University of California
High-Performance
AstroComputing Center
(UC-HiPACC)

International Summer School
on AstroComputing 2012

AstroInformatics

Lecture 1

What is UC-HiPACC?
AstroComputing Challenges
Cosmological Visualizations

Joel R. Primack, UCSC
(Director, UC-HiPACC)

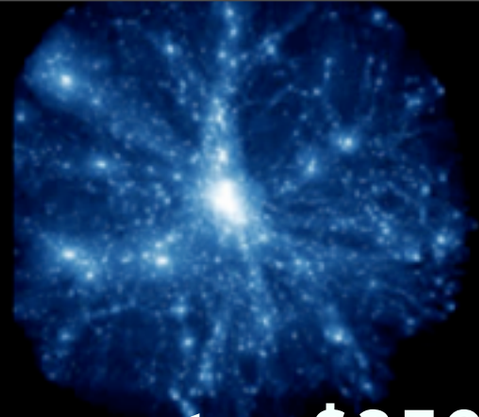
The University of California
High-Performance AstroComputing Center

A consortium of nine UC campuses and three DOE laboratories

As computing and observational power continue to increase rapidly, the most difficult problems in astrophysics are now coming within reach of simulations based on solid physics, including the formation and evolution of stars, planets, and supermassive black holes, and their interactions with their galactic environments.

The purpose of HIPACC is to realize the full potential of the University of California's worldleading computational astrophysicists, including those at the affiliated national laboratories. HIPACC will do this by fostering their interaction with each other and with the rapidly increasing observational data, and by empowering them to utilize efficiently the new supercomputers with hundreds of thousands of processors both to understand astrophysical processes through simulation and to analyze the petabytes and soon exabytes of data that will flow from the new telescopes and supercomputers. This multidisciplinary effort links theoretical and observational astrophysicists, physicists, earth and planetary scientists, applied mathematicians, and computer scientists on all nine UC academic campuses and three national labs, and exploits California's leadership in computers and related fields.

HIPACC's outreach activities will include developing educational materials, publicity, and websites, and distribution of simulation outputs including visualizations that are beautiful as well as educational.



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High-Performance AstroComputing Center
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UC-HiPACC Support: ~$350,000/yr from the University of California

UC-HiPACC Executive Committee

Director: Joel Primack (UCSC) <joel@ucsc.edu>
Coordinator from Northern California: Peter Nugent (LBNL)
Coordinator from Southern California: Michael Norman (UCSD)

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Funding Opportunities

Calls for proposals scheduled twice annually for Fall/Winter & Spring/Summer funding Cycles.

UC-HIPACC will support focused working groups of UC scientists from multiple campuses to pursue joint projects in computational astrophysics and related areas by providing funds for travel and lodging. At the heart of UC-HIPACC are working groups.

1. Small travel grants enable scientists, graduate students, and post-doctoral students to travel easily and spontaneously between Center nodes. UC-HIPACC will fund travel grant proposals submitted by faculty members, senior scientists, postdocs or graduate students up to $1000 on a first-come-first-served basis with a simple application describing the plan and purpose of the travel.

2. Grants ranging between $1000 - $5,000 to support larger working groups or participation in scientific meetings.

3. Mini Conference grants of up to $5,000 to support collaborations of multiple UC campuses and DOE labs.

4. Grants to faculty to support astrocomputing summer research projects by undergraduates.

5. Matching grants of up to $10,000 for astrocomputing equipment.

6. Innovative initiative proposals for other purposes that are consistent with the goals of UC-HIPACC. Such purposes could include meetings or workshops, software development, or education and outreach.

Annual Conferences in Northern and Southern California

HIPACC will sponsor two large meetings each year especially (but not exclusively) for scientists working on computational astrophysics and related topics at the UC campuses and labs. Unlike the more specialized meetings of working groups, we expect that these larger meetings will be broad, with the purpose of bringing theoretical astrophysicists together with computer science specialists, computer hardware experts, and observational astronomers. One meeting will be in northern California and the other in southern California to promote maximum participation. In addition to sharing new information, these meetings will highlight problems needing attention to advance the state-of-the-art and introduce participants to potential colleagues and begin collaborations.

Annual International AstroComputing Summer Schools

HIPACC will support an annual school aimed at graduate students and postdocs who are currently working in, or actively interested in doing research in, AstroComputing. Topics and locations of the annual school will rotate, and Caltech and Stanford are also welcome to participate.

The 2010 school was at UCSC, on the topic of Hydrodynamic Galaxy Simulations. Lectures were presented by experts on the leading codes (AMR codes ART, Enzo, and RAMSES, and SPH codes Arepo, GADGET, and Gasoline) and the Sunrise code for making realistic visualizations including stellar SED evolution and dust reprocessing. There were 60 students, including 20 from outside the USA. Lecture slides and videos, codes, inputs and outputs are on the UC-HIPACC website http://hipacc.ucsc.edu. Funding from NSF helped to support non-UC participant expenses.

The 2011 school was July 11-23 at UC Berkeley/LBNL/NERSC, on the topic of Computational Explosive Astrophysics: novae, SNe, GRB, and binary mergers. The scientific organizers were Daniel Kasen (LBNL/UCB) and Peter Nugent (LBNL). There was additional funding from DOE.

The 2012 school is at UC San Diego/SDSC, on AstroInformatics and Astrophysical Data Mining. The scientific director is Alex Szalay (Johns Hopkins) and the host is Michael Norman, director, SDSC. We have funding from DOE and we are still waiting to learn whether NSF will fund our proposal.

Past UC-HiPACC Conferences & Workshops

- **June 14-16, 2012:** The Baryon Cycle, Beckman Center, Irvine, CA
- **August 8 - 12, 2011:** The 2011 Santa Cruz Galaxy Workshop, UC Santa Cruz
- **August 16 - 18, 2010:** The 2010 Santa Cruz Galaxy Workshop, UC Santa Cruz
- **December 16 & 17, 2010:** The Future of AstroComputing Conference, San Diego Supercomputer Center

Upcoming UC-HiPACC Conferences & Workshops

- **June 24-27, 2012:** The Computational Astronomy Journalism Boot Camp
- **August 13-17, 2012:** The 2012 Santa Cruz Galaxy Workshop, UC Santa Cruz
- **August 17-20, 2012:** High-Resolution Galaxy Simulations Workshop

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Announcing the 2011 UC-HIPACC International AstroComputing Summer School on Computational Explosive Astrophysics

Topics Include: supernovae, gamma-ray bursts, compact object mergers, energetic transients

Location: University of California, Berkeley/ Lawrence Berkeley National Lab/ National Energy Research Scientific Computing Center

Dates: July 18 – July 29, 2011

Organizers: Daniel Kasen & Peter Nugent (UCB/LBNL)

Description: The University of California High-Performance Astro-Computing Center (UC-HIPACC) is pleased to announce the continuation of its international summer school, to be held this year by UC Berkeley and LBNL from July 18-29, 2011. This year's summer school will focus on computational explosive astrophysics, including the modeling of core collapse and thermonuclear supernovae, gamma-ray bursts, neutron star mergers, and other energetic transients. Lectures will include instruction in the physics and numerical modeling of multi-dimensional hydrodynamics, general relativity, radiation transport, nuclear reaction networks, neutrino physics, and equations of state. Afternoon workshops will guide students in running and visualizing simulations on supercomputers using codes such as FLASH, CASTRO, GR1D and modules for nuclear burning and radiation transport. All students will be given accounts and computing time at NERSC and have access to the codes and test problems in order to gain hands on experience running simulations at a leading supercomputing facility.

http://hipacc.ucsc.edu/

UC-HiPACC 2012 International Summer School on AstroComputing students will all get accounts on the new Gordon supercomputer at SDSC with 300 Tb of FLASH memory

Director: Alex Szaley, JHU
Host: Mike Norman, SDSC
HiPACC Director: Joel Primack

We will have ~37 students, 8 from UC, 19 from other US universities, and 10 from abroad.

UC-HiPACC & SDSC present:

AstroInformatics

The 2012 International Summer School on AstroComputing

July 9 - 20, 2012

San Diego Supercomputer Center
University of California, San Diego

http://hipacc.ucsc.edu/ISSAC2012.html

The data available to astronomers is growing exponentially. Large new instruments and new surveys are generating ever larger data sets, which are all publicly available. Supercomputer simulations are used by an increasingly wider community of astronomers. Many new observations are compared to and interpreted through the latest simulations. The Virtual Astronomical Observatory is creating a set of data-oriented services available to everyone. In this world, it is increasingly important to know how to deal with this data avalanche effectively, and perform the data analysis efficiently. The summer school will address this analysis challenge. The topics of the lectures will include how to bring observations and simulations to a common framework, how to query largedatabases, how to do new types of on-line analyses and overall, how to deal with the large data challenge. The school will be hosted at the San Diego Supercomputer Center, whose data-intensive computing facilities, Including the new Gordon supercomputer with a third of a petabyte of flash storage, are among the best in the world. Special access to these resources will be provided by SDSC.


SDSC's Gordon Supercomputer. Photo: Alan Decker.

Director: Alex Szalay (Johns Hopkins University)

Speakers will include:

Main lecturers
Tamas Budavari (Johns Hopkins University)
Andy Connolly (University of Washington)
Darren Croton (Swinburne University)
Gerard Lemson (Max Planck Institute for Astrophysics)
Risa Wechsler (Stanford University)
Rick White (Space Telescope Science Institute)

Additional lecturers
Mike Norman (UCSD/SDSC)
Peter Nugent (LBNL / UC Berkeley)
Joel Primack (UCSC)
Alex Szalay (Johns Hopkins University)
Matt Turk (Columbia University)

Other Details

Housing: Students will be staying at Conference Housing near SDSC on the UCSD campus (approximately $50/night).
Registration for the summer school will be $300. Payment will be required at the time of acceptance.
Aid: UC-HiPACC will cover lodging and travel expenses for UC-affiliated students, and some financial assistance may be available for other students.

Apply by March 16, 2012. For more information and to apply:
http://hipacc.ucsc.edu/ISSAC2012.html

UC-HiPACC AstroInformatics School at SDSC - Program - Weekly View

Week 1 July 9 - 13

			9-Jul	10-Jul	11-Jul	12-Jul	13-Jul
Subject	Start	End	Mon	Tue	Wed	Thu	Fri
Breakfast	8:00 AM	8:30 AM					
Lecture 1*	8:30 AM	9:40 AM	Joel Primack I	Joel Primack II	Matt Turk II	Risa Wechsler III	Gerard Lemson II
Break	9:40 AM	9:55 AM					
Lecture 2*	9:55 AM	11:05 AM	Alex Szalay I	Gerard Lemson I	Risa Wechsler II	Rick White II	Rick White III
Break	11:05 AM	11:20 AM					
Lecture 3*	11:20 AM	12:30 PM	Matt Turk I	Risa Wechsler I	Rick White I	Darren Croton I	Darren Croton II
Lunch	12:30 PM	2:00 PM	Bistro	Great Hall	Bistro	Great Hall	Bistro
Hands-on 1	2:00 PM	3:30 PM	Sinkovitz: Gordon Accounts & Tutorial	Turk: YT	Behroozi: Rockstar	Wechsler: Galaxy Catalogs	Croton: Semi-Analytics
Break	3:30 PM	4:00 PM					
Hands-on 2	4:00 PM	5:30 PM	Sinkovitz: Gordon Accounts & Tutorial	Turk: YT	Behroozi: Rockstar	Rick White	Hacking & Collaborating
			Group Dinner**				

* Lecture times include 10 minute discussions

** The Group Dinner on Monday night will be held at Home Plate sports bar, on the UCSD campus (see Summer School map)

Tentative schedule for Sunday excursion

Additional information will be provided on Monday 7/9

1:00P	Pick up at Thurgood Marshal Apartments - Participants should plan to have lunch on their own **prior** to pickup
1:15P	Drop off at Birch Aquarium
2:30P	Depart Aquarium, deliver to Old Globe Theater Balboa Park
5:30P	Dinner at Home Plate sports bar
8:00P	Drop off at Old Globe Theater – Please be sure to bring a jacket since the performance is outdoors and it can get pretty cool
~11:00P	Pick up from Old Globe Theater Balboa Park return to Thurgood Marshall Apartments

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Above: Jay Whittaker as Richard III (center) with (from left) Danielle O'Farrell and Bree Welch in The Old Globe's Shakespeare Festival production of William Shakespeare's "Richard III," directed by Lindsay Posner, June 3 - Sept. 29, 2012.

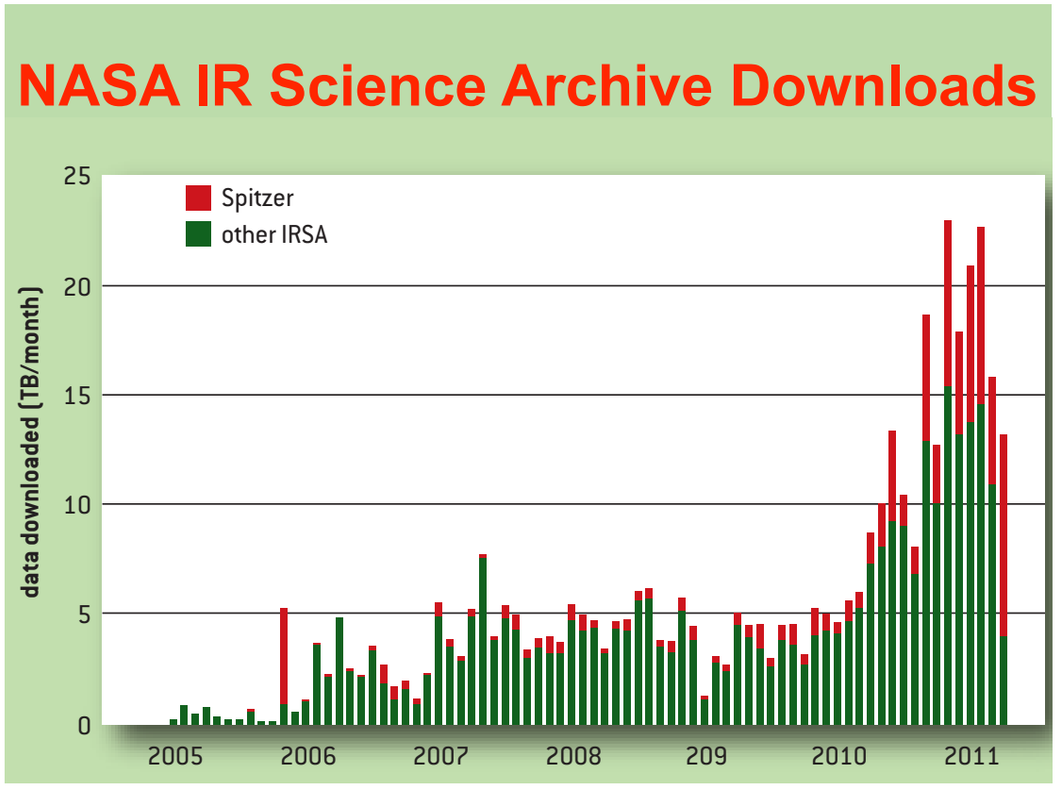
Richard III at the Old Globe Theater

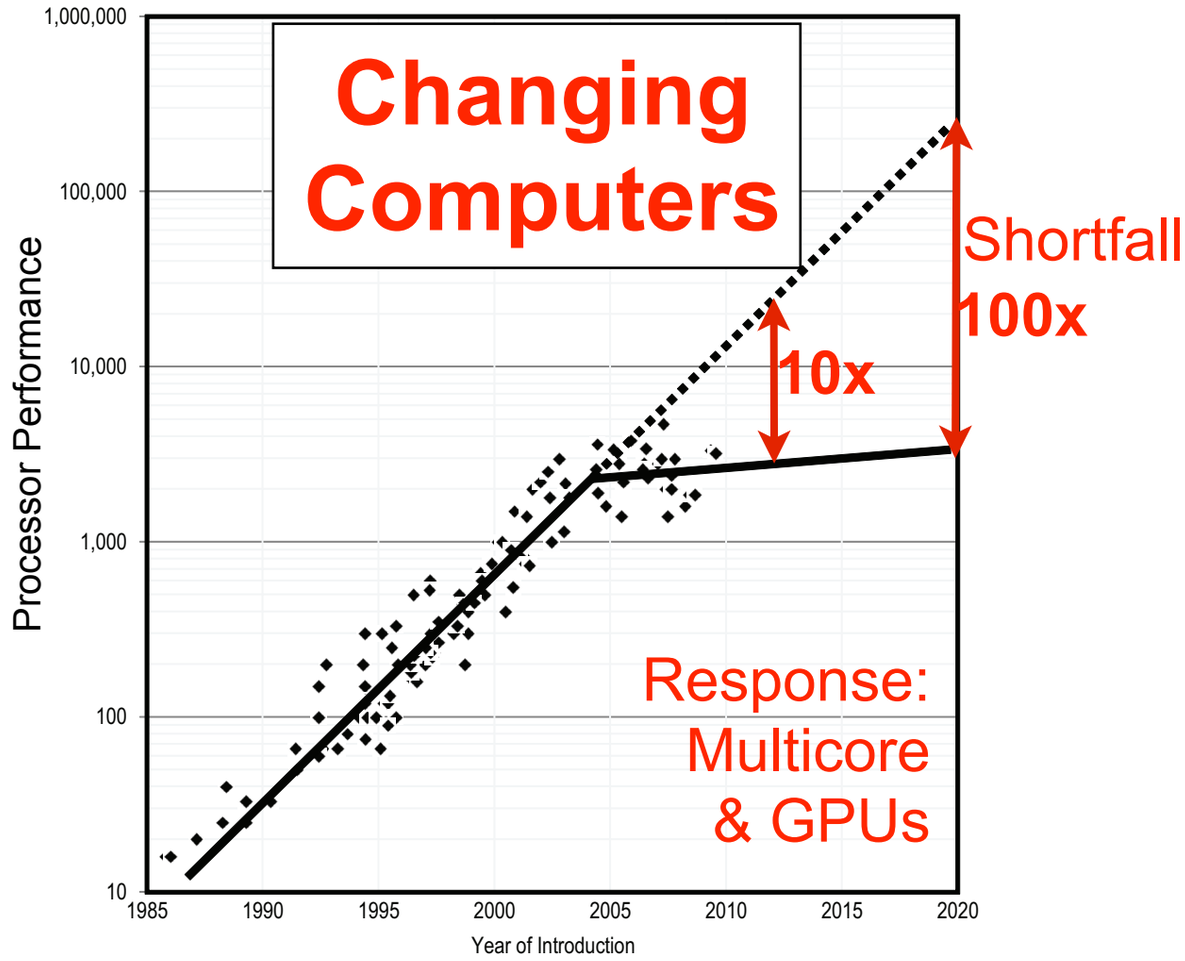
NOW IS THE WINTER OF OUR DISCONTENT MADE GLORIOUS SUMMER BY THIS SON OF YORK...” Jay Whittaker screams his first entrance as Richard III with such strained ferocity you’d think his audience sat across Balboa Park in the Starlight Bowl. For *Richard III*, Shakespeare wrote a star vehicle for a black hole. Richard boasts he will woo and wed Lady Anne (whose husband and father Richard has slain) — and does it in one of theater’s most brilliant scenes. He systematically eliminates whoever stands next in line. In the end, no one will come to his aid, not even a horse.

The title character of "Richard III" is one of the most diabolical and outrageous villains in all of literature. A ruthless Machiavellian, the brilliant and power-hungry lord embarks on a bloody campaign to seize and keep the English crown. Shakespeare paints an unforgettable portrait of obsession, seduction, betrayal and a man who would be king.

Big Challenges of AstroComputing

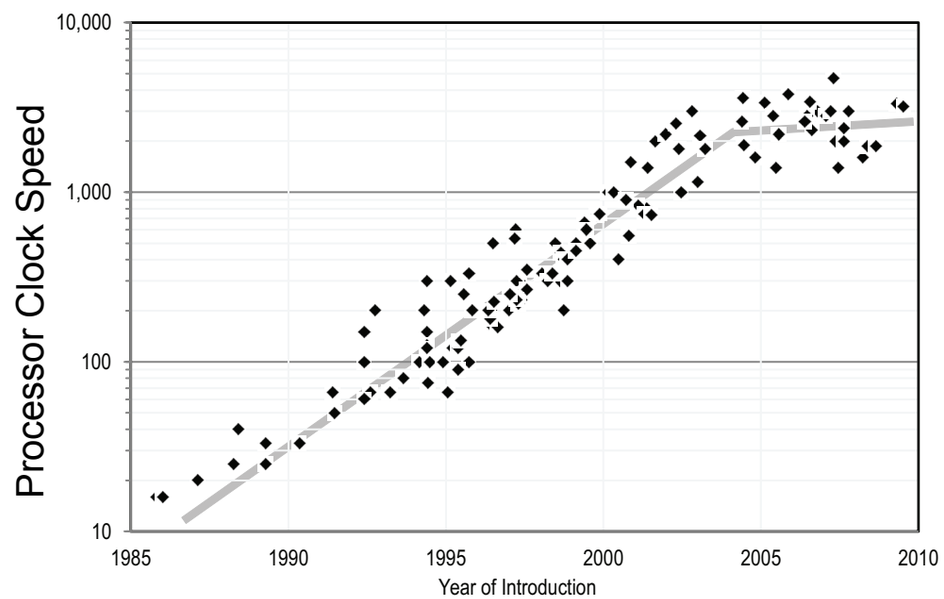
Big Data





LSST

Compared to other astronomical sky surveys, the **Large Synoptic Survey Telescope** (LSST) survey will deliver time domain coverage for orders of magnitude more objects. It is envisioned that this project will produce ~30 TB of data per each night of observation for 10 years. The final image archive will be ~70 PB (and possibly much more), and the final LSST astronomical object catalog (object-attribute database) is expected to be ~10-20 PB. LSST's most remarkable data product will be a 10-year "movie" of the entire sky. This time-lapse coverage of the night sky will open up time-domain astronomy.



High Performance Scientific Computing Needs

The challenges facing us are

"**Big data**" -- too large to move -- from more powerful observations, larger computer outputs, and falling storage costs

Changing high-performance computer architecture -- from networked single processors to multicore and GPUs

These challenges demand new collaborations between natural scientists and computer scientists to develop

Tools and scientific programmers to convert legacy code and write **new codes efficient on multicore/GPU architectures**, including **fault tolerance** and **automatic load balancing**

New ways to **visualize and analyze big data remotely**

Train new generations of scientific computer users

Improve education and outreach

AstroComputing is Prototypical Scientific Computing

Astronomy has several advantages:

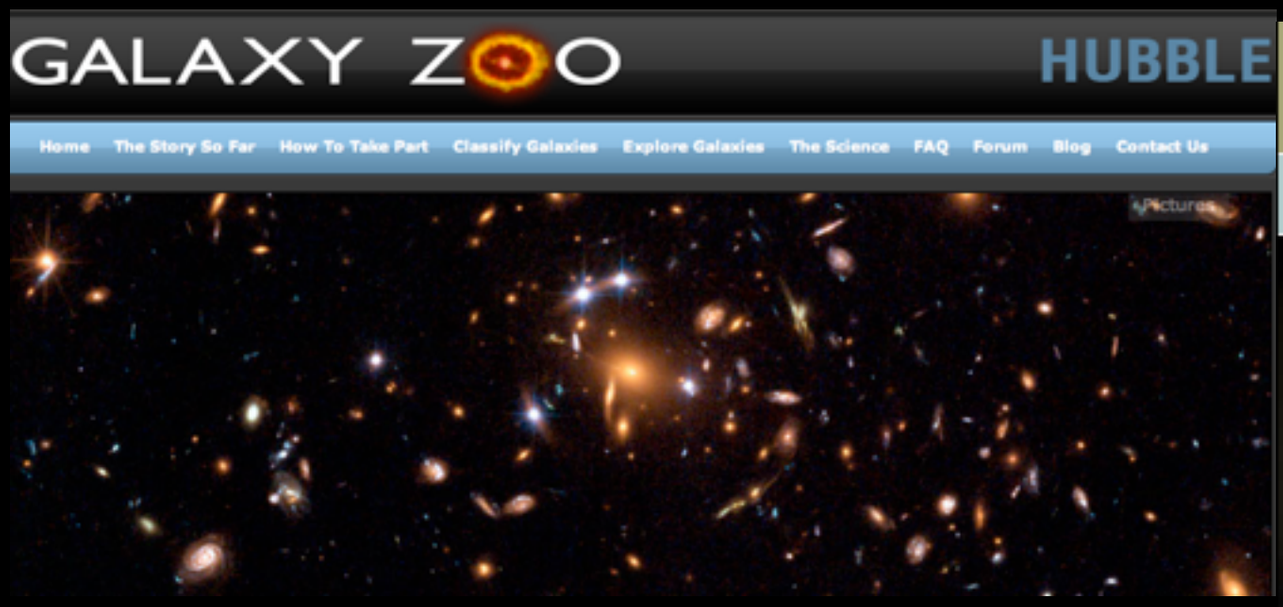
The data tends to be pretty **clean**

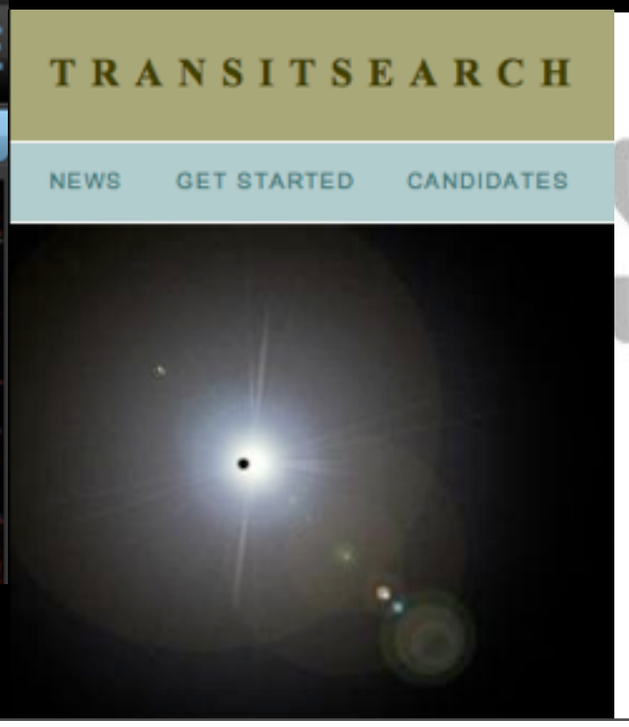
The data is (mostly) **non-proprietary**

The research is (mostly) **funded**

The data is pretty **sexy**

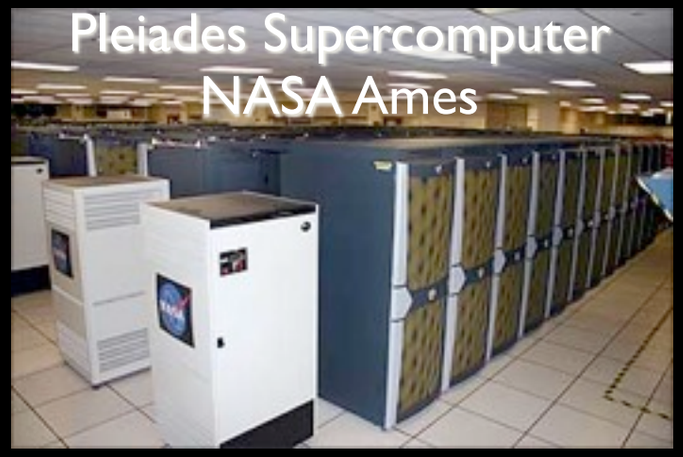
There's a lot of **public involvement**:

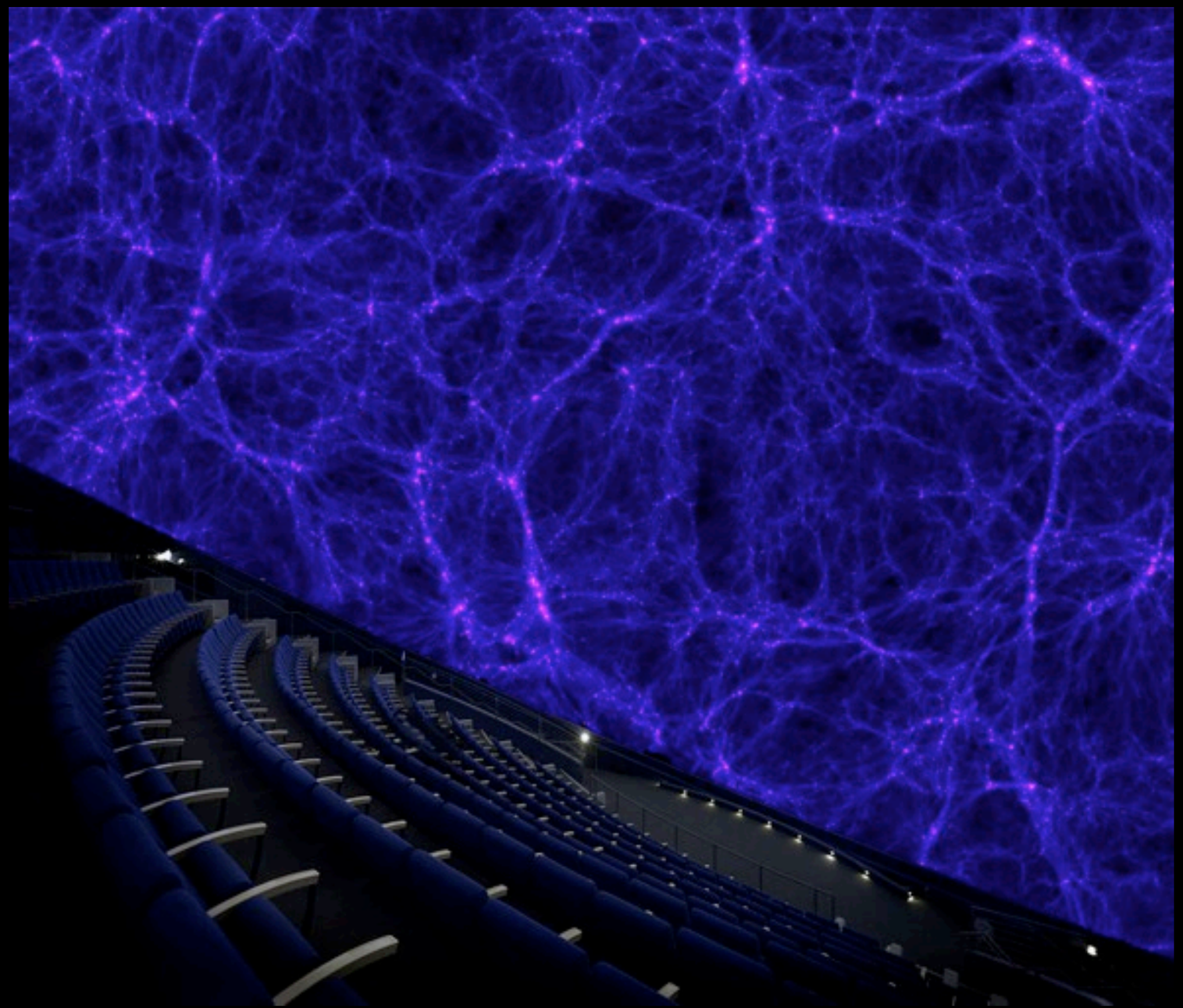




Astro-Computation Visualization and Outreach

Project lead: Prof. Joel Primack, Director, UC High-Performance AstroComputing Center
UC-HIPACC Visualization and Outreach Specialist: Nina McCurdy





HIPACC is working with the Morrison Planetarium at the California Academy of Sciences (pictured here) to show how dark matter shapes the universe. We helped prepare their show *LIFE: a Cosmic Story* that opened in fall 2010, and also a major planetarium show that opened the new Adler Planetarium Grainger Sky Theater July 8, 2011.

Galaxy Merger Simulation

Run on Columbia Supercomputer at NASA Ames Research Center.
Dust simulated using the Sunrise code (Patrik Jonsson, UCSC/Harvard).

Astronomical observations represent snapshots of particular moments in time; it is effectively the role of astrophysical simulations to produce movies that link these snapshots together into a coherent physical theory.

Showing Galaxy Merger simulations in 3D will provide a deeper, more complete picture to the public and scientists alike.

Cosmological Visualization Questions

How best to show the 3D structures? Are fly-throughs effective?

How can we show gas, stars, and dark matter?

How could such visualizations best convey to non-specialists what's happening?

How can we show evolution of structures? Use color? Use arrows or trajectories to show motion?

How can visualizations be most helpful on the web? For planetariums? For teachers at all levels?

How can we show the huge range of scales better?

How can we show and interact with Big Data?

THINK COSMICALLY
ACT GLOBALLY
EAT LOCALLY

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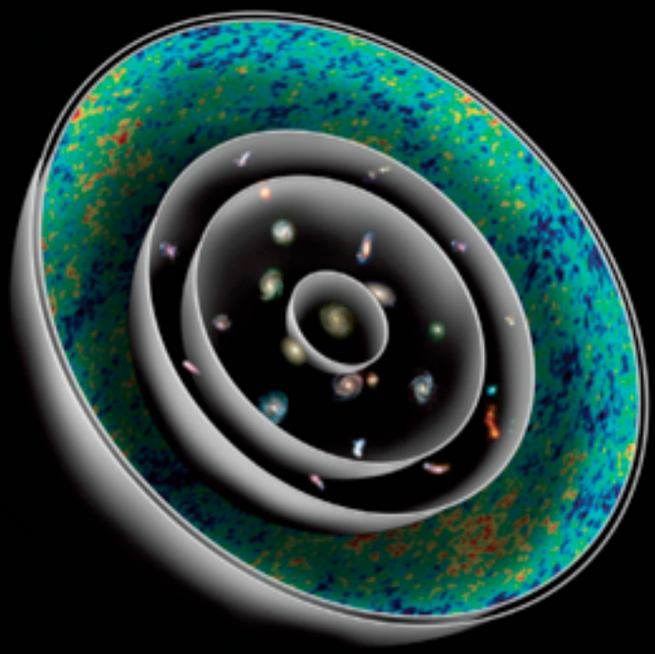
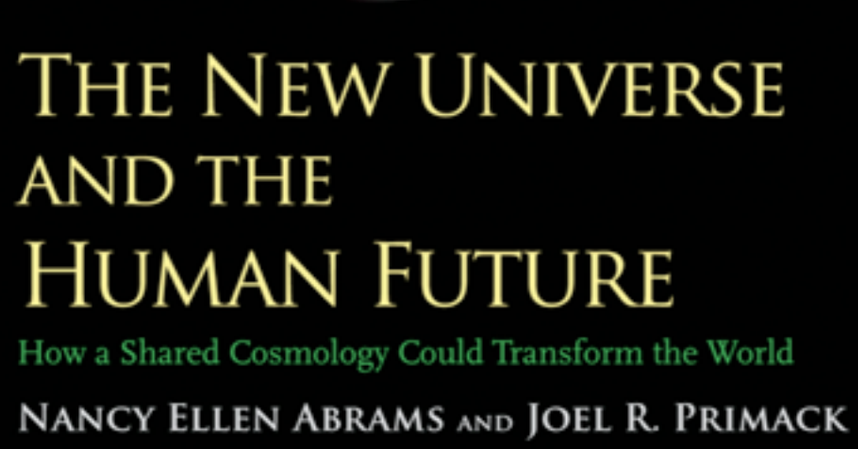
Book Website with images and videos:

New-Universe.org

Visit us on Facebook at

The New Universe
and the Human Future





Yale University Press, 2011/2012