
RECENT RESEARCH IN
COSMOLOGY
Joel Primack
2011
1. Hydrodynamic Simulations of Galaxies Compared to CANDELS Observations
2. Semi-Analytic Modeling of Galaxy Evolution
3. LSS and Dark Matter Halos in an LCDM Universe
4. UC High-Performance AstroComputing Center
5. Reviews and Popularizations

Joel Primack RECENT PhD STUDENTS

Rachel Somerville (PhD 1997) Jerusalem – Cambridge – Michigan – MPI Astronomy Heidelberg (Professor) – STScI/Johns Hopkins – Rutgers (Professor)
Michael Gross (PhD 1997) Goddard – UCSC – NASA Ames (staff)
James Bullock (PhD 1999) Ohio State – Harvard (Hubble Fellow) – UC Irvine (Prof.)
Ari Maller (PhD 1999) Jerusalem – U Mass Amherst (postdoc) – CityTech CUNY (Asst. Prof.)
Risa Wechsler (PhD 2001) Michigan – Chicago (Hubble Fellow) – Stanford U (Asst. Prof.)
T. J. Cox (PhD 2004) Harvard (postdoc, Keck Fellow) – Carnegie Observatories (postdoc)
Patrik Jonsson (PhD 2004) UCSC (postdoc) – Harvard CfA (staff)
Brandon Allgood (PhD 2005) – Numerate, Inc. (co-founder)
Matt Covington (PhD 2008) – analytic understanding of galaxy mergers, semi-analytic models of galaxy formation – U Minn (postdoc) – U Arkansas (Asst. Prof.)
Greg Novak (PhD 2008) – running and comparing galaxy merger simulations with observations – Princeton (postdoc) – Inst Astrophysique Paris (postdoc)
Christy Pierce (PhD 2009) – AGN in galaxy mergers – Georgia Tech (postdoc)
Rudy Gilmore (PhD 2009) – WIMP properties and annihilation; extragalactic background light and gamma ray absorption – SISSA, Trieste, Italy (postdoc)

Joel Primack CURRENT PhD STUDENTS

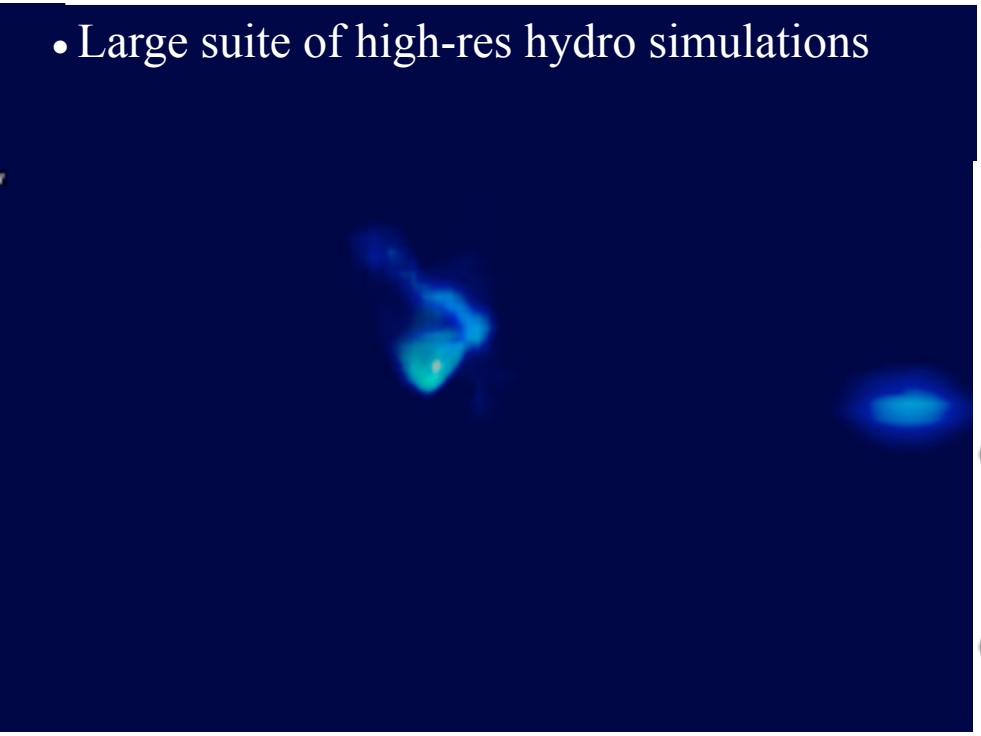
Lauren Porter – properties of early-type galaxies: semi-analytic predictions vs. observations
Chris Moody – kinematics of elliptical galaxies: simulations vs. observations
Priya Kollipara – galaxy morphology: simulations vs. observations

Joel Primack

1. Understanding the key physics of galaxy formation

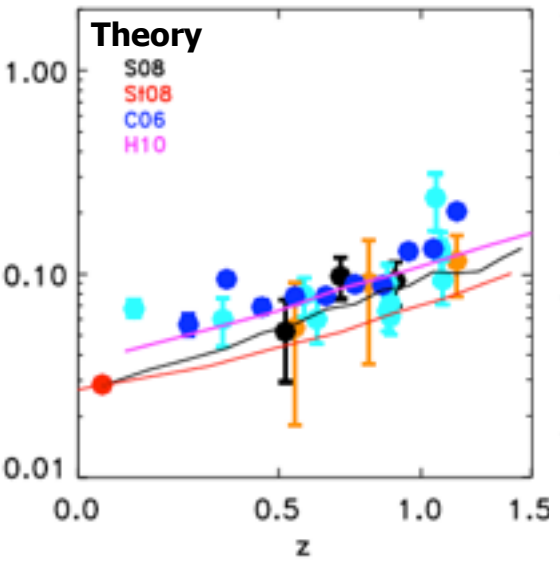
- Largest suite of galaxy merger simulations, including various mass ratios and multiple mergers (Cox PhD 2004, Cox et al. 04, 06, 08; Novak PhD 2008, Novak et al. 2008, 11)
- Dust absorption and re-radiation of starlight in normal and merging galaxies (Jonsson PhD 2004, Jonsson 06, Jonsson et al. 06, Rocha et al. 08, Jonsson et al. 10, Jonsson & Primack 10)
- New methods for comparison with observations, measuring merger rate (Lotz, Primack, & Madau 2004, Lotz et al. 05, 07, 08, 10ab, 11). • X-ray AGN (Pierce et al. 07, PhD09, 10, …)
- Analytic model for galaxy mergers (Matt Covington PhD 2008, Covington et al. 08, 10, 11)
- Predicted age/metallicity vs. SDSS (Porter 2011); merger remnant kinematics (Moody…)

- Large suite of high-res hydro simulations



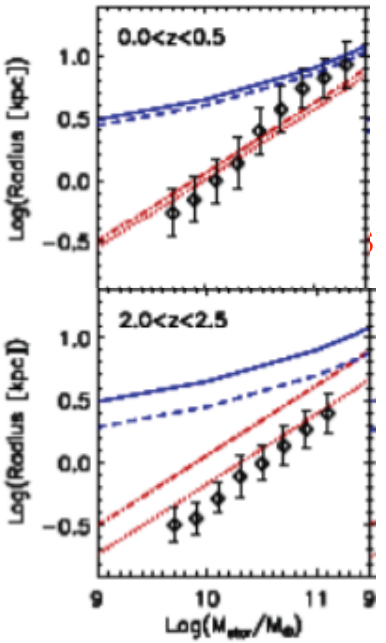
Ceverino, Dekel, Primack, ...

Fractional Major Merger Rates



Lotz+2011

Size vs. Mass
Disks & Spheroids



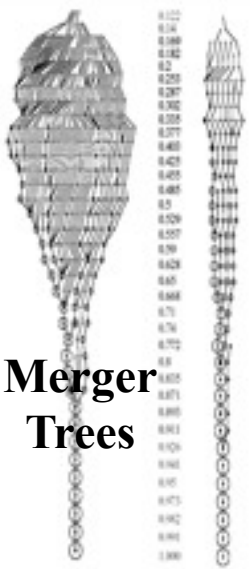
Covington+2011

2. Semi-Analytic Modeling of Galaxy Evolution; Extragalactic Background Light and Gamma Ray Attenuation

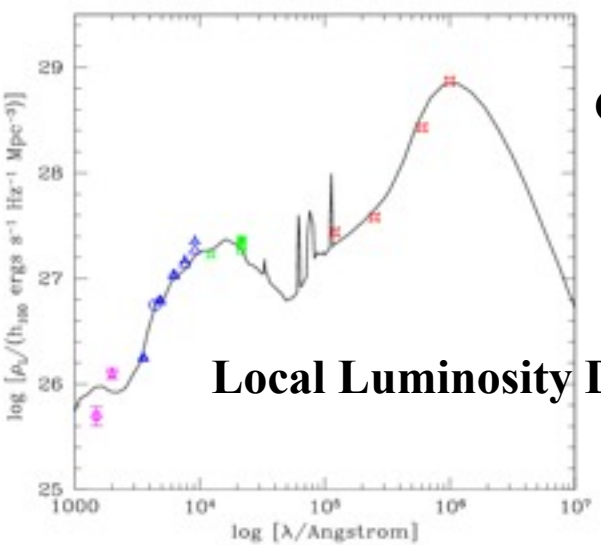
Improved SAM predictions for the evolving galaxy population, including properties of spheroids (including key work by Covington) compared to observations (with Rachel Somerville and Rudy Gilmore 2009, 10, 11ab)

Corresponding predictions for Extragalactic Background Light and implied absorption of TeV gamma rays (with Rudy Gilmore and Piero Madau)

New WMAP5/7 Bolshoi cosmological simulation with 5x higher mass, force, and time resolution than Millennium Run → Merger tree → Better SAMs (with Klypin, Wechsler, Somerville, …)

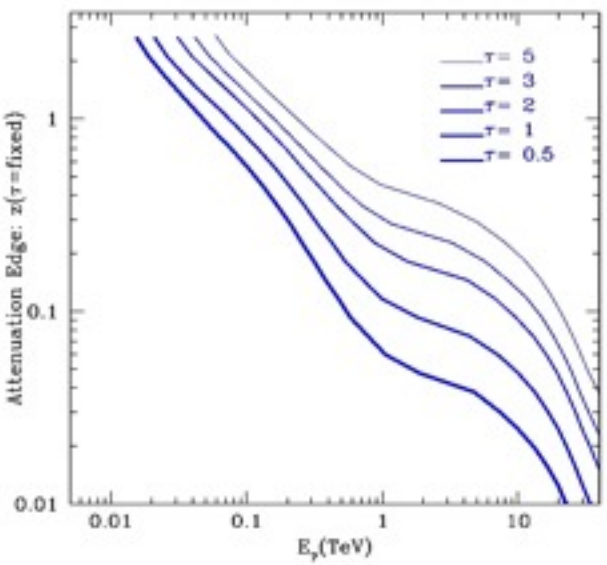


Merger Trees



Local Luminosity Density

Predicted Gamma Ray Attenuation Edge



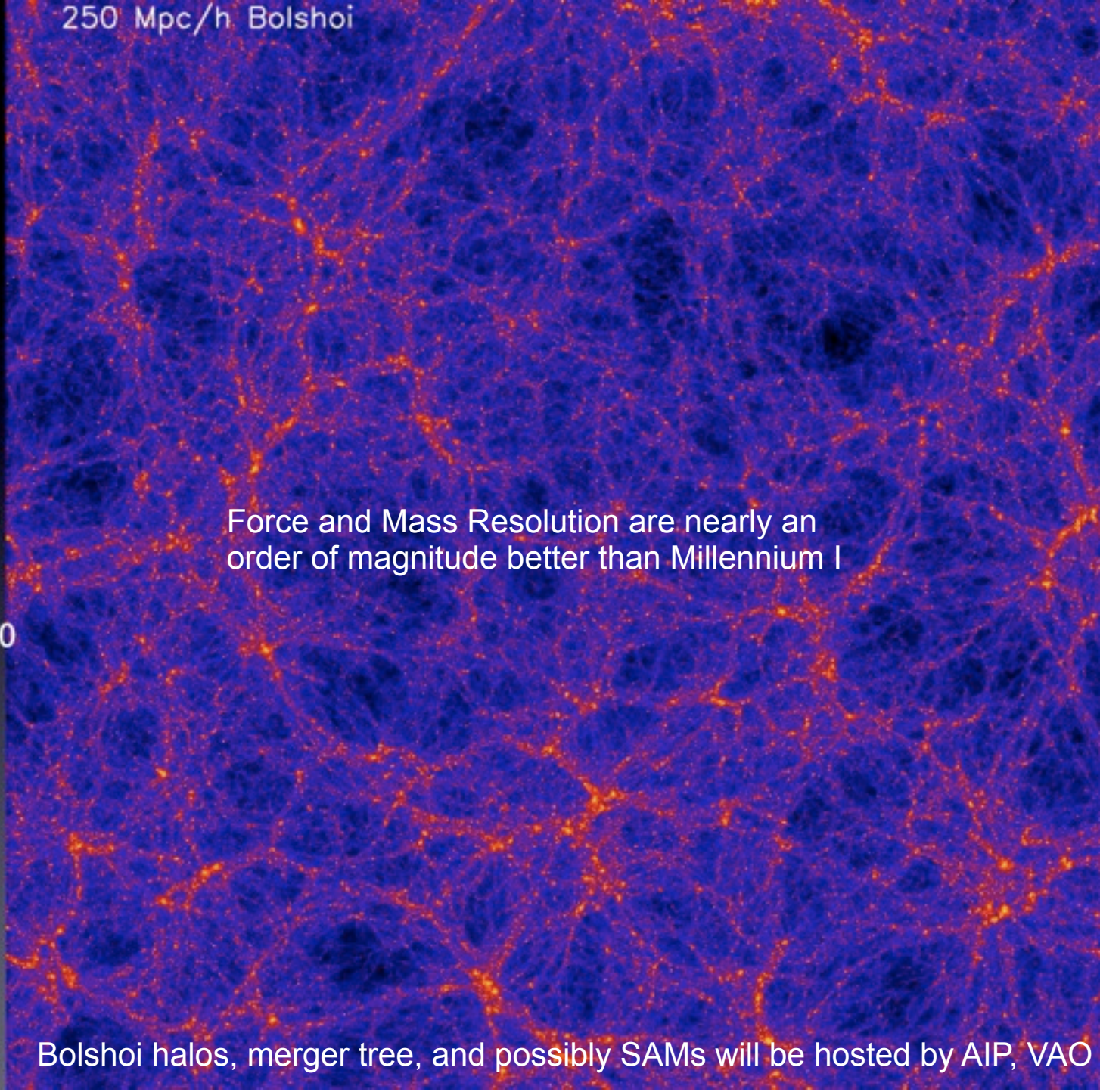
The Bolshoi simulation

ART code

250Mpc/h Box
LCDM
σ_8 = 0.82
h = 0.73
8G particles
1kpc/h force resolution
1e8 Msun/h mass res

dynamical range 262,000
time-steps = 400,000

NASA AMES
supercomputing center
Pleiades computer
13824 cores
12TB RAM
75TB disk storage
6M cpu hrs
18 days wall-clock time



Force and Mass Resolution are nearly an order of magnitude better than Millennium I

Bolshoi halos, merger tree, and possibly SAMs will be hosted by AIP, VAO

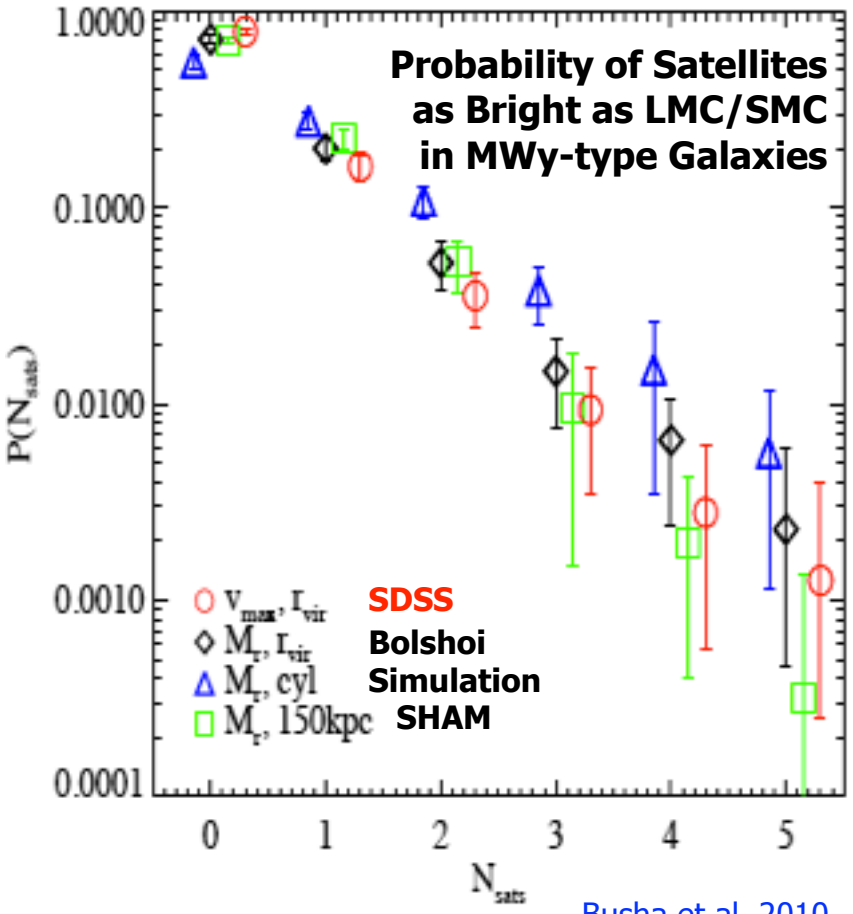
3. LSS and Dark Matter Halos in an LCDM Universe

Radial mass profile and angular momentum vs. merger history; structural merger trees (Bullock & Wechsler PhDs); shapes of dark matter halos (Allgood PhD); abundance and concentration of halos in the Bolshoi simulation (2010); subhalo abundance matching, luminosity-velocity relations, LMC/SMC abundances (2011)

Bolshoi Simulation Zoom-In

$< 10^{-3}$ of Bolshoi volume

Anatoly Klypin & Joel Primack



Busha et al. 2010

4. UC-HIPACC

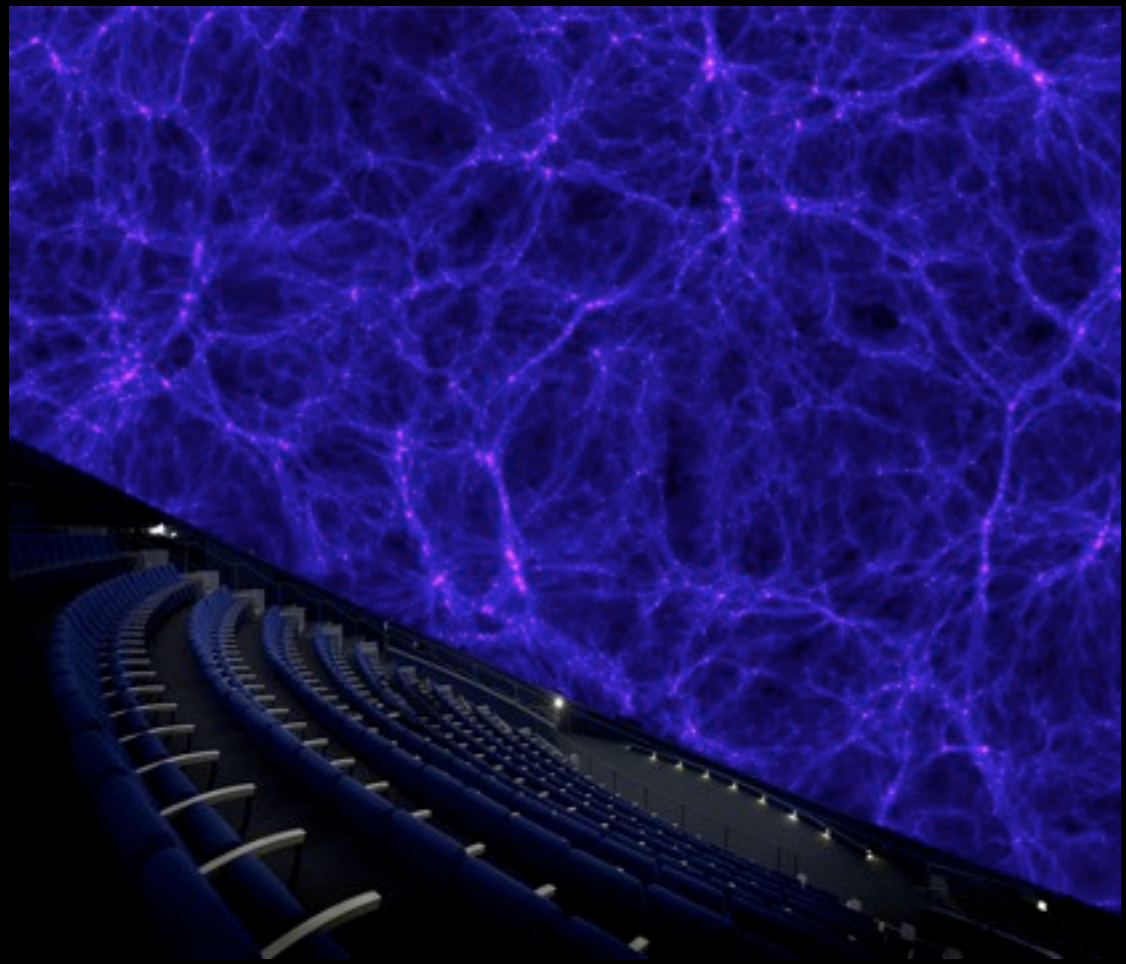
The University of California
High-Performance AstroComputing Center
A consortium of nine UC campuses and three DOE laboratories

The 2010 school was at UCSC, on the topic of Hydrodynamic Galaxy Simulations. The 2011 school will be at UC Berkeley/LBNL on Explosive Astrophysics, and the 2012 school will be at UCSD on Astro-Informatics. Slides and videos at the hipacc website.

http://hipacc.ucsc.edu/

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 are helping prepare their planetarium show opening fall 2010, and also working on a major planetarium show to premiere at the Adler Planetarium in spring 2011.

Joel Primack
Recent Reviews

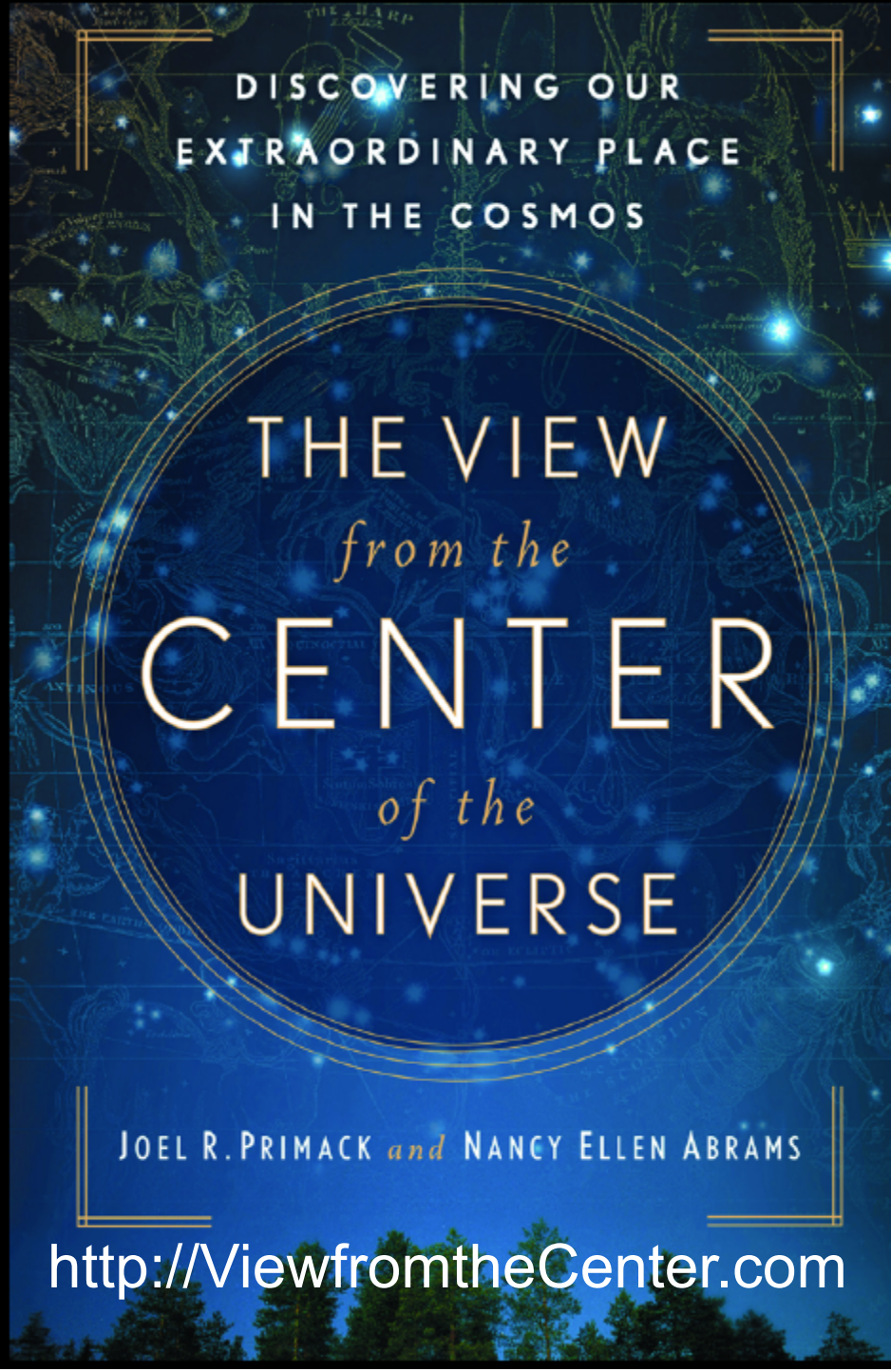
"Dark Matter and Galaxies" - Nat'l Observatory, Rio, 2008

"Brief History of Dark Matter" - KISS Dark Matter Workshop, Caltech, 2009

"Dark Matter: Small Scale Issues" - NewJPhys 2009

"ΛCDM Successes and Challenges" - Dark Matter 2010 Conference

"Observational Gamma Ray Cosmology" - Texas2010, Heidelberg



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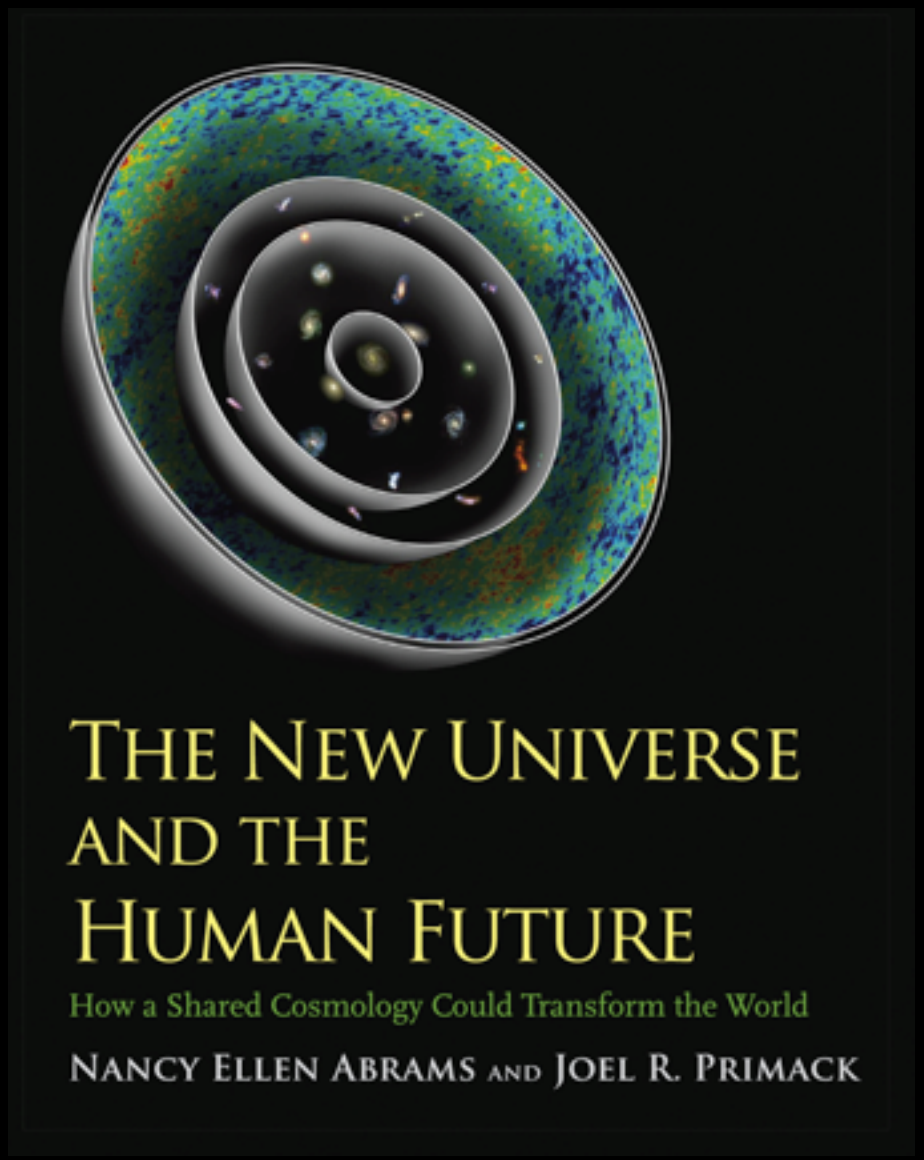
Yale University Press THE TERRY LECTURES SERIES



http://New-Universe.org