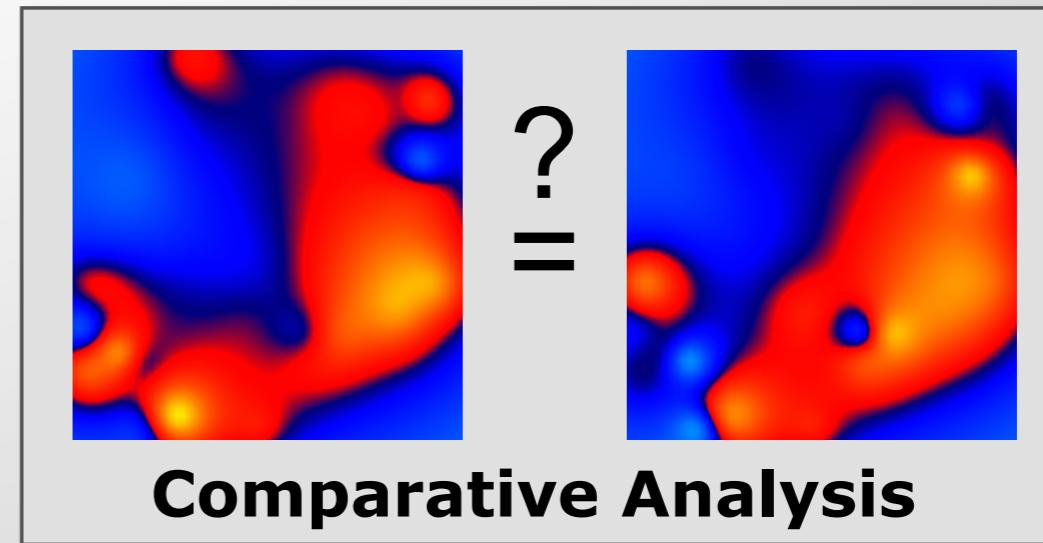
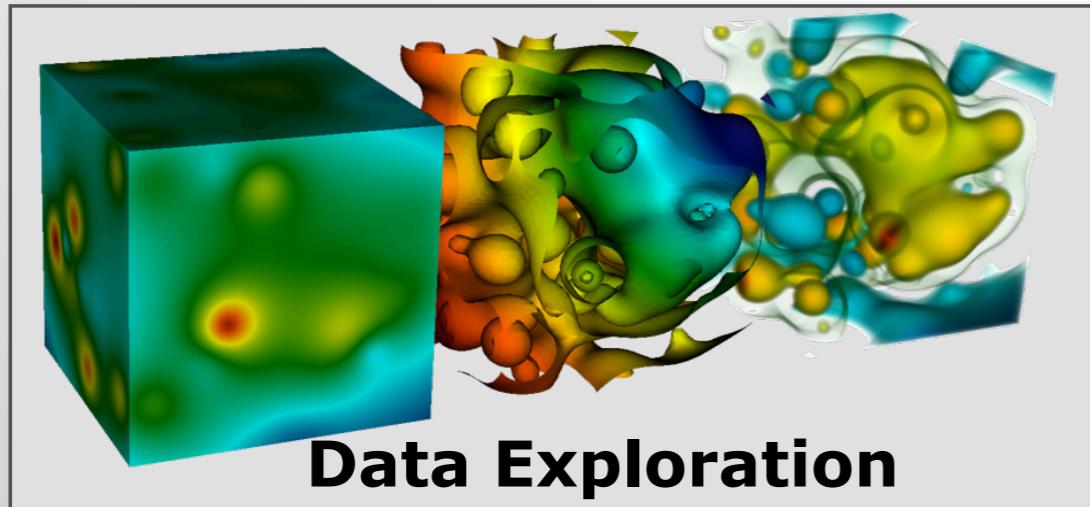


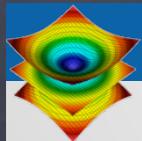
**Density Isovolumne of a
3K³ (27 billion cell) dataset**

Slides From LLNL training course

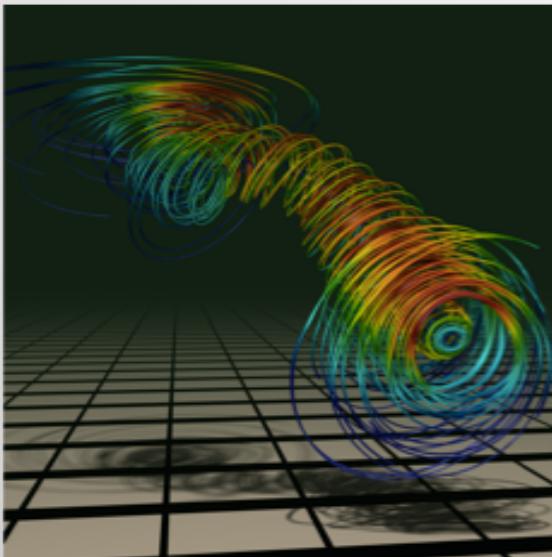


VisIt supports a wide range of use cases.

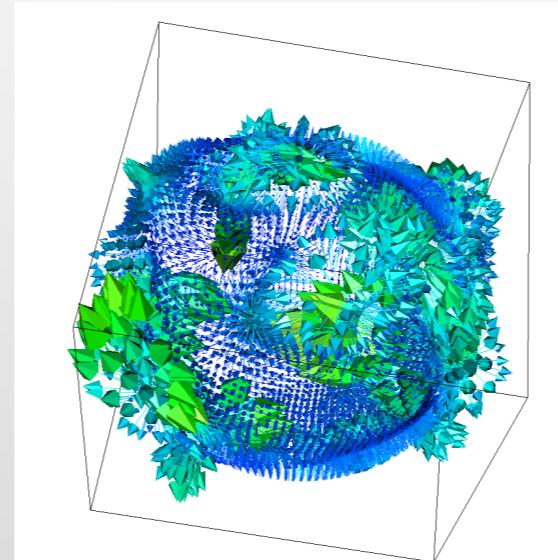




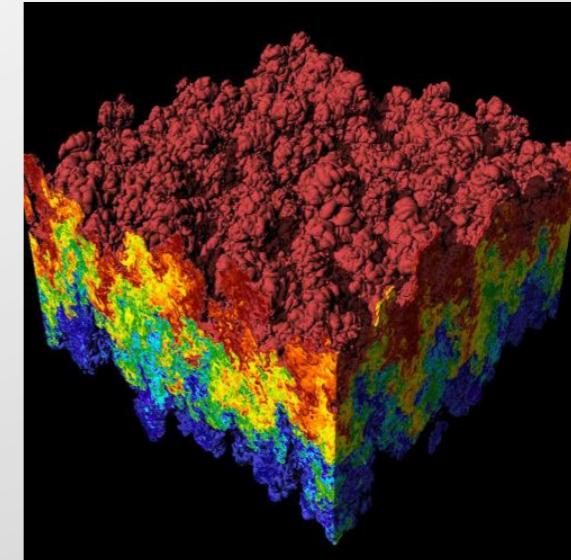
Examples of VisIt's visualization capabilities.



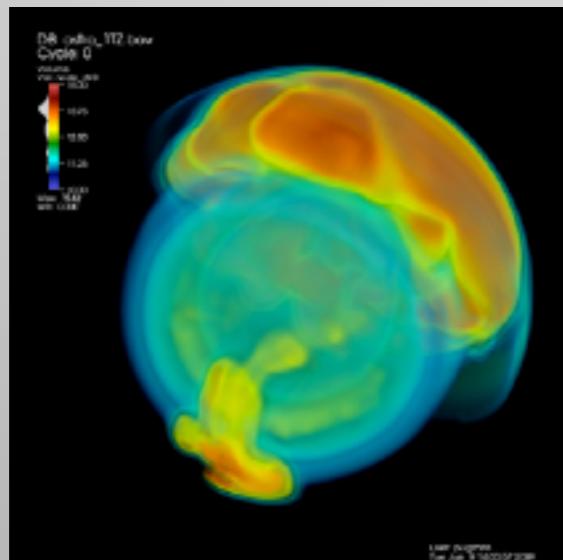
Streamlines



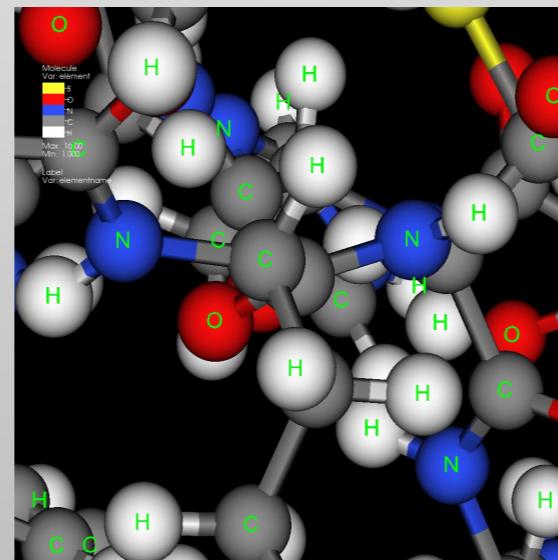
Vector / Tensor Glyphs



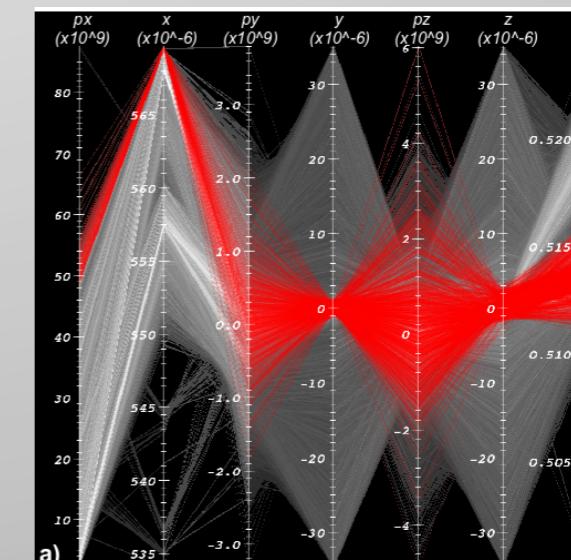
Pseudocolor Rendering



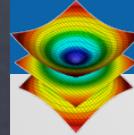
Volume Rendering



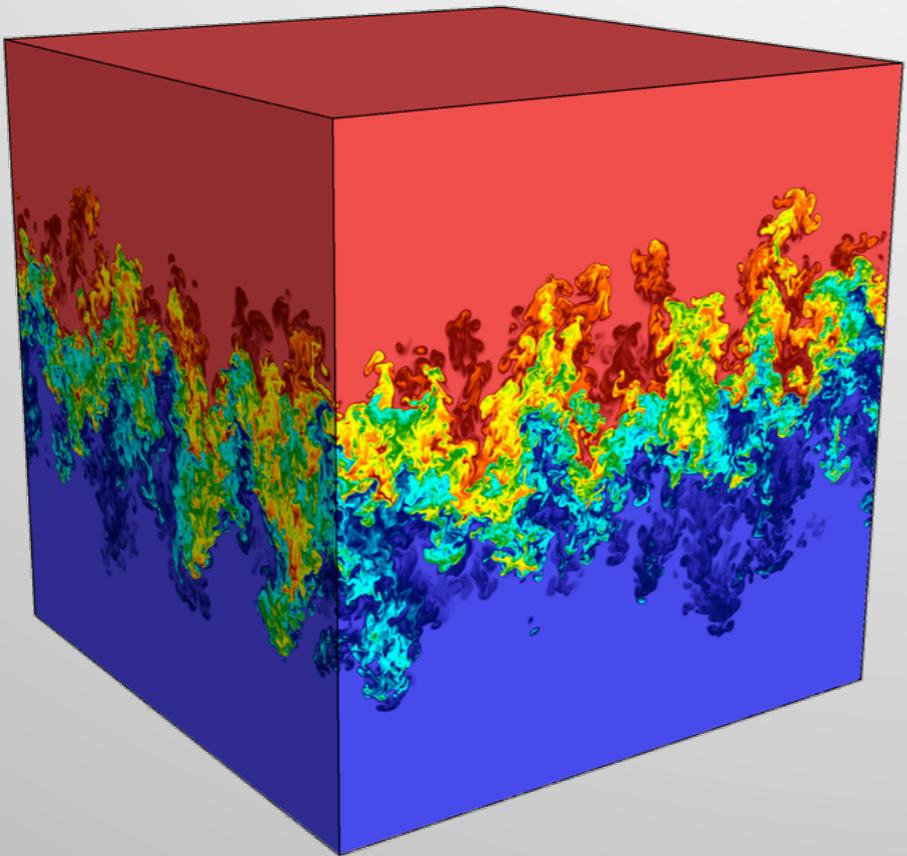
Molecular Visualization



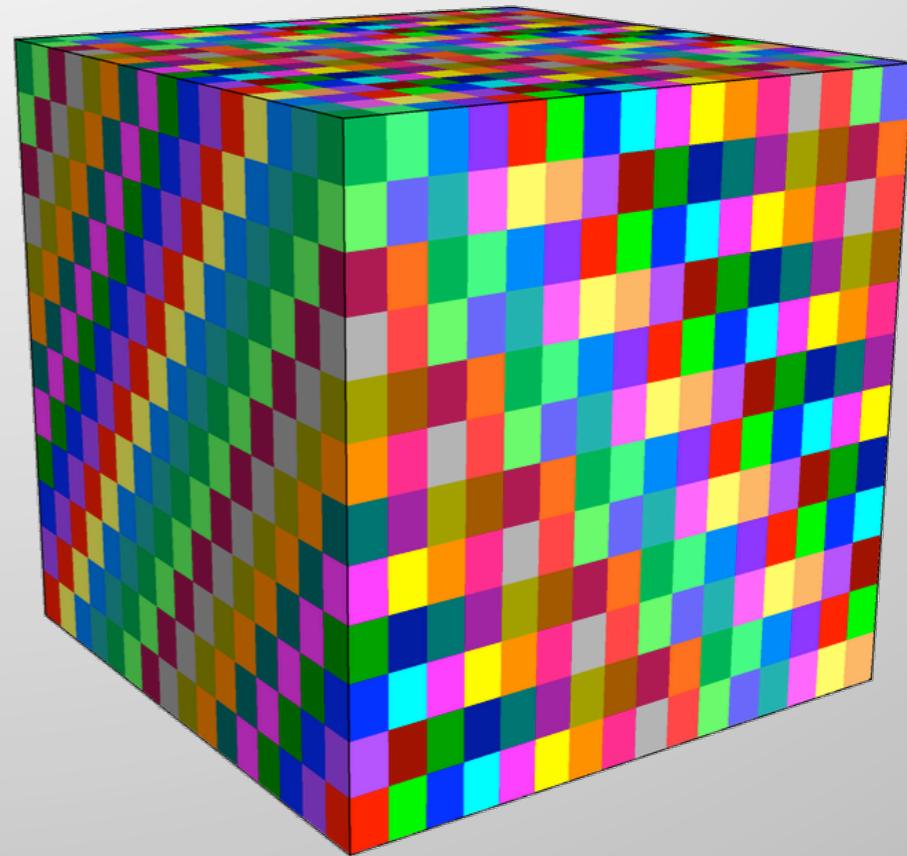
Parallel Coordinates



VisIt uses MPI for distributed-memory parallelism on HPC clusters.

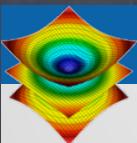


Full Dataset
(27 billion total cells)



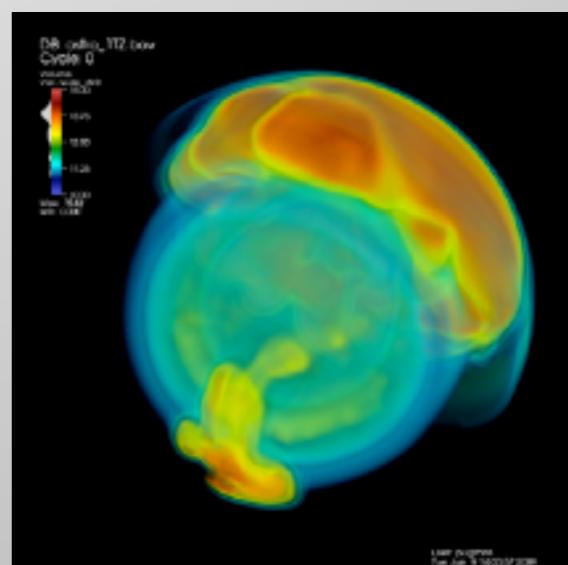
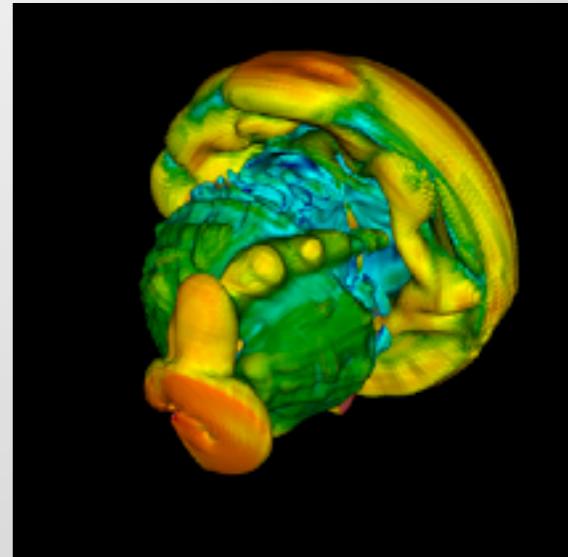
3072 sub-grids
(each 192x129x256 cells)

We are enhancing VisIt's pipeline infrastructure to also support threaded processing.



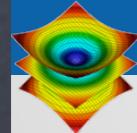
VisIt scales well on current HPC platforms.

Machine	Architecture	Problem Size	# of Cores
Graph	X86_64	$20,001^3$ (8 T cells)	12K
Dawn	BG/P	$15,871^3$ (4 T cells)	64K
Franklin	Cray XT4	$12,596^3$ (2 T cells)	32K
JaguarPF	Cray XT5	$12,596^3$ (2 T cells)	32K
Juno	X86_64	$10,000^3$ (1 T cells)	16K
Franklin	Cray XT4	$10,000^3$ (1 T cells)	16K
Ranger	Sun	$10,000^3$ (1 T cells)	16K
Purple	IBM P5	$8,000^3$ (0.5 T cells)	8K



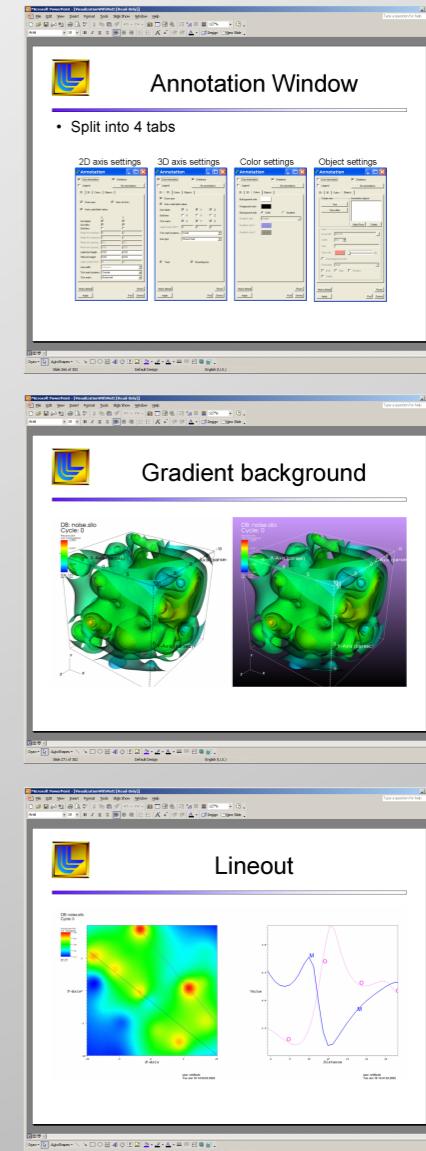
Scaling Studies of Isosurface Extraction and Volume Rendering (2009)

VisIt is also used daily by domain scientists.

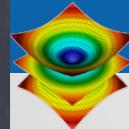


The VisIt team focuses on making a robust, usable product for end users.

- Regular releases (~ 6 / year)
 - Executables for all major platforms
 - End-to-end build process script ``build_visit''
- Customer Support and Training
 - visitusers.org, wiki for users and developers
 - Email lists: visit-users, visit-developers
 - Beginner and advanced tutorials
 - VisIt class with detailed exercises
- Documentation
 - “Getting data into VisIt” manual
 - Python interface manual
 - Users reference manual



Slides from the VisIt class



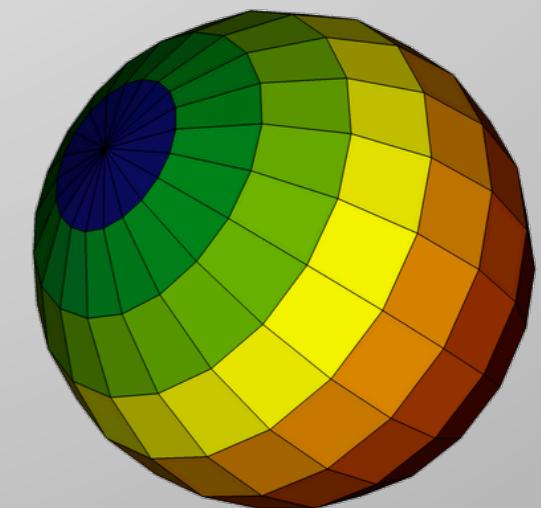
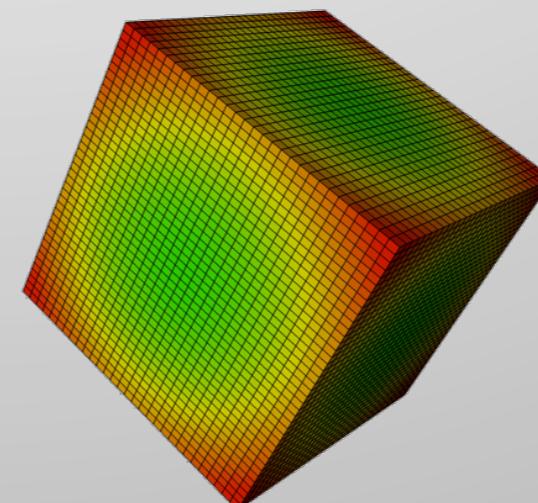
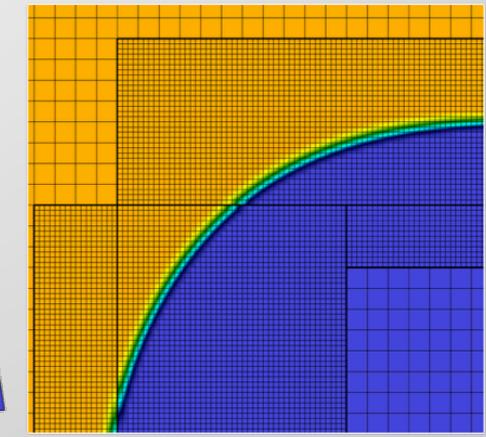
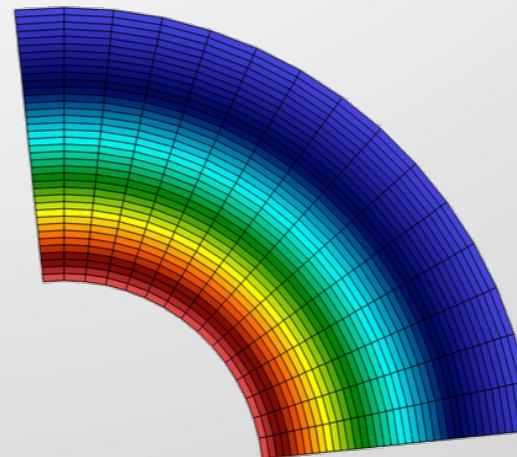
VisIt provides a flexible data model, suitable for many application domains.

- **Mesh Types:**

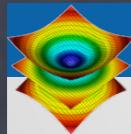
- Point, Curve, 2D/3D
Rectilinear, Curvilinear,
Unstructured
- Domain Decomposed, AMR
- Time Varying

- **Fields:**

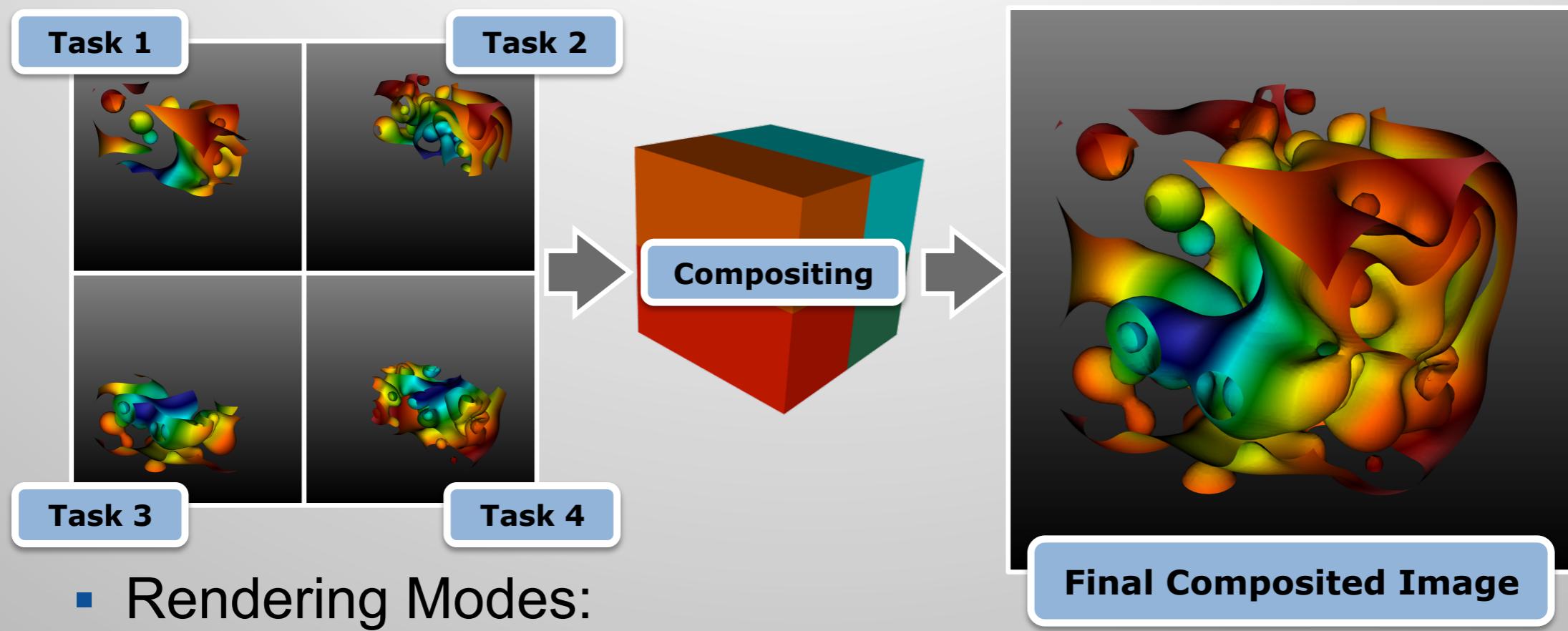
- Scalar, Vector, Tensor,
Material volume fractions,
Species



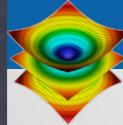
VisIt currently supports over 110 file formats.



VisIt automatically switches to a scalable rendering mode for large data sets.

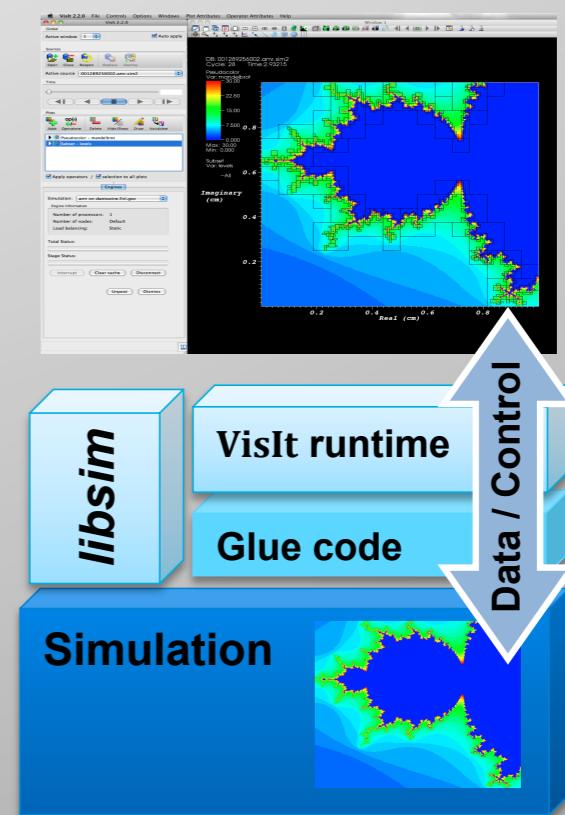


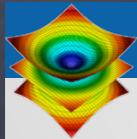
- Rendering Modes:
 - Local (hardware)
 - Remote (software or hardware)
- Beyond surfaces:
 - VisIt also provides scalable volume rendering.



VisIt's infrastructure provides a flexible platform for custom workflows.

- C++ Plugin Architecture
 - Custom File formats, Plots, Operators
 - Interface for custom GUIs in Python, C++ and Java
- Python Interfaces
 - Python scripting and batch processing
 - Data analysis via Python Expressions and Queries.
- *Libsim* library
 - Enables coupling of simulation codes to VisIt for in situ visualization.

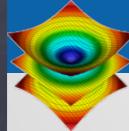




VisIt: What's the Big Deal?

- Everything works at scale
- Robust, usable tool
- Features that span the “power of visualization”:
 - Data Exploration
 - Confirmation
 - Communication
- Features for different kinds of users:
 - Visualization Experts
 - Code Developers
 - Code Consumers

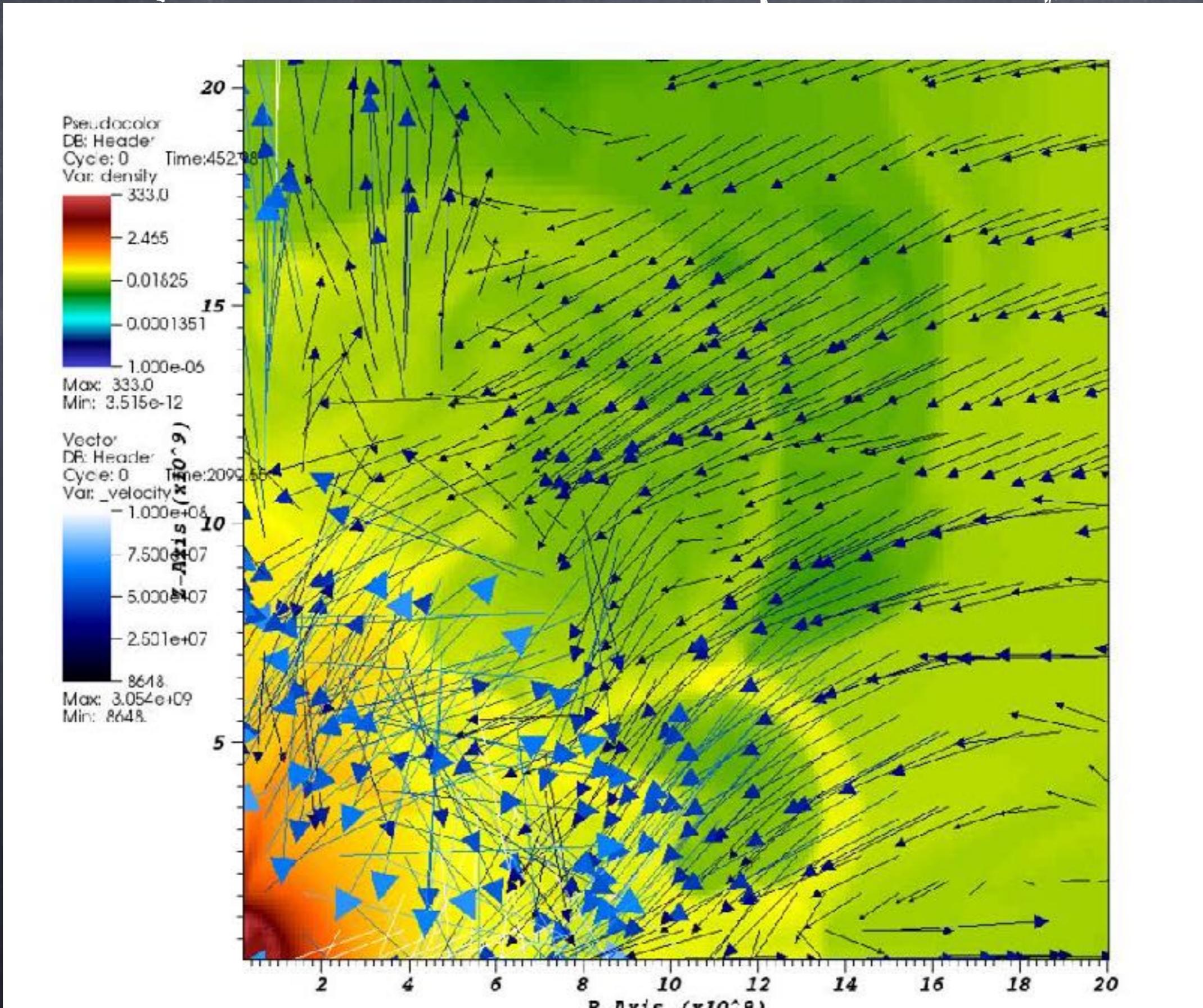
Healthy future: Vibrant Developer and User Communities



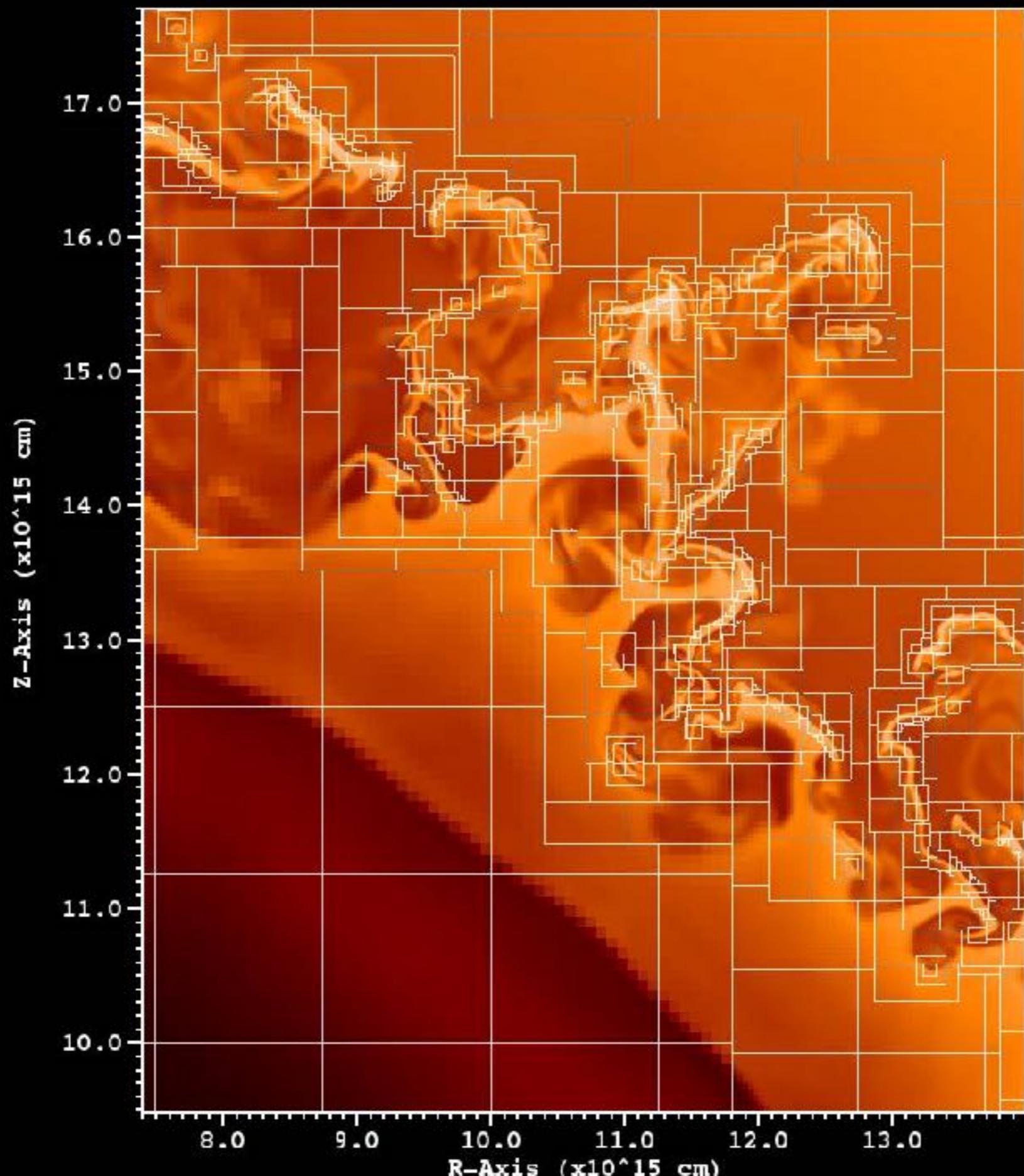
Resources

- **User resources:**
 - Main website: <http://www.llnl.gov/visit>
 - Wiki: <http://www.visitusers.org>
 - Email: visitusers@ornl.gov
- **Development resources:**
 - Email: visit-developers@ornl.gov
 - SVN: <http://portal.nersc.gov/svn/visit>

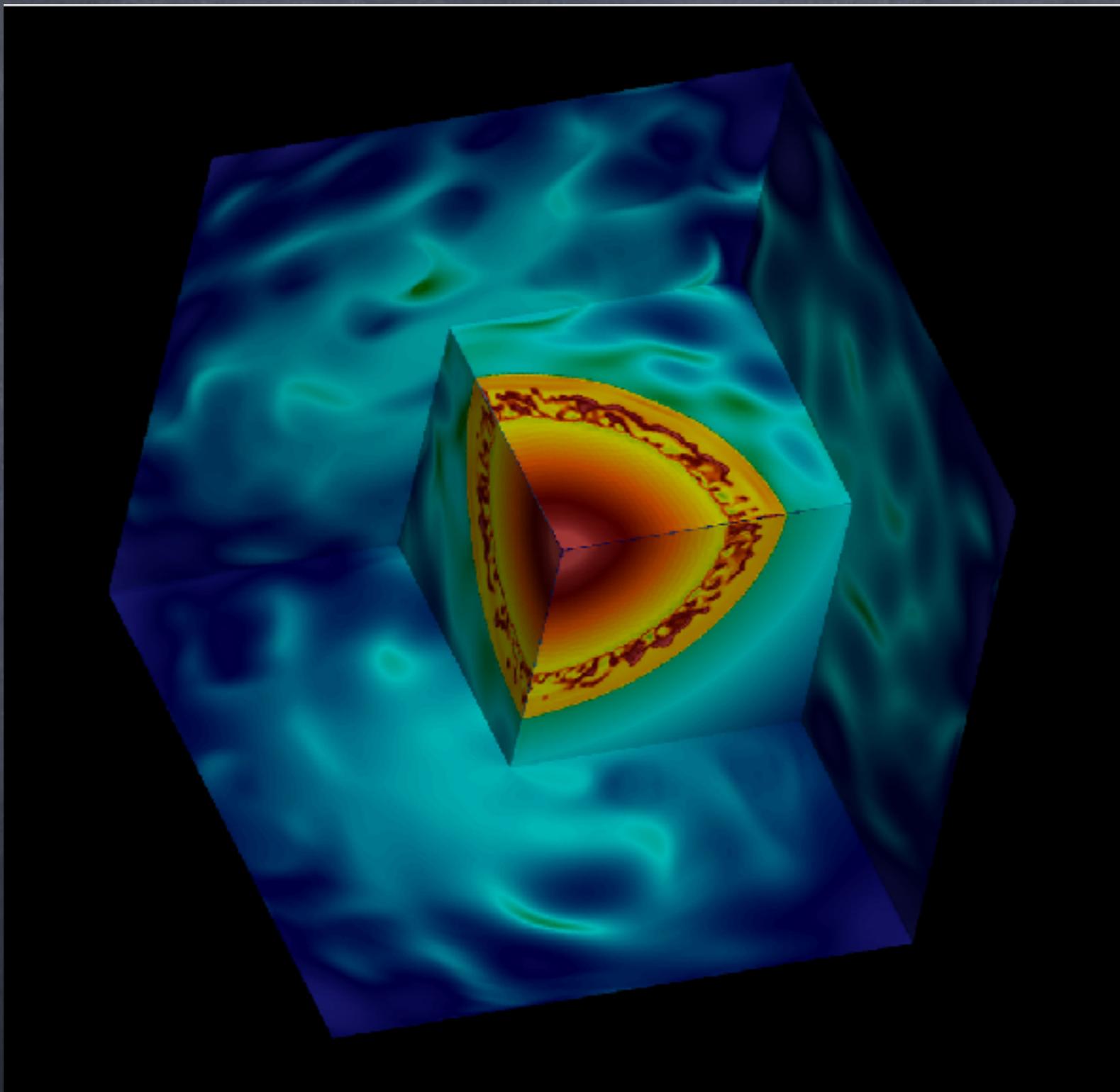
2D Pseudocolor + Vector (Fallback in a supernova)



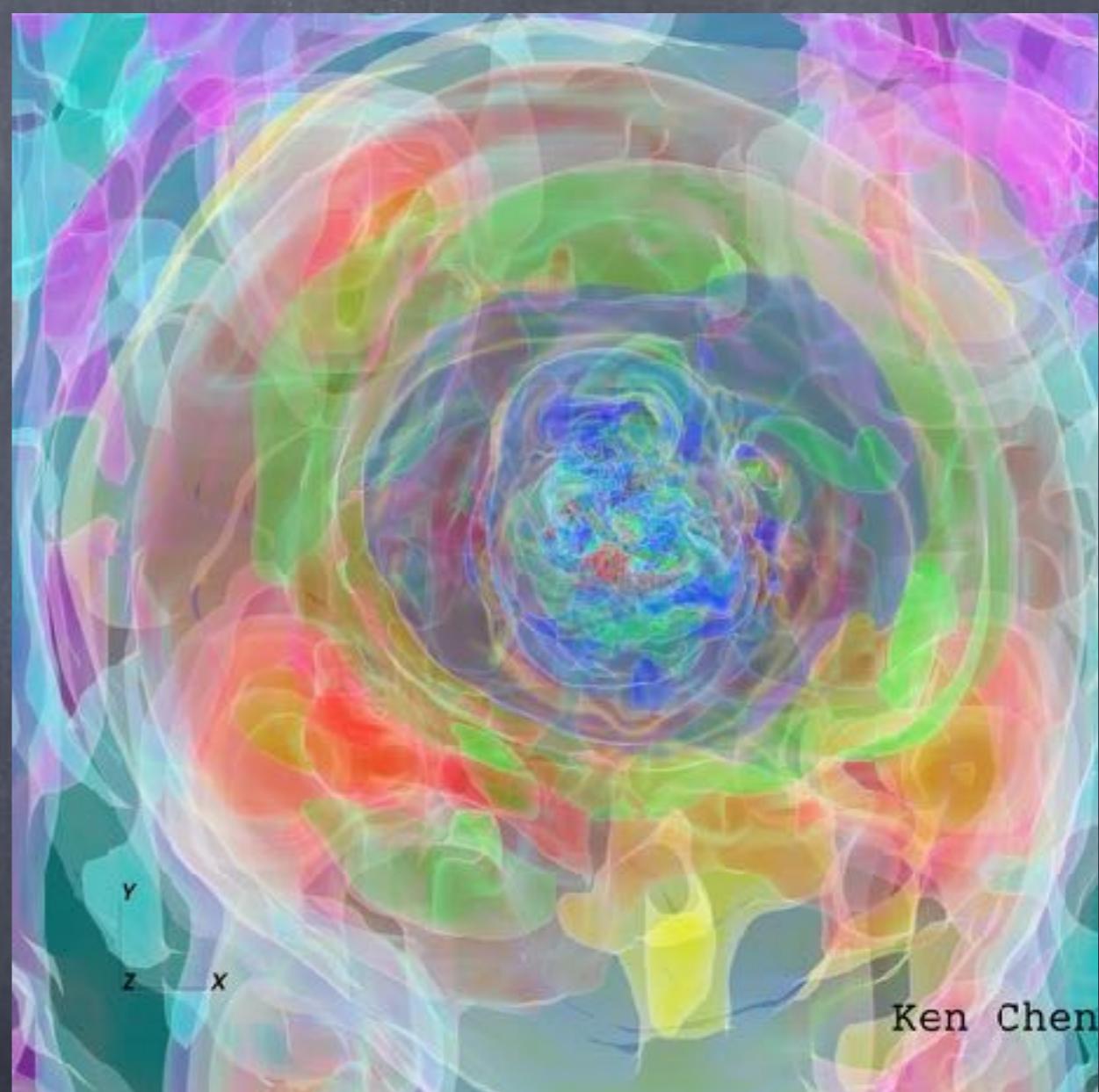
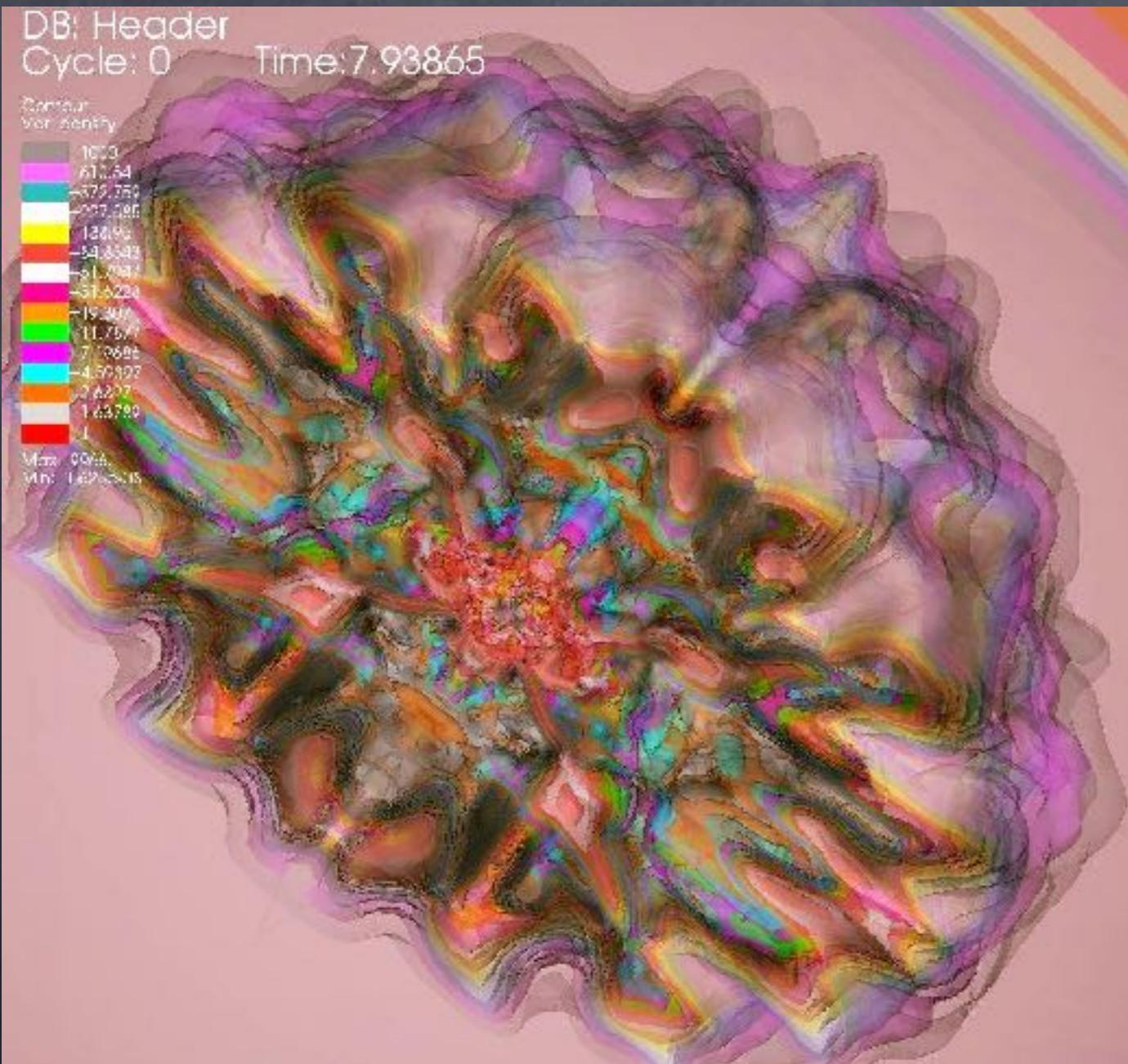
2D Pseudocolor + Mesh



3D Volume Rendering of a Supernova



3D isosurface of a Supernova



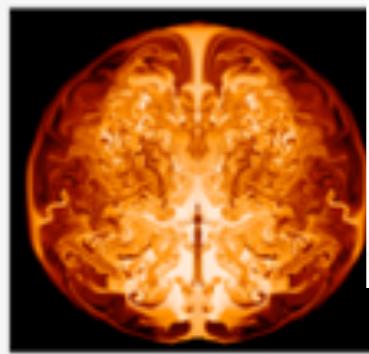
Visual Impacts I

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Slice Through the Interior of a Supermassive Black Hole



U.S. DEPARTMENT OF
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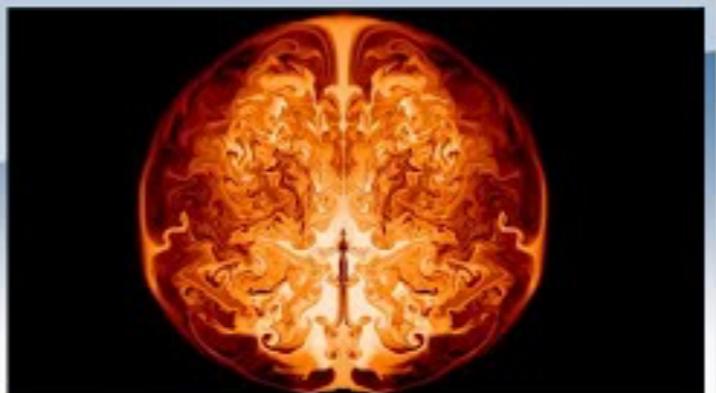
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Simulations Reveal An Unusual Death for Ancient Stars

Findings made possible with NERSC resources and Berkeley Lab code.

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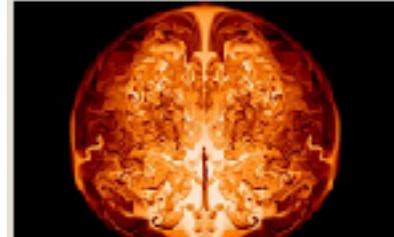
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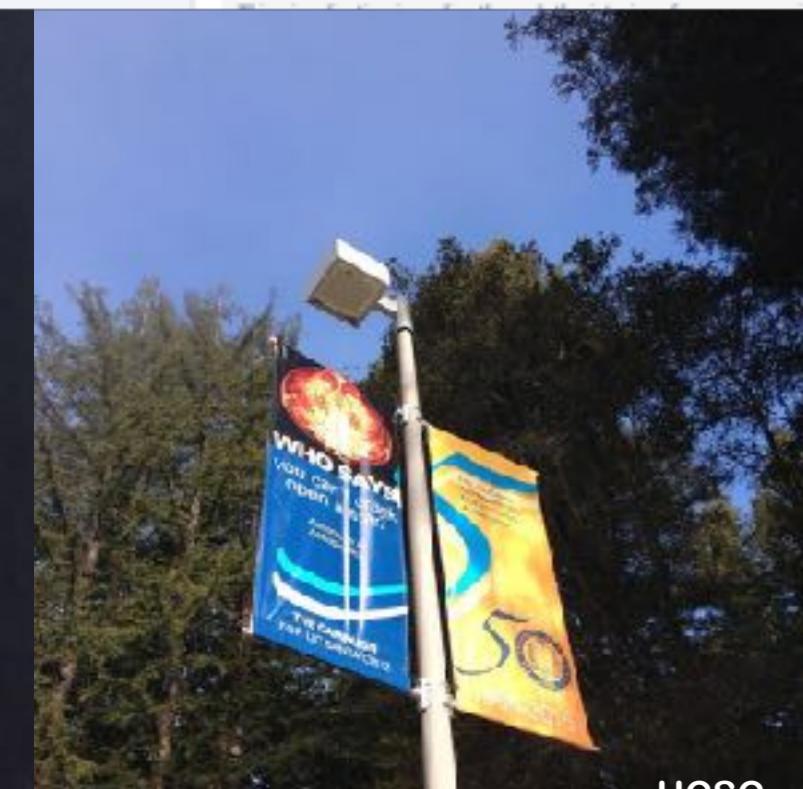
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An Unusual Death for Ancient Stars



Certain primordial stars—those between 55,000 and 16,000 solar masses—may have died unusually. In death, these objects would have exploded as supernovae and burned completely, leaving no remnant black hole behind. [Read More](#)



Visual Impacts II

The image shows the homepage of nature.com. At the top, the word "nature" is written in a large, lowercase, serif font, followed by ".com" in a smaller, lowercase, sans-serif font. The background is red. Below the header, there's a blue banner with the date "07 February 2013". To the left of the banner is a circular image showing a cross-section of a star with a bright, multi-colored interior (blue, yellow, red) and a dark outer layer. Below this image is the text "Ke-Jung Chen/Univ. Minnesota". To the right of the banner, there's a list of news items with blue hyperlinks. The first item is about a dying star's massive outburst. The second section is titled "Latest news" and includes three more items: Europe betting on drug discovery, a summary of the week from 1-7 February 2013, and Landsat 8 being used for rescue operations. At the bottom right, there's a link to "More news from nature".

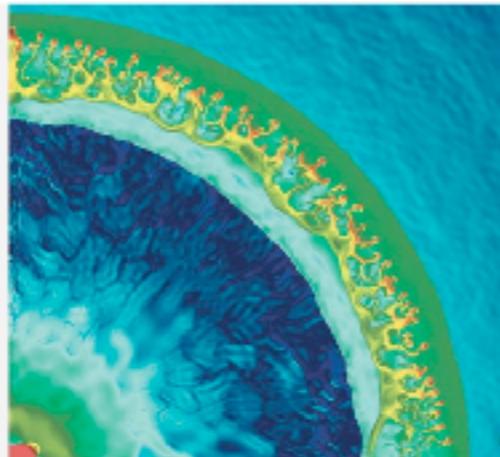
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YAHOO! NEWS

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This image shows a cross-section of a volcano, revealing two layers of molten material separated by a thin rock layer. Two subsequent publications of geo-instable supervolcano chapters, only years apart, reflected

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MOST POPULAR STORIES

A simulation showing a collision between two shells of matter. The shells are depicted as translucent blue and yellow spheres with a textured surface. They appear to be moving towards each other from opposite sides of the frame. The background is a dark, textured blue, suggesting space or a plasma environment.

The image shows the title slide of the report. The background is red. At the top, the title 'Large Scale Computing and Storage Requirements for High Energy Physics: Target 2017' is displayed in white. Below it, the subtitle 'Report of the NERSC Requirements Review' and the date 'Conducted September 11–12, 2012' are also in white. The bottom half of the slide features a large, stylized graphic of the word 'HOPPER' in red and white, with binary code patterns on either side.

Visual Impacts III

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The incredible image of a psyche supernova: Researchers simulate superluminous stellar explosion i

- Ran first 2D simulations of superluminous supernovae with superco
- These types of supernovae shine up to 100 times brighter than norm
- Many suspect they are driven by highly magnetized neutron stars, n

By CHEYENNE MACDONALD FOR DAILYMAIL.COM

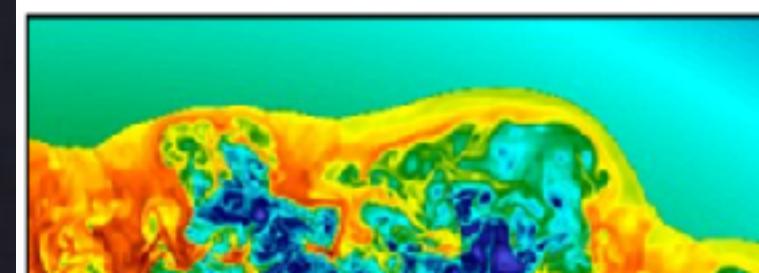
PUBLISHED: 23:47 GMT, 3 February 2017 | UPDATED: 01:14 GMT, 5 February 2017



In a move that sounds like something out of a sci-fi movie, researchers have conducted the first 2D simulations of superluminous supernovae using supercomputers.

These massive stellar explosions shine up to 100 times brighter than normal supernovae, and were only first spotted in the last few years.

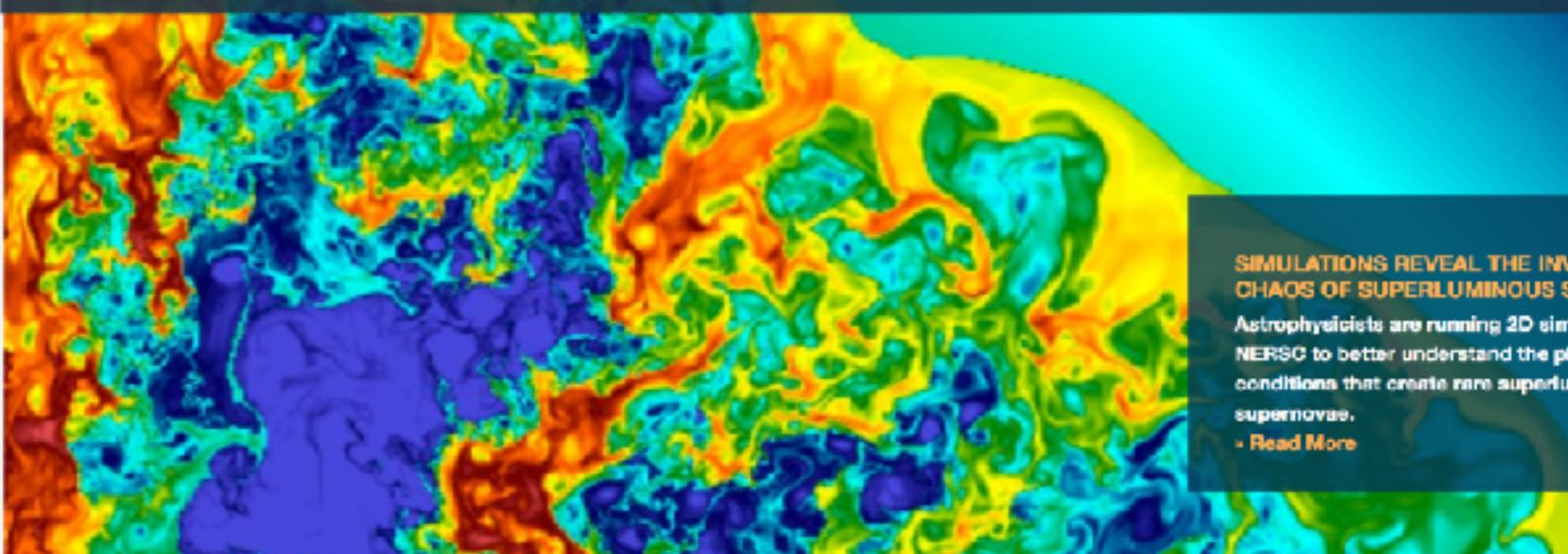
Researchers say the effort will help improve our understanding of the physical conditions that give rise to these ultra-bright objects.



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National Energy Research Scientific Computing Center



SIMULATIONS REVEAL THE INVISIBLE CHAOS OF SUPERLUMINOUS SUPERNOVAE

Astrophysicists are running 2D simulations at the National Energy Research Scientific Computing Center (NERSC) to better understand the physical conditions that create rare superluminous supernovae.

Read More



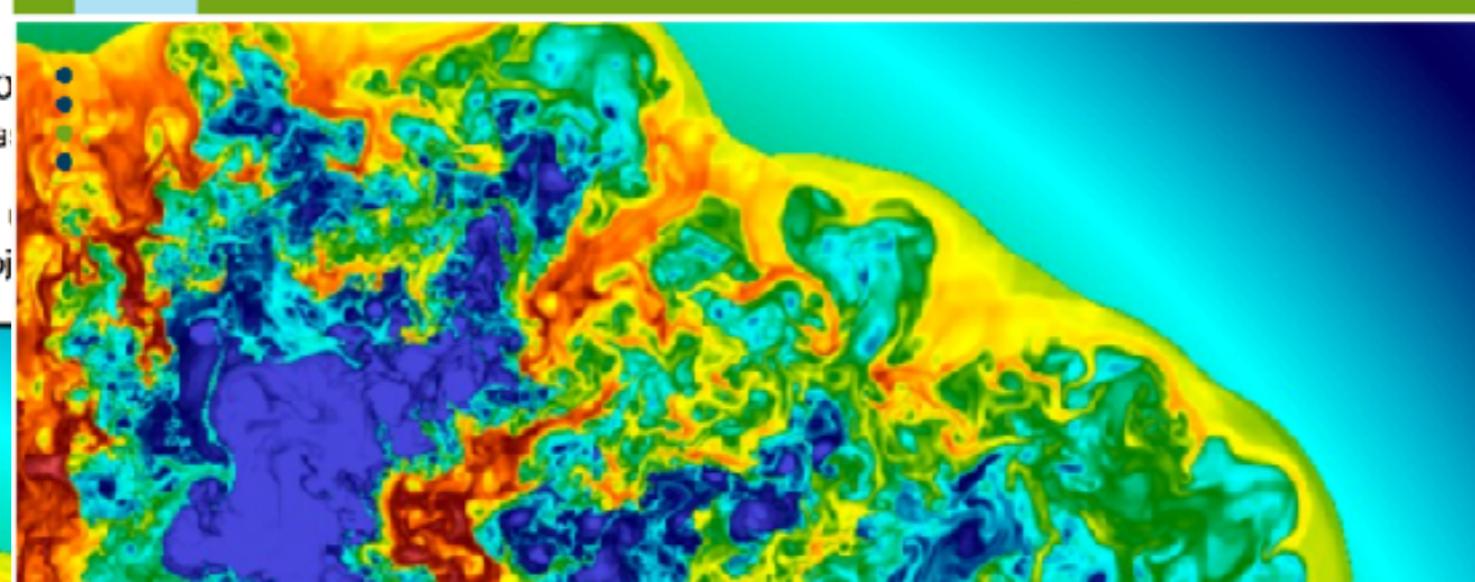
BERKELEY LAB COMPUTING SCIENCES
LAWRENCE BERKELEY NATIONAL LABORATORY



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Invisible Chaos of Superluminous Supernovae

For the first time, astrophysicists are running 2D simulations to better understand the physical conditions that create rare superluminous supernovae.

Visualization Prizes

We will select the best visualization from the projects among different groups, please submit your beautiful pictures to :

kjchen@asiaa.sinica.edu.tw

by Ken Chen