Welcome to the Conference

The University of California High-Performance AstroComputing Center presents

Computational Astrophysics 2014-2020: Approaching Exascale

Lawrence Berkeley Lab - March 21-22

Friday 8:30 – 9:30 **Breakfast** on site (LBL – Building 66 Auditorium)

9:30 am **Welcome** – Joel Primack (UCSC) UC-HiPACC 5th year report, this conference

9:45 am – 1:00 pm **Latest Progress and Current Challenges** – Chair: Peter Nugent

Cosmological simulations – Anatoly Klypin (NMSU), Mike Warren (LANL)

Collisionless fluids - Tom Abel (Stanford)

Galaxy simulations – Dušan Kereš (UCSD), Phil Hopkins (Caltech)

Star formation simulations - Mark Krumholz (UCSC)

Planet formation simulations – Greg Laughlin (UCSC)

Berkeley Institute for Data Science (BIDS) - Saul Perlmutter (UCB/LBNL)

Data-driven astronomical inference with machine learning – Joshua Bloom (UCB)

Simulations of supernovae and neutron star mergers – Dan Kasen (UCB/LBNL)

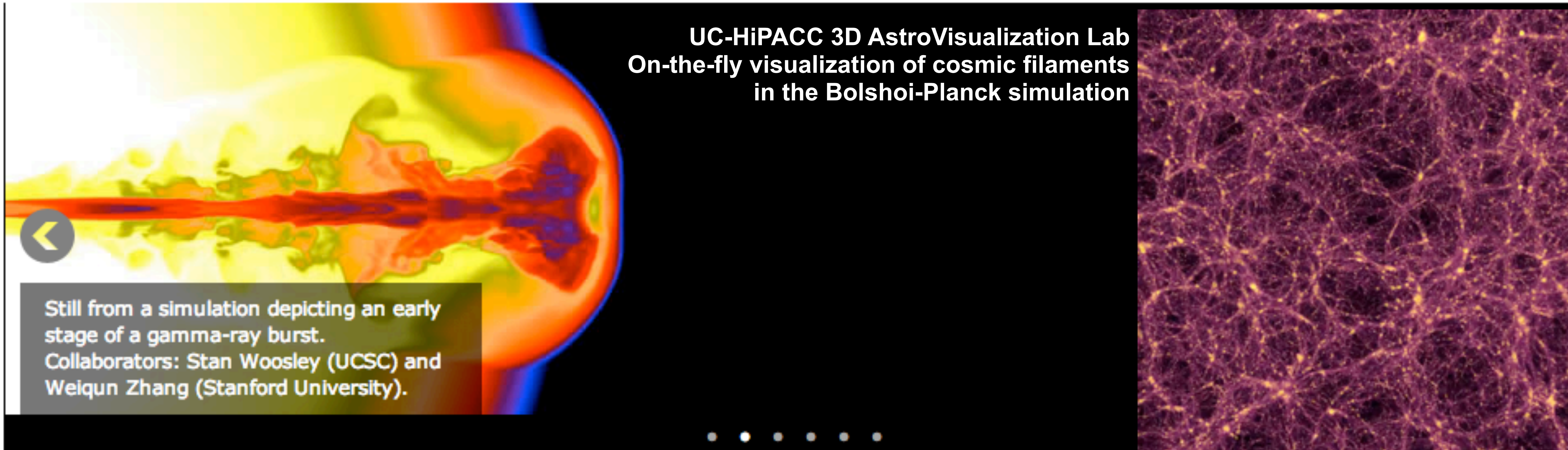
Computational neutrino flavor astrophysics – George Fuller (UCSD)

Time domain computing – Julian Borrill (LBNL), Tom Vestrand (LANL)

1:00 – 2:00 **Lunch** provided on site for all registered participants

http://hipacc.ucsc.edu

UNIVERSITY OF CALIFORNIA
HIGH-PERFORMANCE ASTROCOMPUTING CENTER



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Press Room

- Recent press releases about computational astronomy across the HiPACC consortium
- Press release archive
- Press releases issued by UC-HiPACC

Announcements/Events

- 2014-2020: Approaching Exascale, Lawrence

The purpose of the University of California High-Performance AstroComputing Center (UC-HiPACC) is to realize the full potential of the University of California world class resources in computational astronomy. Read the letter from the Director

2014–2020: Approaching Exascale, Lawrence Berkeley Lab. March 21–22

The 2014 UC-HiPACC International Summer School on AstroComputing, ISSAC2014, will be on nuclear astrophysics, supernovas, and neutrinos. It will be held July 21–August 1 at the San Diego Supercomputer Center, UCSD. George Fuller (UCSD) will be the director, and the lecturers will include Baha Balantekin (Wisc), Joseph Carlson (LANL), Huaiyu Duan (UNM), Alex Friedland (LANL), Dan Kasen (UCB/LBL), Evan Kirby (UCI), Tony Mezzacappa (ORNL), and Yong-Zhong Qian (UMN). We are finalizing the program and we will open applications soon.

March 2014 AstroShort: Discovered: Stellar Dinosaurs!

Stay Connected

In the News

- **"Computational Astronomy Boot Camp" - a feature in the Winter 2012-2013 issue of Science Writers, the quarterly magazine of the National Association of *Science Writers*, by Trudy E. Bell. ...**view article
- "The Cosmological

UC-HiPACC's Astro- Shorts

AstroShort

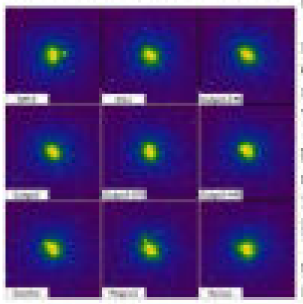
UCI, UCSC, UCSD

AGORA: Seeing the Invisible Elephant

You know the familiar fable about the blind men trying to discern the nature of an elephant simply from feeling the animal with their hands: one at the side of the elephant thought it was like a wall, one at the trunk t... like a snake, and one at the tail thought it w... Each accurately perceived the elephant in p... tactile observations were inconsistent with...

Astronomers are much in the same posit... discern the nature of the Universe. Most of ... mass in the cosmos is cold dark matter—a ... weakly interacting elementary particle that ... both individual galaxies such as our own M... well as entire clusters of hundreds of galax... are blind to it: dark matter does not emit li...

of the cosmic web of large-scale structure in the cosmos. At small scales, computational models can calculate such details as shock waves from supernova explosions, turbulence,



Differences in supercomputer simulations to be compared in the AGORA project are clearly evident in this test galaxy produced by each of nine different versions of participating codes using the same astrophysics and starting with the same initial conditions. The goal of AGORA is to analyze such differences to improve the realism and predictive power of supercomputer simulations, and thus astronomers' understanding of astrophysical processes. Credit: Simulations performed by Samuel Leitner (ART-II), Ji-hoon Kim (ENZO), Oliver Hahn (GADGET-2-CFS), Keita Todoroki (GADGET-3), Alexander Hobbs (GADGET-3-CFS and GADGET-3-AFS), Sijing Shen (GASOLINE), Michael Kuhlen (PKDGRAV-2), and Romain Teyssier (RAMSES)

...ment can be independently reproduced by ... can it be regarded as robust.

Now, a new ambitious multiyear interna... AGORA is figuring out how to reveal the e... and also discern which of the inconsistenci... complexities of astrophysics versus compu...

The challenge of scales

One major challenge, for example, has b... modeling astrophysical processes over the ... scales in the Universe—all the way from th... individual stars to the formation of galaxie...

AstroShort

LANL

HAWC-Eye on the Sky

The most violent phenomena in the Universe—blazars and gamma-ray bursts—are in the sights of a brand new wide-field telescope that began monitoring the heavens high in the mountains of Mexico on August 1, 2013.

Called the High-Altitude Water Cherenkov (HAWC) Observatory, the brand new instrument will observe ... rays (the Universe's most energetic photons) and h... gy cosmic rays (protons and nuclei with energies h... than 100 billion electron volts, or 100 GeV).

For comparison, visible light at a green wavelen... 532 nanometers has an energy of slightly more than ... tron volts (2 eV). "The photons we are looking at a... billion to 100 trillion times more energetic than vis... light," explained Gus Sinnis, the physicist at Los A... National Laboratory in New Mexico who is overse... scientific analysis of HAWC data. Their wavelengt... smaller by the same enormous factors.

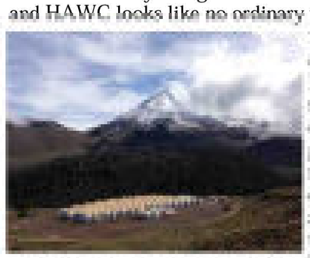
"At these energies, photons behave more like pa... than waves," he continued. "Looking at the cosmos... extraordinarily high energies filters out normal star... galaxies, letting us see only the most extreme objec... nable." Blazars are active galactic nuclei—superma... black holes a million times more massive than the s... generate intense radiation as material falls into ther... jets pointed at us. Gamma-ray bursts originate from ... of supernovae (exploding stars) with jets pointed at ... from merging neutron stars.

which in turn hit other nuclei. In an instant, the shower multiplies to millions of subatomic particles, spreading out to a pancake shape a few hundred meters across when it reaches

A telescope made of water

Extraordinary energies call for extraordinary de... and HAWC looks like no ordinary telescope. For o... it does not form ... age, so there are ... lenses or mirror... stead, the instru... consists of an a... gigantic corruga... tanks—each 4.5 ... deep and 7.3 m ... across—filled w... trapure water. A ... bottom of each t... four photomultip... tubes sensitive t... olet light, one in ... ter and three mo... equilateral trian... around it.

Here's the b... When an energe... ma ray or cosmi... plows into Earth... mosphere, it col... with a nucleus o... atom or molecul... collision produc... getic electrons, ... muons, and other charged subatomic particles trave... downward through the air at nearly the speed of lig...



Array of 115 water tanks of the High-Altitude Water Cherenkov (HAWC) Observatory as it appeared on September 13, 2013. When completed in early 2014, it will have 300 tanks. HAWC is at an altitude of 4,100 meters on the flanks of the Sierra Negra volcano near Puebla, Mexico. It is an international collaboration of over 20 institutions in the U.S. and Mexico. In the background is Pico d'Orizaba, a dormant volcano with an elevation of 5,635 meters (the highest peak in North America outside of Alaska). Credit: Benemérita Universidad Autónoma de Puebla

AstroShort

UCR, UCSC

Measuring Olbers's Paradox

Why is the sky dark at night? That question puzzled centuries of astronomers, including Thomas Digges, Johannes Kepler, and Edmond Halley. After all, if the universe were infinite in all directions, it would be filled with an infinite number of stars, whose collective glow would make the night sky bright. So did a dark sky at night imply that the universe was not infinite? The conundrum was given the name of Olbers's paradox, after the German astronomer Wilhelm Olbers who discussed it in the 1820s.

Well, it turns out that those historical astronomers, working just from first principles, were onto something truly profound—but for reasons they could not anticipate.

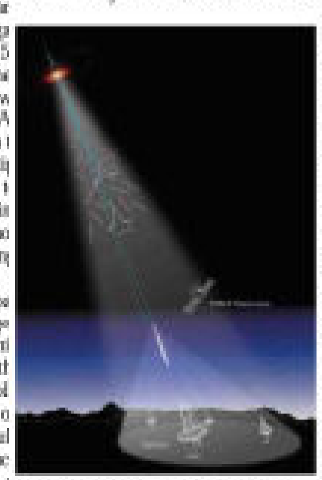
Even from deep space far away from the lights of Earth and the stars of the Milky Way, the sky of intergalactic space is *not* absolutely black. It *does* faintly glow with photons from galaxies, both bright galaxies and those too distant to resolve with current instruments. That ever-so-faint glow is called the extragalactic background light (EBL).

Extragalactic background light

Streaming through deep space today in some form is almost all the light that all galaxies have radiated throughout the history of the Universe. Some of these photons are extraordinarily ancient, emitted billions of years ago and redshifted (expanded in wavelength) with the expansion of the universe. Other photons are comparatively recent from local galaxies nearby. Together, these photons crisscrossing space suffuse the Universe with a faint background glow in the ultraviolet, visible, and infrared regions of the spectrum, rendering the deep night-black void between galaxies not totally dark.

Capturing those precious ancient photons, carefully measuring and counting them, and learning to read the abundance and patterns of the EBL allows astronomers to deduce details both about the early formation of galaxies like our own Milky Way as well as about the grand story of cosmic origin.

Measuring the EBL directly is difficult, however, because our



Energetic gamma rays (dashed lines) from a distant blazar strike photons of extragalactic background light (wavy lines) in intergalactic space, annihilating both gamma ray and photon. Different energies of EBL photons waylay different energies of gamma rays, so comparing the attenuation of gamma rays at different energies from different spacecraft and ground-based instruments indirectly measures the spectrum of EBL photons. Credit: Nina McCurdy and Joel R. Primack/UC-HIPACC; Blazar: Frame from a conceptual animation of 3C 120 created by Wolfgang Steffen/UNAM

solar system and our Milky Way galaxy are themselves awash in light. Only in the past year or so have astronomers succeeded in obtaining actual measurements of the elusive EBL using a clever indirect work-around: observations of gamma rays from blazars—galaxies with supermassive black holes producing jets of gamma rays that happen to be pointed at Earth. The latest results were published in *The Astrophysical Journal* in May 2013 by Alberto Domínguez of the University of California, Riverside, and coauthors.

These pioneering measurements are possible because gamma rays from distant sources collide with lower-energy visible and infrared EBL photons, annihilating both; those collisions with EBL photons thus remove some of the gamma rays. Different energies of the highest-energy gamma rays are waylaid by different energies of EBL photons. Thus, measuring how much gamma rays of different energies are attenuated from blazars at different distances from Earth indirectly gives a measurement of how many EBL photons of different wavelengths exist along the line of sight from blazar to Earth over those different distances.

The new measurements required combining data on X-ray and gamma-ray blazar emissions from space observatories with observations of the highest-energy gamma rays detected by Atmospheric Cherenkov Telescopes on the ground.

What the measurements reveal

The result? The EBL both nearby and from earlier (more distant) epochs is consistent with expectations from the number of galaxies observed, with little room for additional light from exotic hypothetical sources. This important measurement constrains when and how the universe was reionized during the first billion years.

The EBL measurements also show that the galaxies that were shining at "cosmic high noon"—the period from about eight to twelve billion years ago when stars were forming most rapidly—were unlike most nearby galaxies. Nearby galaxies emit most of their light near visible wavelengths. But at cosmic high noon, exploding stars produced dust (made of heavier elements such as carbon, oxygen, and iron) that enveloped star-forming regions and absorbed much of the ultraviolet and visible light, which was reradiated at much longer infrared. As this dust built up in galaxies over cosmic time, it allowed later generations of stars to form along with rocky planets, including Earth.

Future measurements of the EBL using gamma rays from farther away can help reveal the nature of the first stars and galaxies. *—Trudy E. Bell, M.A.*

Further reading: A press release summarizing this work is at http://hipacc.ucsc.edu/PressRelease/CGRH.html. The paper "Detection of the Cosmic γ-Ray Horizon from Multiwavelength Observations of Blazars," by Alberto Domínguez and six coauthors in *The Astrophysical Journal* is at http://arxiv.org/pdf/1305.2162v1.pdf. A definitive book on the history of Olbers's paradox is *Darkness at Night: A Riddle of the Universe* by Edward Harrison (Harvard University Press, 1989).

The University of California High-Performance AstroComputing Center (UC-HiPACC), based at the University of California, Santa Cruz, is a consortium of nine University of California campuses and three Department of Energy laboratories (Lawrence Berkeley Laboratory, Lawrence Livermore Laboratory, and Los Alamos National Laboratory). UC-HiPACC fosters collaborations among researchers at the various sites by offering travel and other grants, co-sponsoring conferences, and drawing attention to the world-class resources for computational astronomy within the University of California system. More information appears at http://hipacc.ucsc.edu

AstroShort

Planets Amidst the Noise

Tau Ceti's planets were not supposed to be there.

They revealed themselves when Steven S. Vogt, astrophysics professor at UC Santa Cruz, and his collaborators were testing a new noise-analysis method on spectrometer data to calibrate their technique. Indeed, the team of 15 astronomers from seven institutions on four continents had picked Tau Ceti specifically because meticulous observations strongly suggested the star had no planetary system.

From the earliest days of the hunt for exoplanets almost 20 years ago, astronomers suspected that evidence of Earth-like planets might be buried in the noise of spectroscopic measurements of stellar radial velocities (stars' velocities in space toward or away from us). Such noise arises from flares and other activity on a star's surface.

The tiny signal...

...ared to stars. Even ...'s center (axis of ...volve around the ...mass). Like a ...ne, the gravitational ...round just a little. ... ...arycenter for our ...r system, for ex...lowly wanders ...r the center of the ...ther than a solar ...ove the Sun's sur...en all the planets ...e same side of the ...tem as Jupiter, the ...er is farther from ...r of the Sun to...ther than it is when ...anets are on the ...side of the solar ...rom Jupiter. In ...rds, the Sun itself ...a slow dance like a ...ing but step of ...of thousands of ...rs around the solar barycenter.

...1980s, exoplanet ...egan to wonder ...the barycentric ...g of a distant star ...may the existence ...Most stars speed ...more meters per ...ue to the pull from ...would speed or ...d, Vogt noted. ...sion spectrometer, ...ctrograph (HIRES) ...ck Observatory for ...measures Doppler ...300,000,000, a ...er second.

...amidst stellar "jitter"

Detecting the barycentric wandering of a distant star is a colossal challenge for both measurement and computational

AstroShort

Discovered: Stellar D...

"We had no idea what these things were," recounted D. Andrew Howell, staff scientist at Las Cumbres Observatory Global Telescope Network and adjunct assistant professor at UC Santa Barbara.

In 2006 and 2007, two objects caught by the detectors of the Supernova Legacy Survey looked like supernov... stars exploding in cataclysmic stellar suicide—but ... act like familiar supernovae. Instead of brightening ... period of maybe three weeks (about 20 days), they ... to take nearly three months (about 80 days). At firs... galaxy could be found, so Howell and his colleague... know "even whether they were supernovae or whet... were in our galaxy or a distant one." And when the... light was spread out into a rainbow, their spectra re... mysterious broa... never seen befor...

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Arrow points to supernova SNLS 06D4eu and its host galaxy, both about 10 billion light years away. Big objects with spikes are stars in our own Milky Way; every other bright dot is a distant galaxy. Credit: University of California, Santa Barbara

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But ... known ... be extra... "10 tim... times b...

AstroShort

The moment pl... ly after midnight N... 27, 2013, from the ... star and resultant ... clicking on telesco... space. Exultant as... at visible, X-ray, g... from telescopes be...

Three indepen... for Optical Respo... scopes—two in N... caught an optical ... up to a peak of 7th ... have been seen in ... had it been pointe... lation Leo), and th...

Los Alamos Nationa... astrophysicist Tom ... with the fast-slew ar... scopes for RAPTOR ... scopes for Optical R... tem. RAPTOR is an ... al system that scans ... optical anomalies a... them when it detects ... unique capability al... mers to witness the ... hole in the constella... Credit: Los Alamos Nati...

...weeks following t... pers in the January ... reveal in detail ju...

The burst of the...

"This was the ... James A. Wren, a... Laboratory and co... GRB 130427A (a... erful gamma-ray b... flash measured in ...

The supernova... galaxy with no na... away. Partly it wa... origin is actually f... than typical long-...

http://hipacc.ucsc.edu

UC-HiPACC's Astro-Shorts

AstroShort

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But the new supernovae did not correspond to any known type. Moreover, based on their distances, they had to be extraordinarily energetic. Their luminosity was roughly "10 times brighter than a thermonuclear [Type Ia] and 100 times brighter than a typical core-collapse supernova," state

Power source?

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AstroShort

LBL Planck: Revising the Universe UCB, UCD

The Universe is about 100 million years older than previously estimated and is expanding slightly more slowly; it also has slightly more dark matter and a bit less dark energy ...suspected. There is no evidence for an addi...ike relativistic particle beyond the three ...inos that have already been discovered; ...is not more than 0.23 electron volts, about ...mit from the earlier results from NASA's ...owave Anisotropy Probe (WMAP). ...key findings revealed by the most accurate ...of the cosmic microwave background ...lest light in the Universe, dating back to ...ter the Big Bang—produced from the first ...data from the Planck satellite and analyzed ...world's most powerful supercomputers. ...ers included, among others, University of

months of observing, it has gathered a trillion data points.

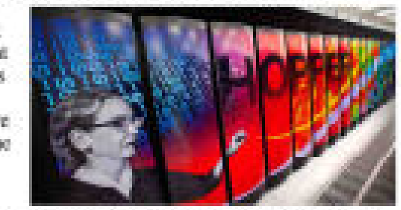
Analyzing such a massive data set is a monumental computational challenge. So in 2007, before the spacecraft was launched, NASA and the DOE negotiated a formal interagency agreement that provided the Planck mission multiyear access to NERSC.

Especially challenging is the task not only of separating the CMB from the instrumental noise and foreground signals from our Milky Way galaxy, but also of then understanding precisely how well this separation has been done. Using a technique called Monte Carlo simulations, the data were crunched on NERSC's 150,000-core Cray XE6 supercomputer Hopper.

Refining our understanding

Although future data releases in 2014 and 2015 will add ...n results from polarization and other measurements, this ...irst release of data reveals results that are already surpris...ing.

The Planck ...data reveal that ...he Universe is ...3.8 billion ...years old, more ...precise than the ...previously ac...cepted age of ...3.7 billion ...years. The Hub...ble constant—...the rate at which ...the Universe is ...expanding—is ...revised down...ward to only ...67.80 plus or minus 0.77 kilometers per second per megaparsec (a megaparsec is about 3 million light-years).



Cray XE6 supercomputer Hopper, named for 20th-century computer scientist Grace Hopper, performed most of the Planck calculations. Hopper is at the DOE National Energy Scientific Computing Center at Lawrence Berkeley National Laboratory. Credit: Roy Kaltschmidt

Planck's results also indicate that dark energy makes up "only" 69.2 percent (plus or minus 1.0 percent) of the density of the Universe (instead of 71.4 percent as measured by WMAP). Thus, dark matter and ordinary matter make up a heftier 30.86 percent. –*Trudy E. Bell, M.A.*

Further reading: The LBNL press release appears at http://newscenter.lbl.gov/news-releases/2013/03/14/massive-planck-simulations/, the NERSC release at http://www.nersc.gov/news-publications/news/science-news/2013/planck-results/, the Davis release at http://blogs.ucdavis.edu/egghead/2013/03/21/planck-...-map-brings-universe-into-focus/, and the Santa Barbara release at http://www.ia.ucsb.edu/pa/display.aspx?pkey=2967.

Papers have been submitted to *Astronomy and Astrophysics*; reprints appear at http://www.sciops.esa.int/index.php?project=PLANCK&page=Planck_Published_Papers .

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AstroShort

LANL A Black Hole is Born—and Caught in the Act!

The moment photons began arriving at Earth shortly after midnight New Mexico time on Saturday, April 27, 2013, from the spectacular suicide of a massive star and resultant birth of a black hole, cameras began clicking on telescopes both on the ground and in space. Exultant astronomers worldwide captured data at visible, X-ray, gamma-ray, and radio wavelengths from telescopes both on the ground and in space.

Three independent RAPTOR (Rapid Telescopes for Optical Response) full-sky monitoring telescopes—two in New Mexico and one in Hawaii—caught an optical flash that within seconds brightened up to a peak of 7th magnitude (yes, bright enough to have been seen in an amateur astronomer's telescope had it been pointed north of the triangle in the constellation Leo), and then faded over the next minute and a half to below 10th magnitude. Simultaneously, the Gamma Ray Burst Monitor (GBM) on the Fermi satellite, the Burst Alert Telescope (BAT) on the Swift satellite, and a veritable armada of other instruments caught the cataclysmic stellar explosion in the act, as did radio telescopes around the world.

Los Alamos National Laboratory astrophysicist Tom Vestrand poses with the fast-slew array of telescopes for RAPTOR (RAPid Telescopes for Optical Response) system. RAPTOR is an intelligent visual system that scans the skies for optical anomalies and zeroes in on them when it detects them. This unique capability allowed astronomers to witness the birth of a black hole in the constellation Leo. Credit: Los Alamos National Laboratory

Even more unusual, the explosion left an afterglow across the electromagnetic spectrum that persisted for weeks following the initial burst. Now, a host of papers in the January 3, 2014, issue of *Science* magazine reveal in detail just what happened.

'The burst of the century'

"This was the burst of the century!" exclaimed James A. Wren, an engineer at Los Alamos National Laboratory and co-author of one of the papers. Indeed, GRB 130427A (as it is now called) was the most powerful gamma-ray burst and the second-brightest optical flash measured in 18 years.

The supernova detonated in a tiny, inconspicuous galaxy with no name some 3.8 billion light-years away. Partly it was so bright because that point of origin is actually five times closer to the Milky Way than typical long-duration gamma-ray bursts moni-

tored by Swift, which are from galaxies that are now more than 17 billion light years away from us (thanks to the faster-than-light expansion of the distant universe according to General Relativity). But partly it was so bright because of the explosion's intrinsic power: it released 10^{54} ergs of energy in all directions, making GRB 130427A one of the most powerful gamma-ray bursts ever detected.

The comparatively long life of the gamma-ray burst points to the death of a star perhaps 25 to 30 times more massive than the Sun, whose internal core of iron abruptly collapsed in on itself, creating a highly magnetized neutron star or black hole. Somehow, this fast-spinning, compact object launches a powerful jet of particles traveling at nearly the speed of light along its axis of rotation. Internal shockwaves within this relativistic jet creates the initial burst of what is called "prompt" emission spanning from optical to gamma-ray wavelengths; in the case of GRB 130427A, the prompt emission lasted about 5 minutes.

Then, when the jet starts colliding with the surrounding outer layers of the star and interstellar medium, external shock waves give rise to a longer-lasting afterglow emission. The afterglow of GRB 130427A—which spanned from radio waves to gamma rays—persisted for weeks.

'A Rosetta-Stone event'

What made this burst different from most others is that the sheer power of the explosion so comparatively nearby allowed astronomers to follow the star's decline in brightness over many wavelengths for weeks, giving them a glimpse into details of the explosion's physics usually too faint to observe.

"It is the link between the optical phenomenon and the gamma rays we haven't seen before," observed another Los Alamos co-author Przemek Wozniak.

"This was a Rosetta-Stone event that illuminates so many things—literally," affirmed lead author, Los Alamos astrophysicist W. Thomas Vestrand. "These are data that astrophysicists will be looking at for a long time to come." –*Trudy E. Bell, M.A.*

Further reading: Link to the paper "The Bright Optical flash and Afterglow from the Gamma-Ray Burst GRB 130427A" by Vestrand *et al.* published in *Science* is at http://arxiv.org/abs/1311.5489 . A LANL press release "Black hole birth caught by cosmic voyeurs," is at https://www.lanl.gov/newsroom/news-releases/2013/November/11.21-black-hole-birth.php .

The University of California High-Performance AstroComputing Center (UC-HiPACC), based at the University of California, Santa Cruz, is a consortium of nine University of California campuses and three affiliated Department of Energy laboratories (Lawrence Berkeley Lab, Lawrence Livermore Lab, and Los Alamos National Lab). UC-HiPACC fosters collaborations among researchers at the various sites by offering travel and other grants, co-sponsoring conferences, and drawing attention to the world-class resources for computational astronomy within the University of California system. More information appears at http://hipacc.ucsc.edu

http://hipacc.ucsc.edu

The University of California
High–Performance AstroComputing Center

A consortium of nine UC campuses and three DOE laboratories

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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Lawrence Livermore National Lab: Peter Anninos

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The University of California
High-Performance AstroComputing Center

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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 does 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 include developing educational materials, publicity, and websites, and distribution of simulation outputs including visualizations that are beautiful as well as educational.

The University of California
High-Performance AstroComputing Center

A consortium of nine UC campuses and three DOE laboratories

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.

UC-HiPACC Small Grants Awarded Spring 2010–Winter 2014

Principal Investigator	Type	Amt $K	UC-HiPACC site(s)	Project
Small Grant Expenditures: Spring/Summer 2010				
Sukanya Chakrabarti	IT	1	UCB, UCI	Dynamical impact of satellites on Milky Way disk
Michele Fumagalli	IT	1	UCSC, UCSD/CASS	Cold gas in high redshift galaxies
Total:		*2*		
Small Grant Expenditures: Fall 2010/Winter 2011				
David Collins	IT	1	UCSD	Travel to attend Enzo Users Workshop
Donald Korycansky	IT	2	LANL, UCSC	Hazardous asteroids
Michael Kuhlen	IT	2	UCB, UCSD	Travel to attend Enzo Users Workshop
Geoffrey So	IT	2	UCSD	Travel to attend Enzo Users Workshop
Daniel Whalen	IT	1	LANL, UCSD	Work with Enzo on primoridal SN remnants
Przemek Wozniak	IT	5	LANL, UCB	Transient classification of petascale sky surveys
Andrea Zonca	IT	1	LBNL, UCSB	Iterative calibration technique for data analysis
Total		*14*		
Small Grant Expenditures: Spring/Summer 2011				
Michael Boylan-Kolchin	Eq	5	UCI	80-TB data storage for Millenium II-simulation
James Bullock	Eq	10	UCI	Rack server for GreenPlanet Cluster
Asantha Cooray	UR	2	UCI	CMB secondary anisotropies
Jason Dexter	IT	1	UCB, UCSB	Numerical simulations of compact objects
Steve Furlanetto	Eq	7	UCLA	Early universe with a 64-GB workstation
George Fuller	IT	3	LANL, UCSD	Neutrino flavor transformation in stellar collapse
Joel Primack	UR	7	UCSC	Properties of dark matter halos
Andrea Zonca	IT	1	LBNL, UCSB	Bandpass mismatch effect on CMB measurements
Andrea Zonca	IT	1	LBNL, UCSB	Scaling study of CMB mapmaker
Total:		*37*		
Small Grant Expenditures: Fall 2011/Winter 2012				
Joel Primack	UR	4	UCSC	Semi-analytic models from Bolshoi simulation
Total:		*4*		

UC-HiPACC Small Grants Awarded Spring 2010–Winter 2014

Principal Investigator	Type	Amt $K	UC-HiPACC site(s)	Project
Small Grant Expenditures: Spring/Summer 2012				
Eugene Chiang	UR	5	UCB	Rotation curves of protoplanetary disks
William Dawson	IT	10	UCD, UCI	Merging cluster collaboration
Jose Onorbe	Eq	6	UCI	High RAM/core node
Enrico Ramirez-Ruiz	Eq	4	UCSC	3D Vizualization Lab
Andrea Zonca	IT	1	UCD, UCSB	Cosmological parameters estimation with PICO
Total:		*26*		
Small Grant Expenditures: Fall 2012/Winter 2013				
Charlie Conroy	IT	2	UCSB, UCSC	Stellar evolution and galaxy formation
Dusan Keres	IT	6	UCB, UCSD	Galaxy simulations with realistic feedback
Mark Krumholz	IT	6	UCB, UCSC, LLNL	Conference on yt
Enrico Ramirez-Ruiz	Eq	3	UCSC	Simulation analysis
Total:		*17*		
Small Grant Expenditures: Spring/Summer 2013				
Jason Dexter	IT	1	UCB, UCSB	radiative transfer calculations compact objects
Total:		*1*		
Small Grant Expenditures: Fall 2013/Winter 2014				
TBD	IT	$ 10	TBD	*yt* workshop for AGORA
Enrico Ramirez-Ruiz	Eq	4	UCSC	Undergrad lab in computational astrophysics
Charlie Conroy	Eq	10	UCSC	SuperStorage server for 144 TB
Joseph Munoz	IT	1	UCSB/UCLA	collaboration with Frederick Davies
Total:		*25*		
Grand Total 4+ years:		***$ 126***		

Eq = Equipment matching funds; IT = Intercampus Travel; UR = Undergraduate Research

The University of California High-Performance AstroComputing Center

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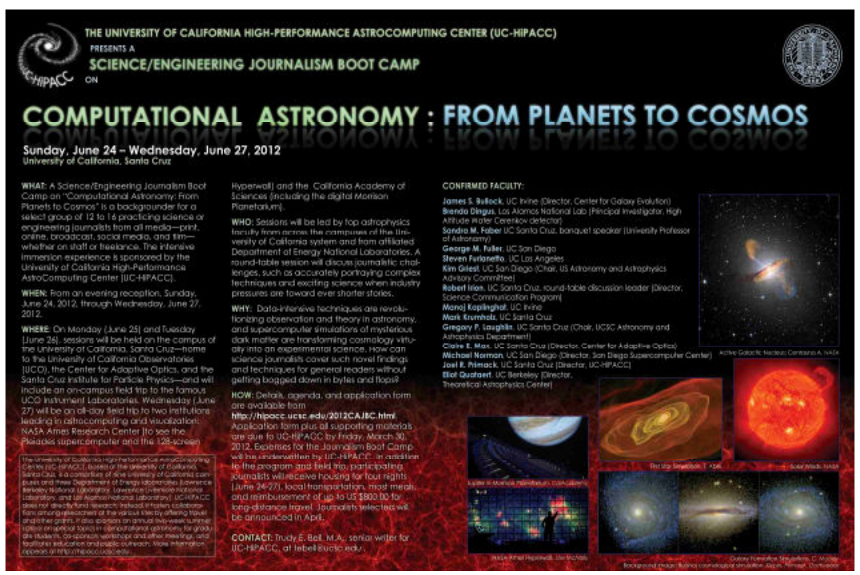
UC-HiPACC Meetings and Schools Held 2010-2014 and Others Scheduled for 2014

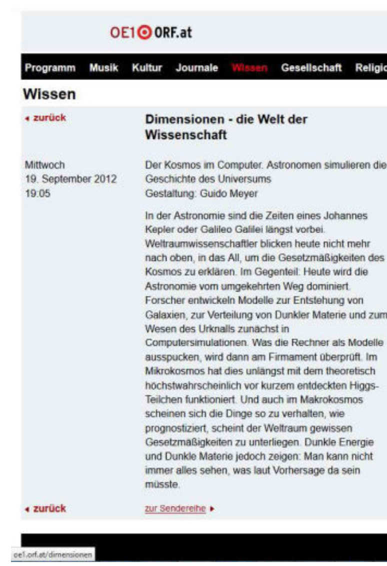
Dates	Name of Meeting	Meeting Location/s	Total Budget $K	UC-HiPACC Contribution $K	Other Sources of Funds	Parti-cipants	No. of Faculty	No. of Students
2010								
June 28-30	Enzo User Workshop	UCSD/SDSC	15	5	UCSD, NSF	45		
July 26-August 13	ISSAC 2010: Galaxy Simulations	UCSC	129	84	NSF ($20K), reg. fees		10	59
August 16-20	Santa Cruz Galaxy Workshop	UCSC	17	6	reg. fees	120		
December 16-17	The Future of AstroComputing	UCSD/SDSC	77	72	UCSD ($5K)	40		
2011								
July 18-29	ISSAC 2011: Explosive Astrophysics	UCB/LBNL	59	37	DOE ($15K), reg. fees		14	28
August 8-12	Santa Cruz Galaxy Workshop	UCSC	9	4	reg. fees	86		
2012								
June 14-16	The Baryon Cycle	UCI	20	10	UCI/CGE	130		
June 23-27	Computational Astronomy Journalism Boot Camp	UCSC/NASA/CAS	43	43	none	20	15	
July 9-20	ISSAC 2012: Astroinformatics	UCSD/SDSC	90	70	DOE ($10K), reg. fees		11	34
August 13-17	Santa Cruz Galaxy Workshop	UCSC	11	5	reg. fees	95		
August 18-20	AGORA kickoff workshop	UCSC	11	11		52		
2013								
July 22-August 9	ISSAC 2013: Star and Planet Formation	UCSC	101	79	reg. fees		16	48
August 12-16	Santa Cruz Galaxy Workshop	UCSC	14	6	reg. fees	95		
August 16-23	AGORA workshop	UCSC	12	12		37		
2014 held or *planned*								
February 12-14	The Near-Field Deep-Field Connection	UCI	35	20	UCI/CGE	100		
March 21-22	*Computational Astrophysics: Approaching Exascale*	*UCB/LBNL*	*20*	*20*	*TBD*	*TBD*		
July 21-August 1	*ISSAC 2014: Nuclear Astrophysics*	*UCSD/SDSC*	*100*	*80*	*grants (TBD), reg. fees*		*TBD*	*TBD*
August 11-15	*Santa Cruz Galaxy Workshop*	*UCSC*	*16*	*8*	*reg. fees*	*TBD*		
August 15-18	*AGORA workshop*	*UCSC*	*13*	*13*		*TBD*		

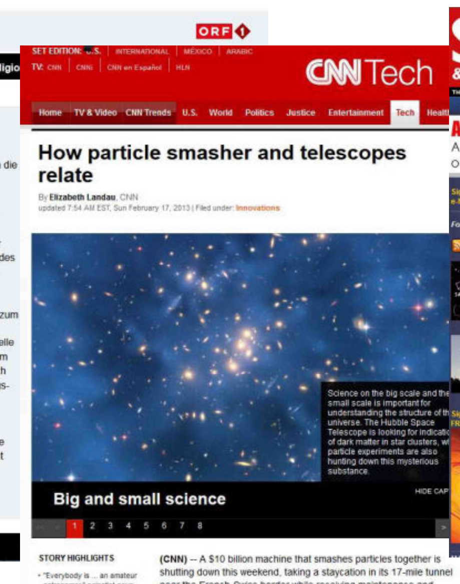
AGORA = Assembling Galaxies of Resolved Anatomy; CAS = California Academy of Sciences; CGE = Center for Galaxy Evolution; DOE = Department of Energy; ISSAC = International Summer School on AstroComputing; NASA = NASA Ames Research Center; NSF = National Science Foundation; SDSC = San Diego Supercomputer Center. All participants in the journalism boot camp were professional science journalists. *Numbers in italics are future estimates.*

UC-HiPACC's June 2012 Boot Camp for Journalists: "Computational Astronomy: From Planets to Cosmos"

The June 2012 boot camp offered two days of intense mini-courses at UC Santa Cruz and an on-campus field trip to the UC Observatories instrument labs; a third day featured field trips to visualization facilities at NASA Ames Research Center and California Academy of Sciences. Seven of the at least 10 resulting online and radio stories and print features (in English, Czech, German, and Spanish) are shown, along with a poster (top left) announcing the boot camp.







The 20 participants accepted to UC-HiPACC's June 2012 boot camp "Computational Astronomy: From Planets to Cosmos"

International Summer Schools on AstroComputing

HIPACC has organized and supported 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 have rotated, and Caltech and Stanford are also welcome to participate. Lecture slides and videos, codes, inputs and outputs are on the UC-HIPACC website http://hipacc.ucsc.edu.

ISSAC 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. Funding from NSF helped to support non-UC participant expenses.

ISSAC 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.

ISSAC 2012 school was 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. There was additional funding from DOE.

ISSAC 2013 school was at UCSC, on Star and Planet Formation. The scientiic director was Mark Krumhols (UCSC), and 26 of the 50 students came from outside the USA.

ISSAC 2014 school will be at UC San Diego/SDSC, on Nuclear Astrophysics and Supernovae. The scientiic director will be George Fuller (UCSD).

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The 2010 school was at UCSC, on the topic of Hydrodynamic Galaxy Simulations

The University of California
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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/

The University of California
High-Performance AstroComputing Center

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

Director: Alex Szaley, JHU
Host: Mike Norman, SDSC

We had 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

SDSC's Gordon Supercomputer. Photo: Alan Decker.

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 largedata-bases, 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.

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

The University of California
High–Performance AstroComputing Center

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UC-HiPACC 2013 International Summer School on AstroComputing students all got accounts on the new hyades mini-supercomputer at UCSC

Director: Mark Krumholz, UCSC

We had 50 students, including 10 from abroad.

UC-HiPACC's

International Summer School on AstroComputing presents:

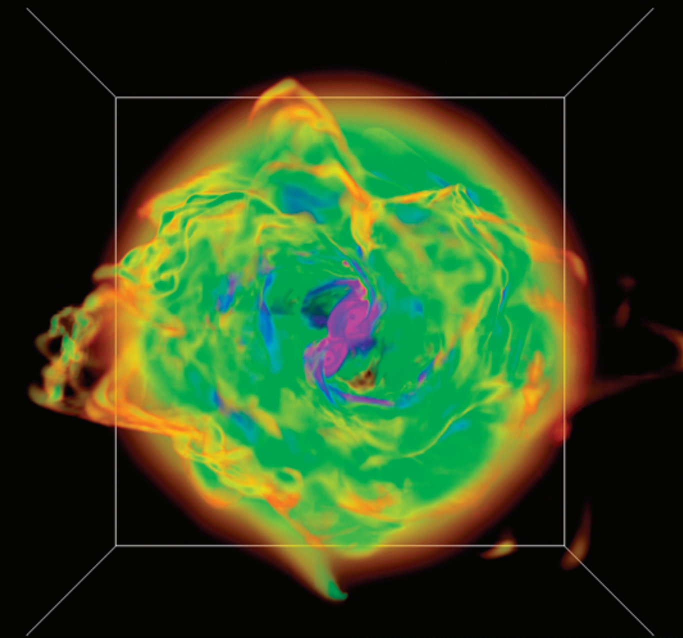
ISSAC 2013: STAR & PLANET FORMATION

July 22 - August 9, 2013

University of California, Santa Cruz

visit us on the web: **hipacc.ucsc.edu/ISSAC2013.html**

Description: Star and planet formation are central drivers in cosmic evolution: they control generation of radiation, synthesis of heavy elements, and development of potential sites for life. Because star and planet formation involve numerous physical processes operating over orders of magnitude in length and time scale, simulations have become essential to progress in the field. The objective of the 2013 UC-HiPACC AstroComputing Summer School is to train the next generation of researchers in the use of large-scale simulations in star and planet formation problems. The school will cover many of the major public codes in use today, including tutorials and hands-on experience running and analyzing simulations. Students will receive accounts on the new 3,000-core supercomputer Hyades on the UCSC campus for the duration of the school.



Volume rendering of the gas density in a simulation of the formation of a 70 Solar mass binary system. Krumholz

The school is directed by Prof. Mark Krumholz (UCSC), and is funded primarily by UC-HiPACC (Prof. Joel Primack, UCSC, Director). Additional funds are being sought from NSF for student support and from DOE for infrastructure support. Students will be housed on the UCSC campus (approximately $50/night). UC-HiPACC will cover lodging at UCSC for all accepted students and also travel for UC-affiliated students. Some financial assistance for travel may be available for other students.

Students must apply by filling in the online form at **http://hipacc.ucsc.edu/ISSAC2013_Application.php**

Applications are due March 16, 2013, although it may be possible to consider late applications. We aim to tell students who apply on time whether they are admitted by April 2, 2013. Upon acceptance, all students who plan to attend will pay a registration fee of $500. Weekday lunches, coffee breaks, the school banquet, and a special excursion will be provided for attendees.

Director: Mark Krumholz (UCSC)

Speakers and Topics will include:

Main lecturers
(5 lectures each and lead afternoon workshops):

Robi Banerjee (U. Hamburg, FLASH)
Paul Clark (U. Heidelberg, GADGET / SEREN)
Patrick Hennebelle (CEA/Saclay, RAMSES)
Stella Offner (Yale, RADMC / HYPERION / CASA)
Tom Quinn (U. Washington, GASOLINE / CHANGA)
Jim Stone (Princeton, ATHENA)

Additional Lecturers

Tom Abel (Stanford, first stars, ENZO)
Neal Evans (U. Texas Austin, observations of massive star formation)
Alyssa Goodman (Harvard, observations of low-mass star formation)
Phil Hopkins (Caltech, the IMF)
Meredith Hughes (Wesleyan, observations of protoplanetary disks)
Kaitlin Kratter (U. Colorado, binary formation)
Mark Krumholz (UC Santa Cruz, massive star formation)
Chris McKee (UC Berkeley, star formation rates)
Eve Ostriker (Princeton, the ISM/star formation connection)
Joel Primack (UC Santa Cruz, star formation and galaxy evolution)

APPLY BY MARCH 16, 2013. For updated information and to apply: http://hipacc.ucsc.edu/ISSAC2013.html

The University of California
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UC-HiPACC 2014 International Summer School at UCSD will be on Neutrino and Nuclear Astrophysics. Students will all get accounts on the Gordon supercomputer at SDSC

Director: George Fuller, UCSD
Host: Mike Norman, SDSC

Apply by April 14, 2014
http://hipacc.ucsc.edu/issac2014.html

UC-HiPACC AND SDSC PRESENT

Neutrino and Nuclear Astrophysics

The 2014 International Summer School on AstroComputing

July 21 - August 1, 2014

San Diego Supercomputer Center
University of California, San Diego

http://hipacc.ucsc.edu/issac2014.html

The interplay of frontier research in neutrino physics, nucleosynthesis, abundance observations, and high-performance computing lies at the heart of efforts to understand core collapse supernovae, compact object mergers, and the mass assembly history of galaxies. New observations are driving exciting new developments in these fields. This school will provide the background for addressing these issues, including use of several of the relevant computer codes. The school will be hosted at the SDSC, whose data-intensive computing facilities, including the Gordon supercomputer with a third of a petabyte of flash storage, are among the best in the world. All students at ISSAC 2014 will have accounts on Gordon, and will participate in hands-on code sessions in the afternoons with lectures in the mornings.

Director: George Fuller (UCSD)

Main Lecturers
Baha Balantekin (University of Wisconsin)
Joe Carlson (Los Alamos National Lab)
Hualyu Duan (University of New Mexico)
Alex Friedland (Los Alamos National Lab)
Dan Kasen (UC Berkeley/Lawrence Berkeley Lab)
Evan Kirby (UC Irvine)
Tony Mezzacappa (Oak Ridge National Lab)
Christian Ott (Caltech)
Yong-Zhong Qian (University of Minnesota)

Additional Lecturers
John Cherry (Los Alamos National Lab)
Vincenzo Cirigliano (Los Alamos National Lab)
Carla Fröhlich (North Carolina State University)
George Fuller (UC San Diego)
Mark Paris (Los Alamos National Lab)
Joel Primack (UC Santa Cruz)

Housing: students will be staying at conference housing near the SDSC on the UCSD campus.

The **registration fee** for ISSAC 2014 will be $300; payment will be required at the time of acceptance. UC-HiPACC will cover lodging for all students, and some financial assistance may be available for travel expenses.

Apply by April 14, 2014, at the website http://hipacc.ucsc.edu/issac2014.html

UC-HiPACC Conference & Workshops

- **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
- **August 8 - 12, 2011:** The 2011 Santa Cruz Galaxy Workshop, UC Santa Cruz
- **June 14-16, 2012:** The Baryon Cycle, Beckman Center, Irvine, CA

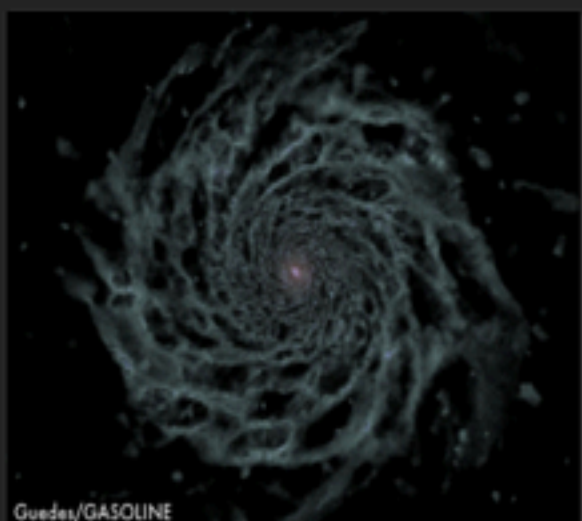
- **June 24-27, 2012:** The Computational Astronomy Journalism Boot Camp
- **August 13-17, 2012:** The 2012 Santa Cruz Galaxy Workshop, UC Santa Cruz
- **August 17-20, 2012:** High-Resolution Galaxy Simulations Workshop
- **August 12-15, 2013:** The 2013 Santa Cruz Galaxy Workshop, UCSC
- **August 16-19, 2013:** AGORA Galaxy Simulation Workshop, UCSC
- **February 12-14, 2014:** Near-Field/Far-Field Cosmology, UC Irvine
- **March 21-22, 2014:** Computational Astrophysics 2014-2020: Toward Exascale, LBL
- **August 11-15, 2014:** The 2014 Santa Cruz Galaxy Workshop, UCSC
- **August 15-18, 2014:** AGORA Galaxy Simulation Workshop, UCSC

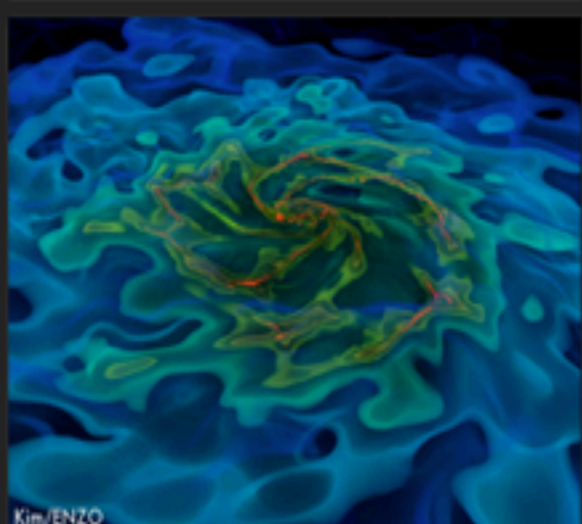
AGORA Assembling Galaxies of Resolved Anatomy

A High-resolution Galaxy Simulations Comparison Initiative To Tackle Longstanding Challenges in Galaxy Formation

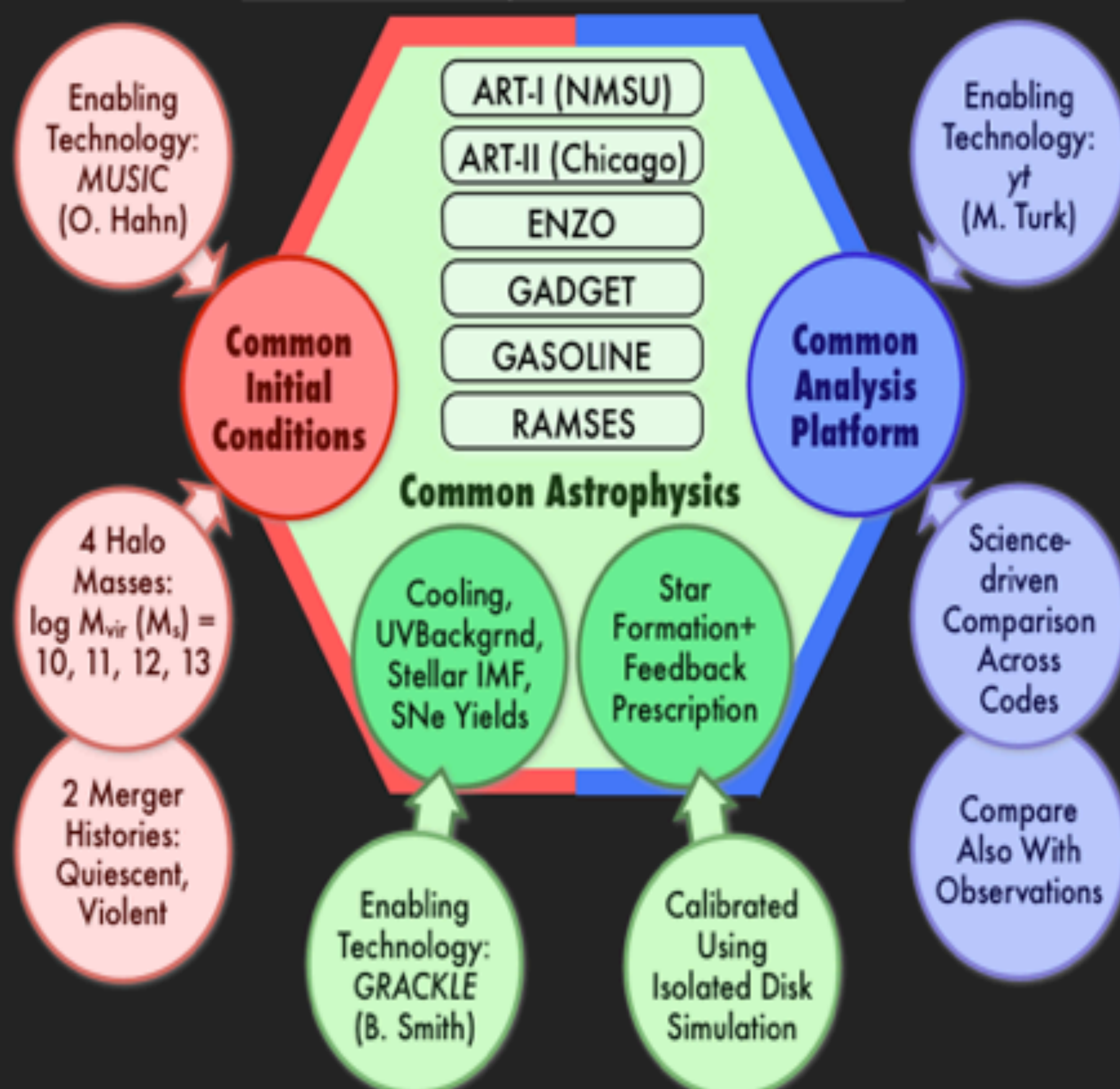
Steering Committee: Piero Madau & Joel Primack (UCSC), co-chairs; Tom Abel (Stanford), Nick Gnedin (Chicago), Romain Teyssier and Lucio Mayer (Zurich), James Wadsley (McMaster)

High-res Galaxy Simulations





AGORA Comparison Infrastructure



AGORA Goal & Team

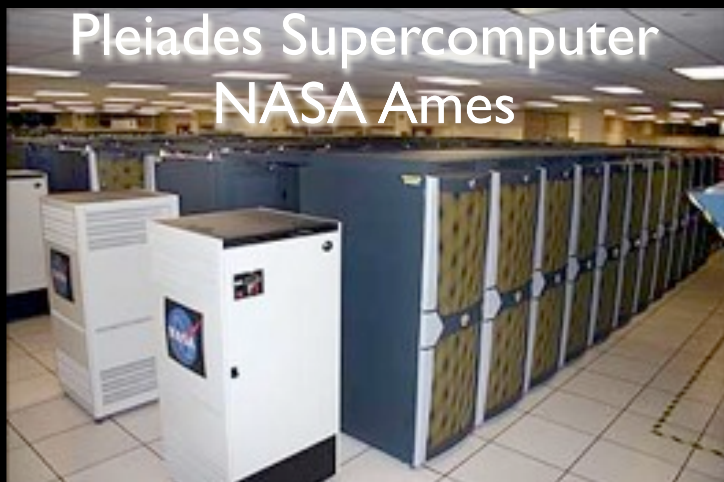
- GOAL: A multi-platform study to raise the realism and predictive power of high-resolution (<100 pc) galaxy simulations collectively
- TEAM: 4 task working groups and 9+ science working groups, 94 participants from 47 institutions as of 2nd Workshop, Aug. 2013
- DATA SHARE: Simulation data will be radpily available to public

- AGORA First light: Flagship paper by Ji-hoon Kim et al. (arXiv:1308.2669; www.AGORAsimulations.org) ApJS, 210, 14 (2014)
- Project funded in part by:

Astro-Computation Visualization and Outreach

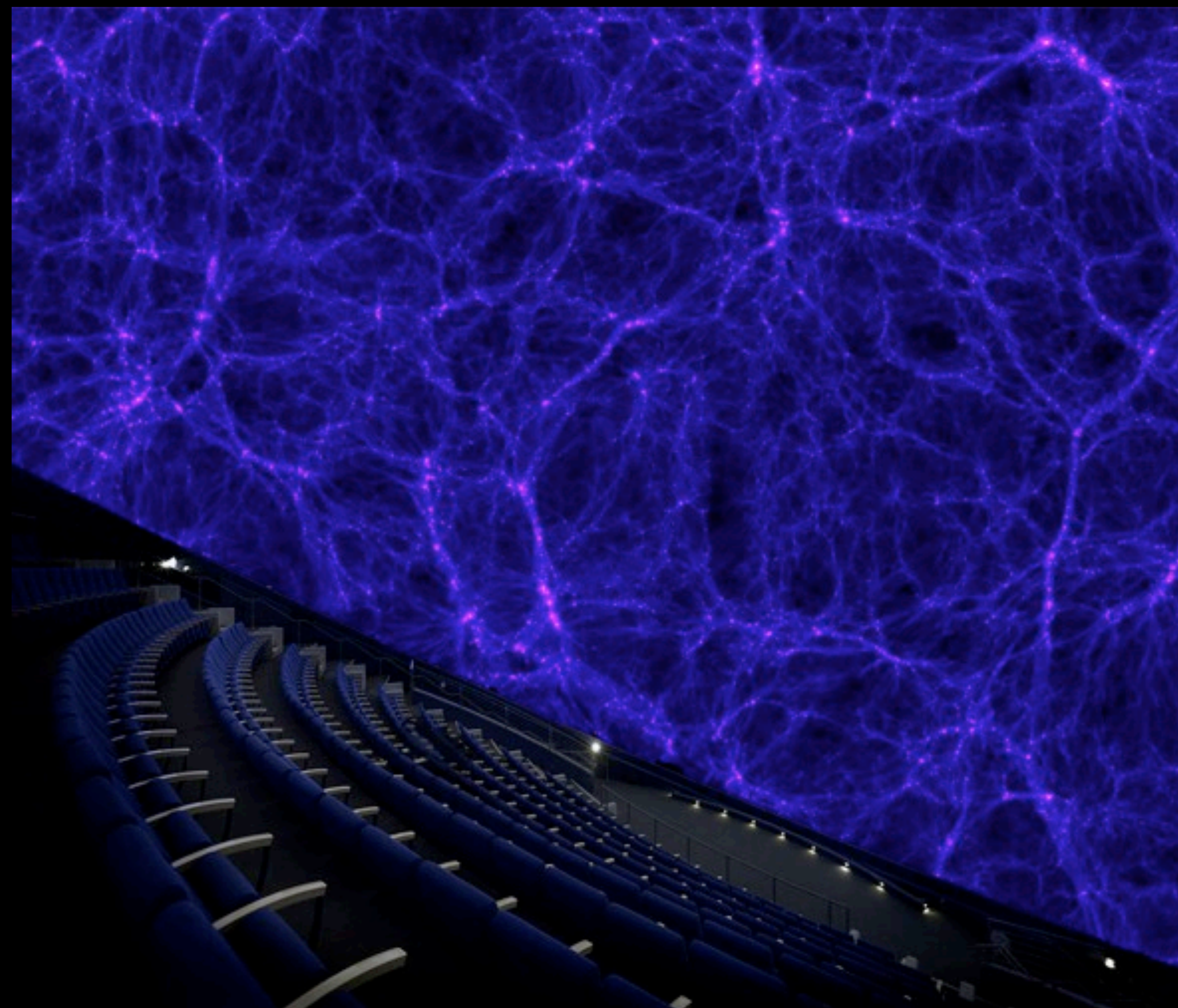
Project lead: Prof. Joel Primack, Director, UC High-Performance AstroComputing Center
UC-HIPACC Visualization and Outreach Specialist: Nina McCurdy

http://hipacc.ucsc.edu

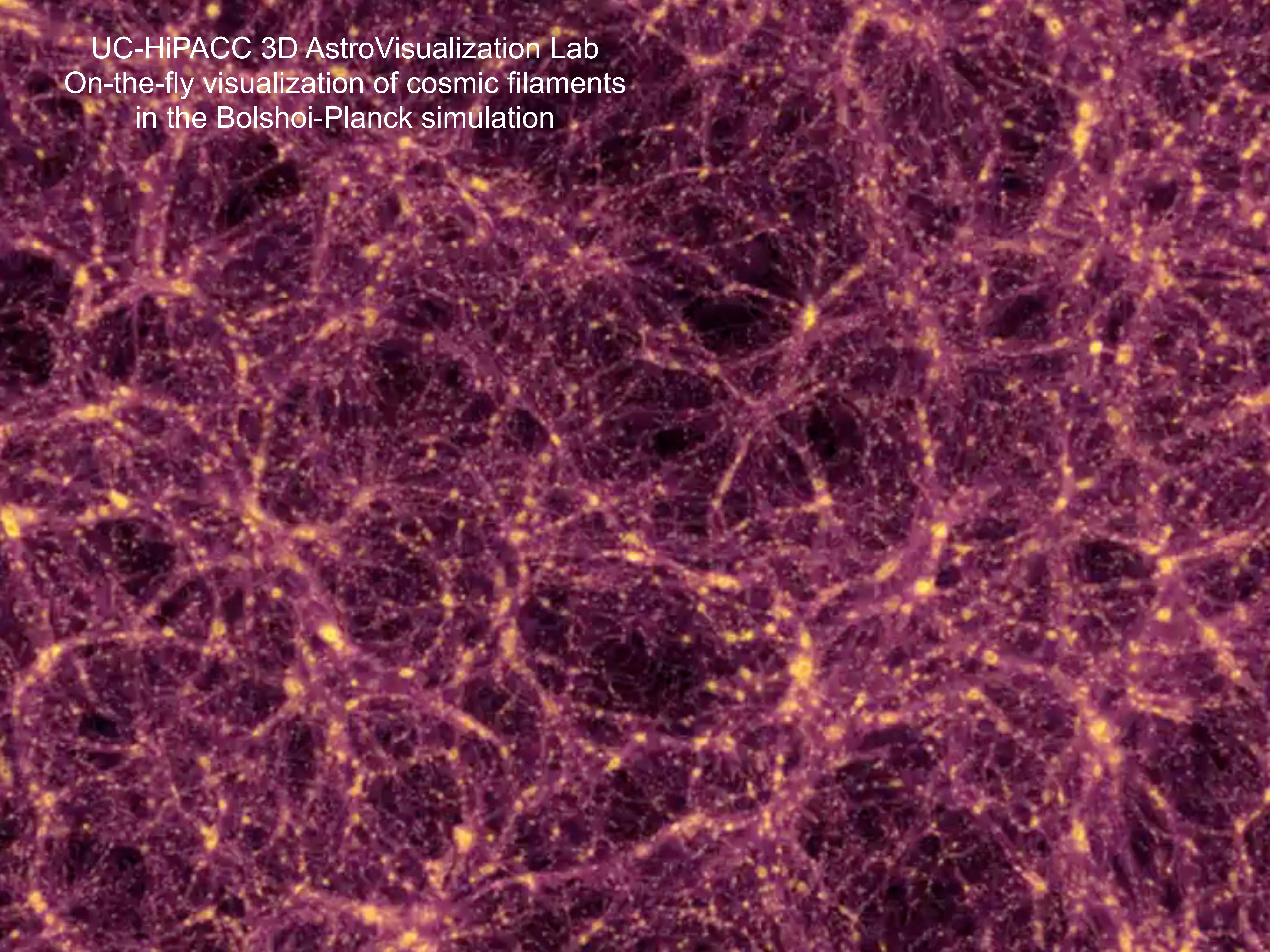

Pleiades Supercomputer
NASA Ames


California
Academy of Sciences


Adler Planetarium
Chicago



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.


UC-HiPACC 3D AstroVisualization Lab
On-the-fly visualization of cosmic filaments
in the Bolshoi-Planck simulation