

# University of California High-Performance AstroComputing Center



## The First Four+ Years: 2010–2014

The University of California High-Performance AstroComputing Center (UC-HiPACC), based at the University of California, Santa Cruz, is a consortium of all the University of California campuses plus three Department of Energy laboratories: Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, and Los Alamos National Laboratory.

UC-HiPACC supports or co-sponsors activities in computational astronomy to further collaborations in fundamental research. It also raises awareness of computational astronomy—especially the pioneering research throughout the UC system—through education and public outreach.

UC-HiPACC was founded in January 2010 with a five-year grant from the University of California. This report summarizes the Center's principal programs, activities, and achievements during its first four-plus years, 2010–2013 and into 2014.





# University of California High-Performance AstroComputing Center The First Four+ Years: 2010–2014

Collectively, the faculty and laboratories throughout the University of California system arguably comprise the largest and most powerful computational astrophysics group in the world. The purpose of the University of California High-Performance AstroComputing Center (UC-HiPACC) is to realize the full potential of UC's world-leading computational astrophysics system-wide.



an obligation to return value to California and to the public: Its outreach activities include developing educational materials made available through websites, planetarium shows, videos, popular magazines, and other media, and distributing visualizations from astrophysical simulations that are both beautiful and educational.

UC-HiPACC accomplishes that purpose in four ways. First, it is *multidisciplinary*: it links theoretical and observational astrophysicists, physicists, earth and planetary scientists, applied mathematicians, and computer scientists across all UC campuses and three DOE national laboratories, to take advantage of California's leadership in computers and related fields. Second, UC-HiPACC is *collaborative*: it fosters researchers' interaction both with one another and with rapidly increasing observational data, through mini-grants for travel, support for working groups and meetings, and other mechanisms. Third, UC-HiPACC is *enabling*: it empowers researchers to utilize efficiently 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. Finally, as part of a public state institution, UC-HiPACC is *fully aware of*

Support for UC-HiPACC, totaling \$350,000 per year for five years, comes from the office of the University of California Vice President for Research and Graduate Studies, Steven Beckwith, through the Multicampus Research Programs and Initiatives (MRPI) competition.

## UC-HiPACC's Key Activities

In its first four-plus years, UC-HiPACC's has created and funded two major, important, and original activities.

One, in education, is the annual advanced **International Summer School on AstroComputing (ISSAC)** for graduate students and postdoctoral fellows. Held every year since 2010 and focusing on various special topics in computational astronomy, the schools have attracted many of the best young astrophysicists from the UC system, the United States generally, and leading foreign centers.

The other, in research, is the major international **Assembling Galaxies of Resolved Anatomy (AGORA) project** to ensure reproducibility among the leading high-resolution galaxy simulation codes (computer programs), and to help improve the codes so that simulated galaxies look and act increasingly like



All photos in this report are by Trudy E. Bell except as noted.

Plenty of time is allotted for formal and informal collaborations at working meetings supported by UC-HiPACC. Discussion images are from 2013 AGORA workshop, 2013 Institute for the Philosophy of Cosmology, and 2011 Galaxy Workshop; group photo is from 2013 Galaxy Workshop. **ON COVER** (clockwise): Images from 2012 Computational Astronomy Journalism Boot Camp, 2013 AGORA workshop, 2011 advanced International Summer School on AstroComputing, and 2013 Galaxy Workshop (at a session of the American Institute of Physics Division of Particles and Fields).

## 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	Participants	No. of Faculty	No. of Students
<b>2010</b>								
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		
<b>2011</b>								
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		
<b>2012</b>								
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		
<b>2013</b>								
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		
<b>2014 held or planned</b>								
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	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.*

real observed galaxies. AGORA collaborators are running high-resolution galaxy simulations with (as much as possible) the same astrophysics, in order to compare them with one another, with fundamental theory, and with observations. All the outputs are being analyzed in exactly the same way using the *yt* volumetric data analysis and visualization toolkit, which UC-HiPACC is facilitating by hosting *yt*-AGORA working meetings and developing software using the latest graphic processing units (GPUs) to allow remote users to interact visually with their supercomputer outputs through their browsers.

In addition, UC-HiPACC sponsors or co-sponsors **working meetings** in northern and southern California that bring together astrophysicists with computer scientists and engineers to extend the state of the art in computation and data analysis. Many meetings last only a few days and involve only a few scientists, but others are longer conferences (*see table above*). A fourth key activity is fostering collaborations across the campuses of the UC system and affiliated DOE labs with mini-grants to enable travel and matching funds for computational equipment (*see table on page 4*).

### Advancing Education

From its inception, the intention of UC-HiPACC's annual advanced **International Summer School on AstroComputing (ISSAC)** for graduate students and postdoctoral fellows is to empower young astronomers with data-intensive methods for comparing massive observational data with massive theoretical outputs. Besides their educational value, ISSACs are increasing broader awareness of UC's excellence and leadership in computational astrophysics.

Each year ISSAC meets at a different UC-HiPACC venue and focuses on in-depth study of a special topic. Relevant

computer codes with sample inputs and outputs are made available to all the participants on a powerful computer, on which all students have working accounts so they can learn to use the codes hands-on during workshop sessions. Beginning with the first ISSAC in 2010, slides and videos of the ISSAC lectures as well as photographs are posted on the UC-HiPACC website for scientists and the general public worldwide.

*ISSAC 2010* at UC Santa Cruz, directed by Anatoly Klypin (New Mexico State University) and hosted by Joel Primack (UCSC) on **Galaxy Simulations**, featured 10 lecturers and 59 graduate students and postdocs. Faculty and student expenses were partially supported by a grant from the National Science Foundation. UC-HiPACC provided supercomputer accounts for students on the Triton system at the San Diego Supercomputer Center (SDSC), plus relevant codes and outputs.

*ISSAC 2011* at UC Berkeley and the Lawrence Berkeley National Laboratory, directed by Peter Nugent and Dan Kasen (UC Berkeley and LBNL) on **Computational Explosive Astrophysics**, concentrated on the modeling of core collapse and thermonuclear supernovae, gamma-ray bursts, neutron star mergers, and other energetic transients. With the help of a grant from the Department of Energy, all travel and lodging was reimbursed for the 14 lecturers and 28 students, who were provided with supercomputing accounts and time on the Hopper supercomputer at LBNL's National Energy Research Scientific Computing (NERSC) Center.

*ISSAC 2012* at UC San Diego and the San Diego Supercomputer Center focused on **AstroInformatics**—data mining for computational astronomy, directed by Alex Szalay (Johns Hopkins University) and hosted by Michael Norman (UCSD). There were 11 lecturers and 34

students. UC-HiPACC covered lodging and some travel expenses; there was also a grant from the DOE. Faculty and students were given supercomputing accounts on SDSC's brand new Gordon supercomputer.

*ISSAC 2013* at UC Santa Cruz and directed by Mark Krumholz (UCSC), focused on the use of large-scale simulations in **Star and Planet Formation**. There were 16 lecturers and 48 students. UC-HiPACC funds covered lodging and refreshments. Accounts on UCSC's new 3,000 core supercomputer Hyades were provided for all the lecturers and participants, with all relevant codes with sample inputs and outputs.

*ISSAC 2014* at UC San Diego and the San Diego Super-

computer Center, to be held July 21–August 1 and directed by George Fuller (UCSD), will focus on **Neutrino and Nuclear Astrophysics**. Accounts will be provided for lecturers and students on SDSC's Gordon supercomputer. Applications are now being accepted.

## Enabling Research

In 2013, for the second year, UC-HiPACC sponsored the international **Assembling Galaxies of Resolved Anatomy (AGORA)** (<http://www.agorasimulations.org/>) project. AGORA is a major research initiative of more than 90 astrophysicists from over 40 institutions worldwide to compare how 10 leading simulation codes model the evolution of galaxies at high resolution, using the same initial conditions, UV background, and gas cooling, and the same analysis code *yt* (<http://yt-project.org/>). Over the three days of the 2013 AGORA working meeting (August 16–18) at UCSC, 50 leading cosmologists and computational astrophysicists from more than 25 leading institutions worldwide shared their initial results from 13 working groups, each addressing key technical and scientific aspects of the comparisons. The analysis focused on comparing both the performance of the codes and the astrophysical results, including comparing the results with astronomical observations.

Many of the working groups are led by postdoctoral astrophysicists or junior faculty members. Between the annual workshops, participants work on the project remotely, with web meetings using the SeeVogh web conference platform supported by UC-HiPACC. UC-HiPACC also supported development workshops for the *yt* astrophysics analysis and visualization code that AGORA is using.

In January 2014, the 20-page AGORA flagship paper was published in *Astrophysical Journal Supplement*. Several more papers are in preparation. The AGORA project is also supported by a NERSC Data Pilot Program allocation of substantial computing and storage. In addition, AGORA is supported by the new UCSC Hyades astrophysics computer system, purchased with a NSF MRI grant and including a PetaByte AstroData system donated by Huawei Technologies Co. The third annual AGORA workshop will be August 15–18, 2014.

Meantime, in all four years (2010–2013), UC-HiPACC has co-sponsored

### UC-HiPACC Small Grants Awarded Spring 2010–Winter 2014

Principal Investigator	Type	Amt \$K	UC-HiPACC site(s)	Project
<b>Small Grant Expenditures: Spring/Summer 2010</b>				
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
<b>Total:</b>		<b>2</b>		
<b>Small Grant Expenditures: Fall 2010/Winter 2011</b>				
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 primordial 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
<b>Total</b>		<b>14</b>		
<b>Small Grant Expenditures: Spring/Summer 2011</b>				
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
<b>Total:</b>		<b>37</b>		
<b>Small Grant Expenditures: Fall 2011/Winter 2012</b>				
Joel Primack	UR	4	UCSC	Semi-analytic models from Bolshoi simulation
<b>Total:</b>		<b>4</b>		
<b>Small Grant Expenditures: Spring/Summer 2012</b>				
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 Visualization Lab
Andrea Zonca	IT	1	UCD, UCSB	Cosmological parameters estimation with PICO
<b>Total:</b>		<b>26</b>		
<b>Small Grant Expenditures: Fall 2012/Winter 2013</b>				
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 <i>yt</i>
Enrico Ramirez-Ruiz	Eq	3	UCSC	Simulation analysis
<b>Total:</b>		<b>17</b>		
<b>Small Grant Expenditures: Spring/Summer 2013</b>				
Jason Dexter	IT	1	UCB, UCSB	radiative transfer calculations compact objects
<b>Total:</b>		<b>1</b>		
<b>Small Grant Expenditures: Fall 2013/Winter 2014</b>				
TBD	IT	\$ 10	TBD	<i>yt</i> 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
<b>Total:</b>		<b>25</b>		
<b>Grand Total 4+ years:</b>		<b>\$ 126</b>		

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



As shown by these images from UC-HiPACC's 2013 advanced International Summer School on AstroComputing (ISSAC) at UC Santa Cruz, tours of visualization laboratories, formal presentations, hands-on instruction, informal coaching, stimulating discussions, and relaxation with fellow grad students and postdocs and with faculty are all part of the ISSAC experience. The 2014 ISSAC will be at UC San Diego/San Diego Supercomputer Center.

the annual **Santa Cruz Galaxy Workshop** at UCSC each August, co-organized by Primack and Hebrew University Professor of Physics Avishai Dekel. In 2013, the five-day Galaxy Workshop attracted 90 participants from more than two dozen institutions worldwide, including from four UC campuses. As usual, slides and video recordings of all the talks were posted on the UC-HiPACC website. The 2014 Galaxy Workshop will be August 11–15.

UC-HiPACC has also sponsored or co-sponsored special topical conferences. Most recently, in February 2014, it co-sponsored with the UC Southern California Center for Galaxy Evolution (CGE) a conference at the Beckman Center of the National Academies at UC Irvine, entitled **The Near-Field, Deep-Field Connection**. In March 2014, it cosponsored with Lawrence Berkeley National Laboratory a conference **Computational Astrophysics 2014-2020: Approaching Exascale**; the twin goals of this meeting were to discuss the future of astrophysics in general and the future of UC-HiPACC specifically.

In 2013, UC-HiPACC provided staff support for a three-week **Institute for the Philosophy of Cosmology** at UCSC, with funding from a Templeton Foundation grant to Rutgers University. Participants included 28 advanced graduate students and postdocs (two-thirds having backgrounds mainly in philosophy of science and the rest in physics/astrophysics) and 20 faculty lecturers.

Previously, in 2012, UC-HiPACC co-sponsored the **Barion Cycle Conference** with the CGE at the Beckman Center at UC Irvine. In the three-day conference, 130 theorists and observers (including ones from seven UC campuses) focused on the cycle of gas through galaxies and the intergalactic medium across cosmic time. In December 2010, UC-HiPACC organized a major conference on **The Future of AstroComputing** at UC San Diego and the San Diego Supercomputer Center, for two major purposes: to clarify the big issues for the next five years in astrophysical computation and data, and to bring leaders in the field together to meet with key computational astrophysicists, especially from the University of California and other West Coast institutions including Stanford

University. Earlier that year, UC-HiPACC co-sponsored an **Enzo User Workshop** at UC San Diego on the cosmology simulation code Enzo.

### Shaping Careers

In 2013, for the fourth year, UC-HiPACC sponsored two funding cycles for small grants in support of computational astrophysics research that includes collaborations among two or more UC campuses and/or the affiliated DOE labs. For grad students, such travel and collaborations can be a career-shaping opportunity: they can learn from other leading faculty members, master skills not taught on their own campuses, line up writers for crucial letters of recommendation, and form other contacts and alliances that can powerfully influence their futures. In 2013, UC-HiPACC funded six **collaborative research efforts** linking six campuses and one DOE lab, and **co-funded equipment** with matching funds at one campus. In 2013 UC-HiPACC also supported use of the **SeeVogh** scientific web conference platform for computational astrophysics research on the UC campuses and affiliated DOE laboratories.

In the first eight funding cycles from early 2010 through late 2013, 33 small grants (grants under \$10,000) were awarded to researchers at seven UC campuses and two DOE labs, totaling over \$125,000. Some of these grants helped support travel between campuses and labs, including mini-conferences. Small grants have also supported UC undergraduate research projects in computational astro-



Photo by Adler Planetarium

As part of its outreach efforts to K-12 students and the general public, UC-HiPACC provides dramatic astrocomputing visualizations to major planetariums, such as the Bolshoi cosmological simulation, shown on the dome of the Grainger Sky Theater of the Adler Planetarium in Chicago.

physics or provided matching funds for purchases of computational hardware.

## Outreach

UC-HiPACC has helped provide content from cosmological simulations to several major planetariums. In 2010, it contributed to the show *LIFE: A Cosmic Story* at the Morrison Planetarium of the California Academy of Sciences in San Francisco. In 2011, simulation outputs of black holes (from UCSC astronomy professor Enrico Ramirez-Ruiz) and cosmology (from Joel Primack) were prominently featured in *The Searcher*, the inaugural show of the Adler Planetarium’s new Grainger Sky Theater, with 20 advanced projectors creating an image in the dome 8000 pixels across. UC-HiPACC worked closely with the scientific staff of both planetariums. UC-HiPACC Public Outreach and Scientific Visualization Coordinator Nina McCurdy connected the computation and visualization team at NASA Ames Research Center with the Morrison and Adler Planetariums and with visualization experts at the National Center for Supercomputing Applications (NCSA) at the University of Illinois. In 2013 Primack was an advisor to the American Museum of Natural History on their Hayden Planetarium show *Dark Universe*, which opened in March 2014 in San Francisco at the Morrison Planetarium of the California Academy of Sciences and will be seen at planetariums around the world.

In the summers of 2011 and 2012, UC-HiPACC supported UCSC Education graduate student Zoe Buck (advised by UCSC Prof. Doris Ash) to conduct pre- and post-show interviews with Adler viewers on the effectiveness of *The Searcher*. In August 2012, Buck presented her findings at the Astronomical Society of the Pacific’s annual education and public outreach conference Communicating Science in Tucson, Arizona.

Since 2010, UC-HiPACC’s site <http://hipacc.ucsc.edu/> has posted meeting announcements plus **photographs, videos, and slides from speakers and presenters at UC-HiPACC events**. One innovative program that debuted in 2012 was a series called **AstroShorts**: free approximately semi-monthly one-page features on research in computational astronomy specifically designed to be reprinted in the monthly newsletters of amateur astronomical societies; they immediately proved to be popular with astronomy clubs around the country.

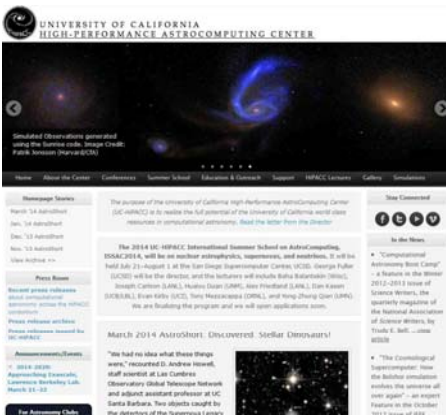
In January 2014, Steve Zaslaw was hired as webmaster to manage the website’s archives of lectures, visualizations and reference material, succeeding webmaster Eric Maciel. He is also focused on increasing the visibility of UC-HiPACC on the internet and through Facebook, Twitter, and other social media. Other accomplishments included the creation and publication of **two comprehensive Wikipedia articles** on the Bolshoi Cosmological Simulation and UC-HiPACC.

Significant for both research and outreach, **AstroViz**—the UC-HiPACC Visualization Gallery—debuted on the website in late 2012, making astrocomputing simulation images and videos more easily accessible to the scientific community, educators, journalists, and the general public. AstroViz is hosting many of the best astronomical visualizations developed anywhere over the past two decades.

Also in 2012, Ramirez-Ruiz and Primack created a 3D Astronomical Visualization Laboratory (nicknamed the **3D VizLab**) with partial support from UC-HiPACC. The 3D VizLab is developing and testing innovative new 2D and 3D scientific visualization software, which will be made publicly available. Nvidia Corp. donated their new Quadro K6000 GPU to the 3D VizLab, and zSpace, Inc.,



The 20 participants accepted to UC-HiPACC’s June 2012 boot camp “Computational Astronomy: From Planets to Cosmos” (group photo also shows several of the faculty members) included magazine feature writers, online writers and new media specialists, several public information officers from major universities, an Emmy Award-winning documentary filmmaker, and several international journalists. The 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.



UC-HiPACC's website home page (upper left) is appealing to students and educators. In 2012, UC-HiPACC debuted one-page AstroShorts (upper right), which describe research in computational astronomy at one of UC-HiPACC's 12 consortium sites, for reprinting in astronomical society newsletters. UC-HiPACC staff also were involved in the publication of feature articles for the general public (column at lower right).

donated their new "holographic" 3D visualization product zSpace. Previously, 3D VizLab director Nina McCurdy represented Primack's group and UC-HiPACC in the NASA exhibit at Supercomputing 2010 (the annual international conference for high-performance computing, networking, storage, and analysis) in New Orleans, LA; at Supercomputing 2011 and at the Astro-Viz Workshop 2011 (both in Seattle, WA, but in different months); and at Supercomputing 2012 in Salt Lake City, UT. In 2012, McCurdy presented astro-visualizations at a Goethe Institut art/science symposium in San Francisco.

Alex Bogert, who became 3D VizLab director in June 2013, has developed a portable visualization software package called pyRGBA, with the help of two computer science undergraduates, John Holdener and Nicholas Smith, who helped build major components. The software includes a hardware volume renderer that can easily be attached to a remote web browser. It generates 2D or 3D simulation output visualization videos in real time on the latest GPUs, including supporting remote streaming, to make it possible for more people in the scientific community to create visualizations. Using pyRGBA, Bogert has made visualizations of the large scale structure of dark matter from the Bolshoi simulations, which can be seen in real-time 3D on the VizLab hardware, output as a high definition video, or streamed to a remote user's browser. This software is being used in the AGORA galaxy simulation comparison project, and will be made public.

As a major outreach initiative, in June 2012, UC-HiPACC sponsored the first science/engineering journalism boot camp to be held on the West Coast in astronomy, and the first ever held anywhere on astrocomputing. The boot camp, called **Computational Astronomy: From Planets to Cosmos**, consisted of two full days of formal sessions at UC Santa Cruz, in which 15 faculty from six UC campuses and DOE labs presented one-hour mini-courses on key topics in computational astronomy. A third day featured field trips to the Hyperwall of NASA Ames Research Center and the visualization facilities of

the California Academy of Sciences in San Francisco. The 20 science and engineering journalists in all media represented publications and productions that collectively reach over 10 million readers and viewers worldwide. At least 10 feature stories resulting from subjects introduced in the boot camp appeared in 2012 and 2013.

In 2012, Primack wrote a feature article on the Bolshoi cosmological simulation for the semi-popular *IEEE Spectrum* magazine. Since joining UC-HiPACC in June 2011, Senior Writer Trudy E. Bell has written or coauthored five feature articles on aspects of computational astronomy for other semi-popular magazines. In 2012, one on big data was published in *The Bent* and one on the Bolshoi cosmological simulation co-authored with Primack was the July cover story in *Sky & Telescope*. An account of the journalism boot camp appeared as a feature in the winter 2013 issue of *ScienceWriters*, the quarterly magazine of the professional National Association of Science Writers. Now in press for publication in 2014 is another cover story for *Sky & Telescope*, this one on CANDELS, the largest-ever Hubble Space Telescope survey, co-authored with Primack, University of California Observatories director Sandra M. Faber, CANDELS co-leader Henry C. Ferguson, and David Koo (UCSC). Just submitted to *Scientific American* is a feature on the extragalactic background light, coauthored with Primack and Alberto Dominguez from UC Riverside. Bell has also written six UC-HiPACC press releases on computational astronomy around the UC campuses (one of which led to a 2012 feature story "A Box of Universe," by Brian Hayes in *American Scientist*) and written and designed a dozen AstroShorts. She also regularly aggregates press releases about astronomy research around the UC-HiPACC consortium.





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Joel R. Primack specializes in the formation and evolution of galaxies and the nature of dark matter, which makes up most of the matter in the universe. He is one of the principal originators and developers of the theory of Cold Dark Matter, the basis for the standard modern picture of structure formation in the universe. With support from the National Science Foundation, NASA, and the Department of Energy, he uses supercomputers to simulate and visualize the evolution of the universe and the formation of galaxies, comparing the predictions of theories to the latest observational data. He is the author, with Nancy E. Abrams, of popular books on modern cosmology: *The View from the Center of the Universe* (2006) and *The New Universe and the Human Future* (2011).



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Trudy E. Bell (M.A., history of science/American intellectual history) is a science/technology journalist whose 19 top awards include the David N. Schramm Award of the American Astronomical Society (2006). A former editor for *Scientific American* and *IEEE Spectrum* magazines, she is now a contributing editor for *Sky & Telescope* magazine. She has written or co-authored a dozen books, including a picture history *The Great Dayton Flood of 1913* (2008), the Smithsonian Science 101 volume *Weather* (2007), the Institute of Electrical and Electronics Engineers' millennium book *Engineering Tomorrow* (2000), four books for middle-school ages about the solar system, and five books on bicycling. She has observed five total solar eclipses.



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Alex Bogert (B.S., physics) creates scientific visualizations and acts as a liaison between the academic and high tech communities; his 2013 senior thesis focused on particle physics simulation and analysis. He is focused on creating interactive tools for scientists to display their data, including remote interactive display of visualizations and animations. He built and administered the UCSC computer cluster used to process Large Hadron Collider data, and worked at CERN in Geneva performing particle physics simulation analysis.



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Sue Grasso (M.A., education) manages and supervises the operations of UC-HiPACC. She serves as liaison with collaborating institutions, coordinates events, and handles purchases, payments, and travel reimbursements. Her previous experience includes marketing for the University Press at both Yale and UC Berkeley, teaching at the junior high and high school levels, and coordinating GATE (Gifted And Talented Education) and professional development programs for Santa Cruz City Schools.



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