Cosmological Outreach via Visualizations

Randall H. Landsberg
Director of Education & Outreach KICP
Director of Public Outreach Dept. AA

Kavli Institute for Cosmological Physics at The University of Chicago
Agenda

I. Introduction
   • Context: Scientific Research Community
   • E-media

II. Very Quick - Cosmology Primer

IV. Chicago-centric Science Examples
   • Data Visualized & Sense of Place
   • Dissemination

V. Other Current Outreach of Interest
Outreach in the Scientific Research World

- Strength of U. Chicago Astronomy & Astrophysics
  - Astronomy/Cosmology Inherent Appeal to the Public
  - Culture & Long History
    - Adler Planetarium Charter & Joint Appointments
    - Director of Public Outreach
- Large Umbrella Grants - Support Sustained Efforts
  - Kalvi Institute for Cosmological Physics
    - NSF Physics Frontier Center
      - ~$4M/yr
    - Suite of Outreach Activities
      - Space Explorers K-12 Inner City
      - Cosmology Short Courses
      - Museum Partnership & More
- Required by Science Funding Agencies
  - National Science Foundation Criterion 2 - “Broader Impacts”
Visualization & Electronic Media

- **Appropriate/Real**
  - Authentic Artifacts (esp. in Astronomy = Observational Science)
  - Transport People to Inaccessible Places/Energies/Scales

- **Fast**
  - Days/Hours Vs Years for Physical Exhibits

- **Flexible**
  - Infinite Dynamic Range (quarks to the cosmos)
  - Interactive
  - Make for One Media - Adapt for Others
  - (Easy & Inexpensive to Install)

- **Needed (Hardware Revolution w/o Content)**
  - Museums, Web Pages, New Technologies
  - Full Digital Domes
    - Planetaria now = Visualization Theaters
  - Technology in the Classroom
GeoWall 3D

@ KICP, Adler & on Campus

- Side by Side Stereo Projection
  - Different Views for Right & Left Eyes
- Components (Off the Shelf Hardware <$10K)
  - CPU w/Dual Video Output
  - 2 DLP Projectors
  - (Adjustable Rack for Projectors)
  - 2 Polarizing Filters (linear or circular)
  - Crossed Polarizing/3D Glasses
  - Polarization Preserving Screen
- Software (mostly freeware)
  - Partiview, Walkabout, Immersaview, Wallview, PokeScope
Cosmus - Cosmology Museum Effort:
R. Landsberg, M. SubbaRao, D. Surendran

- Visualization of Current/KICP Science
  - REAL Data
  - Software
  - New Platforms – e.g., Side-by-Side Stereo & PSP
- Connecting Museums, Educators & Researchers
- Web Repository of “Products” – Freely Downloadable
  - 3D Interactives
  - 2D Interactives
  - Stereo Photos
  - Movies & Animations

http://astro.uchicago.edu/cosmus
Mini Modern Cosmology Primer
Makeup of Universe Today

Visible Matter
(stars 0.4%, gas 3.6%)

Dark Matter
(suspected since 1930s, known since 1970s)

Dark Energy
(suspected since 1980s, known since 1998)

Also:
radiation (0.01%)
Universe Observed Today: Matter

MOVIE
SDSS DR4 - clip
http://astro.uchicago.edu/cosmus/aas06/sdss_DR4.mov
Universe Observed Today: Matter
Sloan Digital Sky Survey Mapping the Observable Universe

3D Map 25% Sky
Large Scale Structure of the Universe
>180M Celestial Objects - Photometry
>1M galaxies/quasars – Spectroscopy
Survey
Geometry
On the Sky:

Northern Survey:
~1/4 the sky

Southern Survey:
3 slices

(Look away from the Milky Way)
Apache Point Observatory
Southern New Mexico
SDSS 2.5-meter telescope
SDSS Digital Camera

Top to bottom:

g'
z'
u'
i'
r'

filters

Drift Scan Mode

120 Megapixels

Cooled to –200 degrees
Spectroscopic Plates for Redshift Survey 640 Fibers per Plate
Dark Matter - Direct Mapping/Detection

Galaxy Cluster Abell 2218
HST • WFPC2
NASA, A. Fruchter and the ERO Team (STScI) • STScI-PRC00-08
Evolution of the Dark Matter Landscape Simulations

A. Kravstov       e.g.  http://cosmicweb.uchicago.edu/filaments.html
Dark Energy (Map Maker) I
Arrival at South Pole
Movie

YouTube

http://www.youtube.com/watch?v=h64QqHlcf7M

or

http://pole.uchicago.edu/
Particles from Space
Ultra High Energy
Cosmic Rays

• VERITAS Array
  - Amado, AZ

• Pierre Auger Observatory
  - Malague, Argentina
• Gamma Ray Telescope **Array**
• Seven Dishes - Each 36 feet in diameter w/ 315 mirrors
• Potential very high energy gamma rays sources:
  - black holes
  - pulsars
  - gamma-ray bursts
  - supernova remnants
  - globular clusters
  - galaxies including our own

10-100 GeV Shower
Auger Observatory - Pampas of Argentina

- Ultra-High Energy Cosmic Rays \([10^{20}\text{eV}]\) expect \(1/\text{km}^2/\text{century}\)
- Size of Rhode Island (5x Times the Size of Paris)
- 1,600 Surface Detectors & 24 Fluorescence Telescopes
- Lead by Jim Cronin – Nobel Laureate
- \(10^{20}\text{eV}\) impact produces \(10^{11}\) particles over 20km²
Auger Surface Detector Animation
UHECR Over Chicago Movie
1 TeV Proton

see

http://astro.uchicago.edu/cosmus/projects/aires/protonshoweroverchicago.mpeg
UHECR Over Geneva Movie
1EeV Proton

see

http://astro.uchicago.edu/cosmus/projects/aires/proton_1EeV.mov
Black Hole - Center of Milky Way Galaxy

- DATA
  - Observation of Central Stars
  - Multiple Years
  - Using Adaptive Optics
- From Motions & Freshman Physics Deduce - SUPER MASSIVE OBJECT
- Can Predict Future Orbits
- Andrea Ghez (UCLA) (Hyde Park Native)
- Basis for Textbook Problems
Year: 1995.2


Data: Andrea Ghez, Jessica Lu (UCLA)
Visualization: Dinoj Surendran, Randy Landsberg, Mark SubbaRao (UChicago / Adler / KiCP)

UCLA Galactic Center Group
Other Notable Current Outreach Efforts

- Festival of Maps
  - Skyzome
- Cafe Scientifique
  - Next - Flying Snakes 10/29
- SPT/Exploratorium
- Open Invitation to KICP Lab & Adler SVL
Festival of Maps: Chicago

- **Science Workshop**
  - *Cosmic Cartography: Mapping the Universe from the Big Bang to the Present* (12/4-6)

- **Professional Development Informal Science Educators**
  - *Chicago Maps the Cosmos: Cosmology Short Course for Museum & Planetarium Staff* (12/7-9)

- **Public Events**
  - Dec. 5 *Cosmic Cartography: Journey Through the Universe*
    - Rocky Kolb, Mike Turner & Guests @ The Art Institute
  - Jan. 12 *Mapping the Heavens: The Universe Revealed by the Sloan Digital Sky Survey*
    - Josh Frieman @ Adler Planatarium

- **On Exhibit - Adler Mapping the Universe & SVL**
  - Adler Mapping the Universe Exhibit & SVL
  - SkyZome Installation (maybe)
SkyZome: Interpreting Cosmic Cartography

- Collaborative art/science installation SAIC & U.Chicago
- Millennium Park
- Urban Sized
- 22,000 programmable dynamic light elements
- Cosmology Narratives
- Existence - TBD
“Cafe scientifique is a place where for the price of a cup of coffee or a glass of wine, anyone can come to explore the latest ideas in science and technology. Meetings have taken place in cafes, bars, restaurants and even theaters, but always outside a traditional academic context.”

KICP Goals:
• To engage broader public audience in the excitement of current research
• To improve the communications skills of the researchers involved
FORMAT

Casual Location = Pub

- Map Room (Bucktown)

Brief (15-20 min) Intro to Topic
- Everyone on the Same Page
- Limited Visual Aids

Break (readjust, recharge)

Question & Answers (~90min)

Moderator
- Sets Tone
- Introduces Speaker
- Guidelines for the Evening
Quarterly

Plans for Burst Mode (IPY, Festival of Maps)

Advertising: Posters & E-media

Mix of Topics (Emphasis on Cosmology)

Past Cafes:

- Beta Test Cafe “Why is the Past Different from the Future: Cosmological Perspectives on the Nature of Time” Sean Carroll (4/26/06)

- “Icy Eye on the Infant Universe: Tales from an Antarctic Cosmologist” Jeff MacMahon (9/18/07)

- “Global Warming” David Archer (1/10/07)

- “Measuring the Big Bang: Still Confused After All These Years” Stephan Meyer (3/28/07)

- “Is it the Genes or Just the Jeans? Biology of Gender” Mark Osadjan (6/18/07)
Reactions/Survey

- Overwhelmingly Positive
- Attendance 50-70 people/Cafe
- Majority Non-Scientists (>75%)
- 100% Want More Cafes
- 250 Registered for the Cafe Email List

“Likes” Responses:
- Beer + intellectual stimulation = fun
- Openness to questions
- Casual approach
- Informal yet not absurdly dumbed down
- Learning about Dark Energy and how it works in the universe
- I love coming to these – I am in administration at the art school and like to hear the different perspective
- PLEASE DO THIS MORE OFTEN
**Reactions/Media**

**Chicago Tribune**

**Qualities of Life: Scene**

**Think 'n' drink**

Cafe Scientifique puts a nice head on a bar scene thirsty for something more

By Chris McNamara
Special to the Tribune
Published January 21, 2007

**WSST's Periodicity**

#34

**Extras: Hard Science, Cold Beer**

Yearning to hoist a pint and listen to a lecture on string theory? Visit our mashup of geek drinking clubs to find a Cafe Scientifique to match your interests.

By Neal Ungerleider

**Gapers Block**

A web publication • Established in 2003 • Chicago, Illinois

**Columbia Chronicle**

Get your science on

Cafe Scientifique brings together booze, science to create

By Tiffany Breyne
Where to Look

- KICP Viz Lab AAC 045
- Adler Space Visualization Lab (SVL)
- Cosmus Website
  - http://astro.uchicago.edu/cosmus
- Alt Media
  - YouTube
  - GoogleVideo
  - Podcasts (Slacker Astronomy)
- South Pole Telescope Website (SPT)
  - http://pole.uchicago.edu
- KICP Website  http://kicp.uchicago.edu/
Thanks To

- Department of Astronomy & Astrophysics
- **Kavli Institute of Cosmological Physics**
  - KICP Faculty
  - Kavli Foundation
  - National Science Foundation (NSF)
    - NSF PHY-0114422

- Mark SubbaRao (UC/Adler)
- Dinoj Surendran (UC/Microsoft Research)
The End