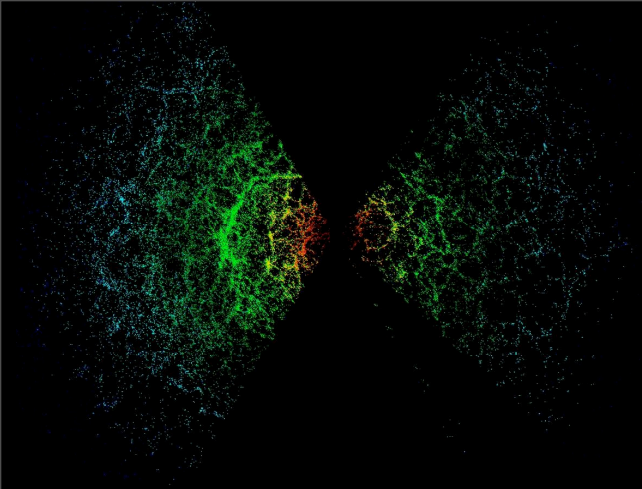
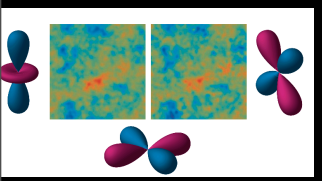


Astronomical Visualizations from the Research Frontiers

Randall H. Landsberg

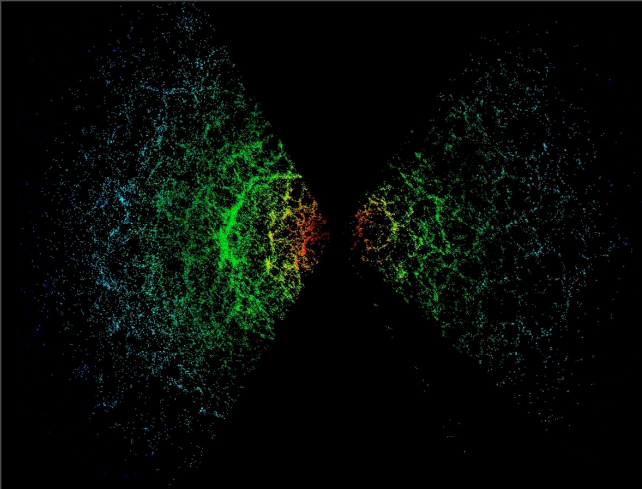
Director of Education & Outreach KICP

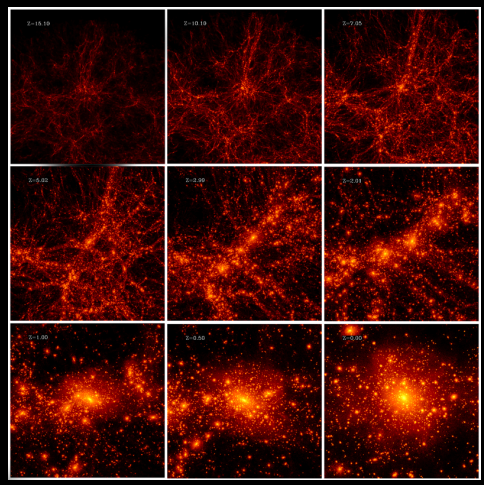
Director of Public Outreach Dept AA



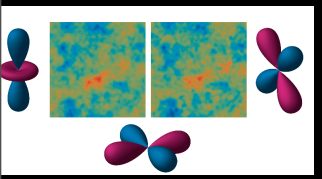
Kavli Institute
for Cosmological Physics
at The University of Chicago

Department of
ASTRONOMY & ASTROPHYSICS
THE UNIVERSITY OF CHICAGO





Astronomical Visualizations from the Research Frontiers



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Agenda

I. Astro Viz Intro

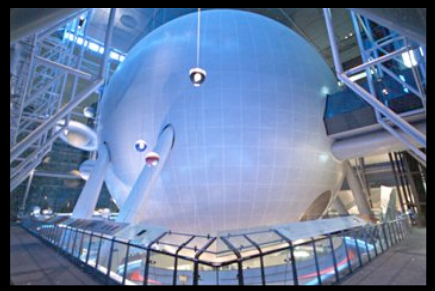
- What is Going on: Research & Public
- Why Interesting

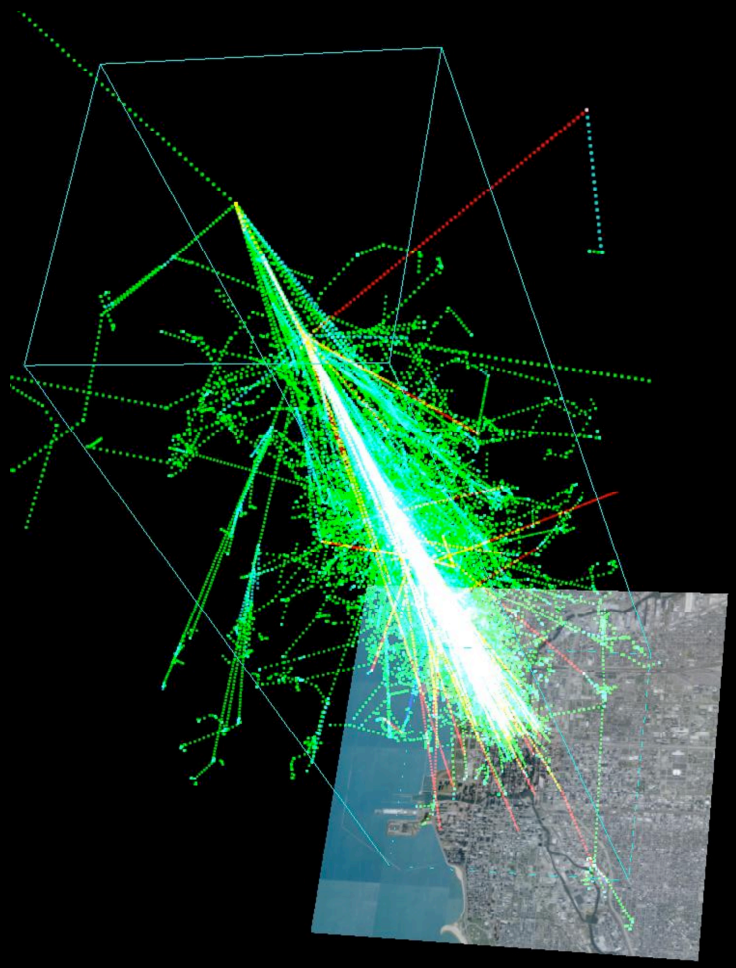
II. Very Quick - Cosmology Primer

IV. Chicago-centric Science Examples

- Viz & Pictures of Experiments

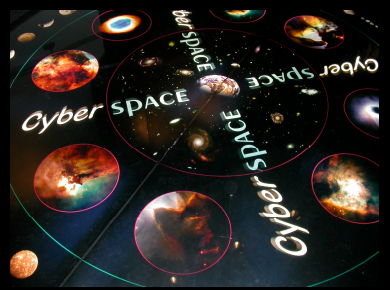
V. Pretty Pictures as Time Permits





Visualization & Electronic Media

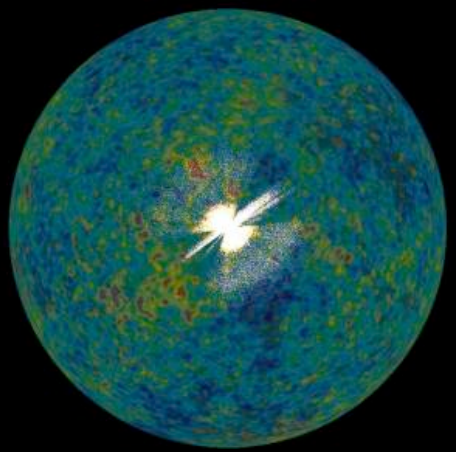
- Appropriate/Real
  - Authentic Artifacts (esp. in Astronomy = Observational Science)
  - Transport People to Inaccessible Places/Energies/ Scales
- Fast
  - Days/Hours Vs Years for Physical Exhibits
- Flexible
  - Infinite Dynamic Range (quarks to the cosmos)
  - Interactive
  - Make for One Media - 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

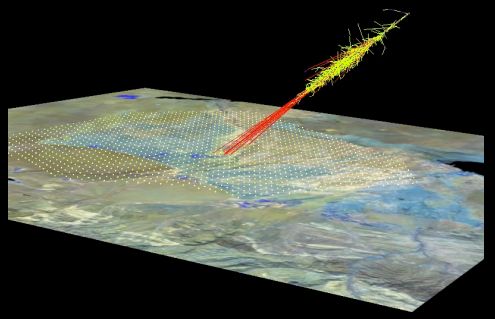


Cosmus - Cosmology Museum Effort:

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

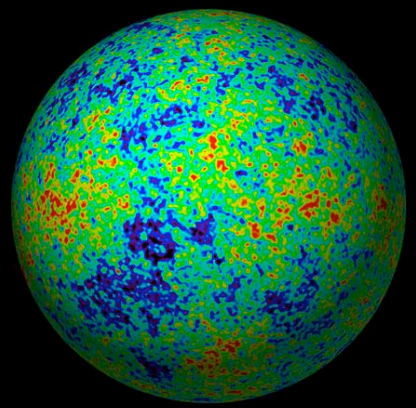




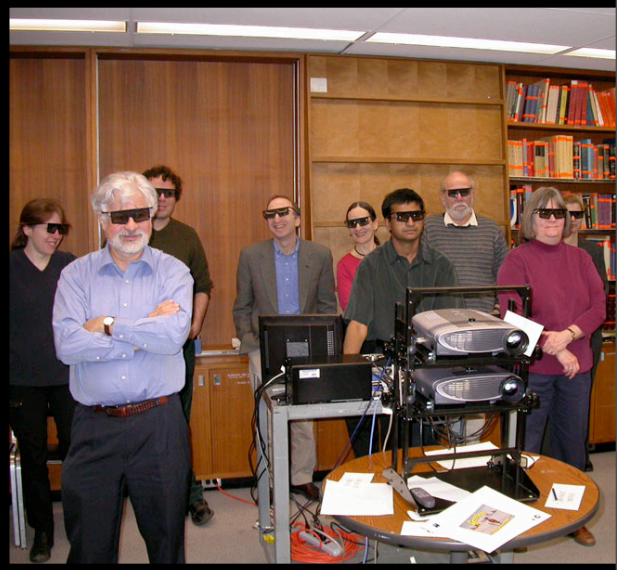
http://astro.uchicago.edu/cosmus

Cosmus Visuals

- **Visualization of Data Sets**
  - **Interactives & Movies**
    - SDSS/WMAP Observations
    - Cosmic Ray Showers Simulations
      - Over Malargue, Over Chicago
    - LSS Dark Matter Simulations
    - Black Hole Center of the Galaxy
    - Supernova Explosions
- **Virtual Visits & Remote Contacts**
  - Experiments& Exotic Locations
  - Stereo Photos & Photo Essays
    - Auger
    - Veritas
    - SDSS/APO
    - Mars
    - SZA
    - South Pole



GeoWall 3D

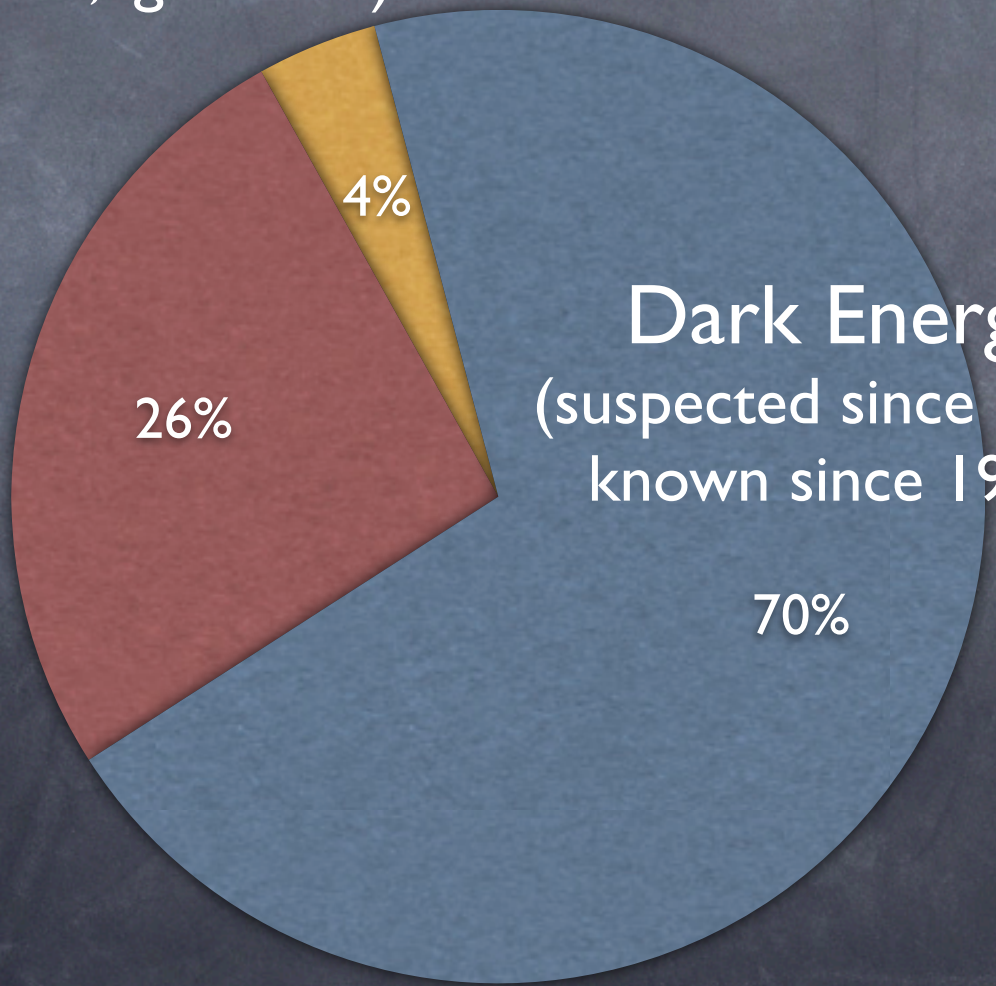


- Side by Side Stereo Projection
  - Different Views for Right & Left Eyes
- Components (Off the Shelf Hardware <$10K)
  - CPU w/Dual Video Output
  - 2 DLP Projectors
  - (Adjustable Rack for Projectors)
  - 2 Polarizing Filters (linear or circular)
  - Crossed Polarizing/3D Glasses
  - Polarization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

Mini Modern Cosmology Primer

Makeup of Universe Today

Visible Matter
(stars 0.4%, gas 3.6%)

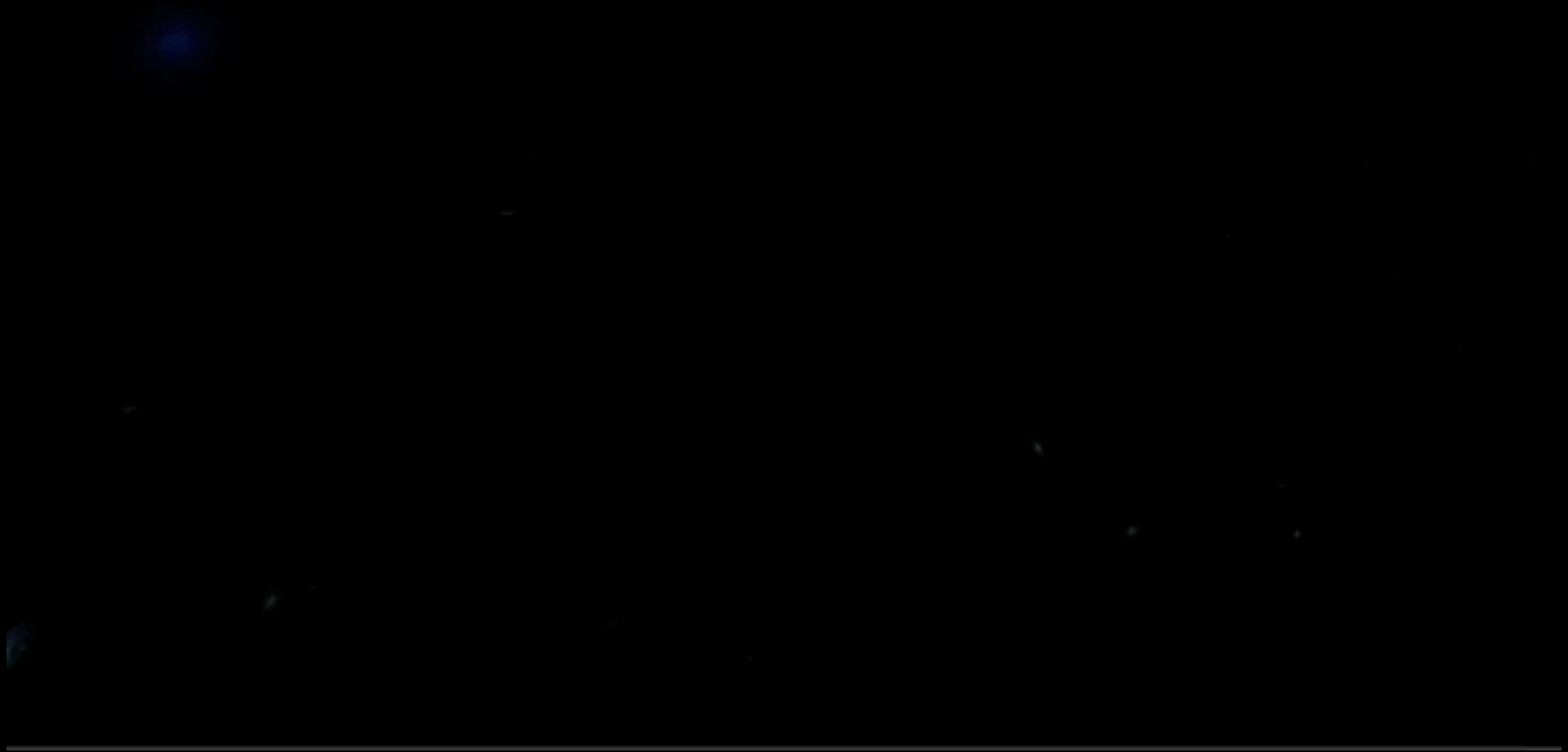


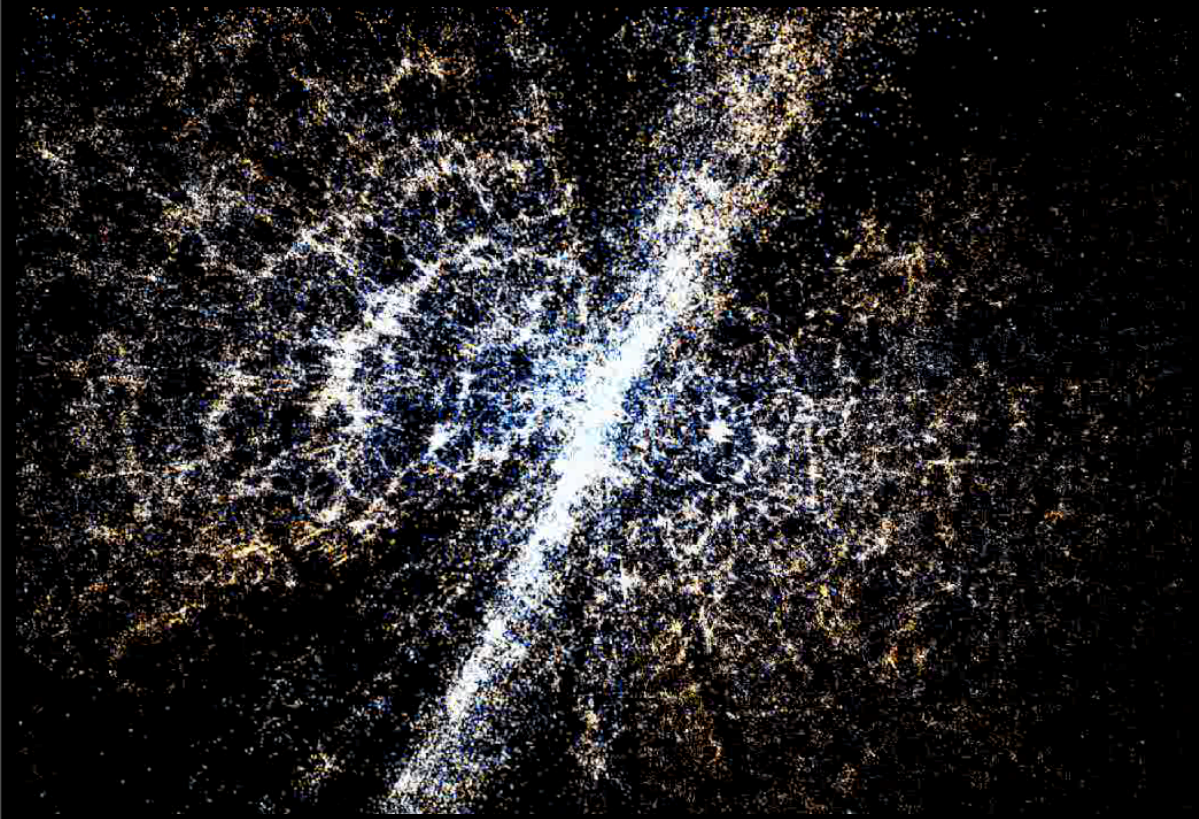
Dark Matter
(suspected since 1930s
known since 1970s)

Dark Energy
(suspected since 1980s
known since 1998)

Also:
radiation (0.01%)

Universe Observed Today: Matter





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

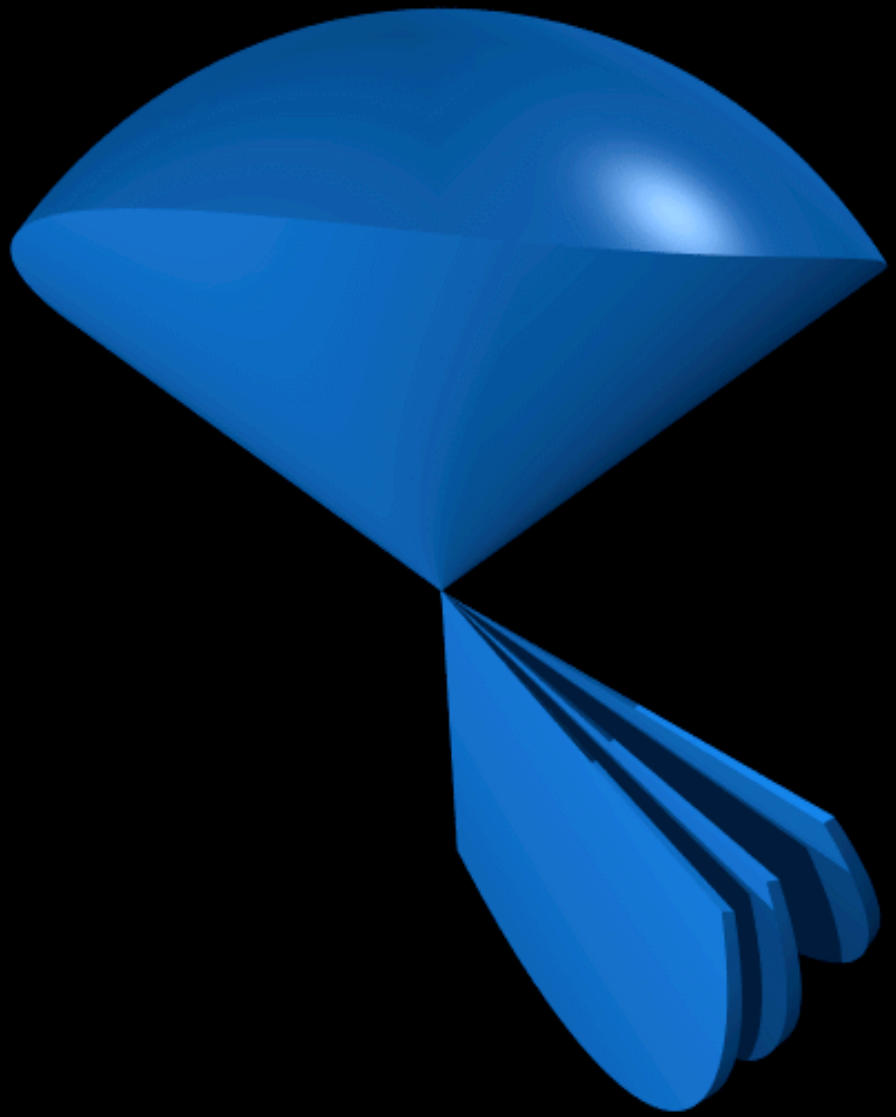
SDSS

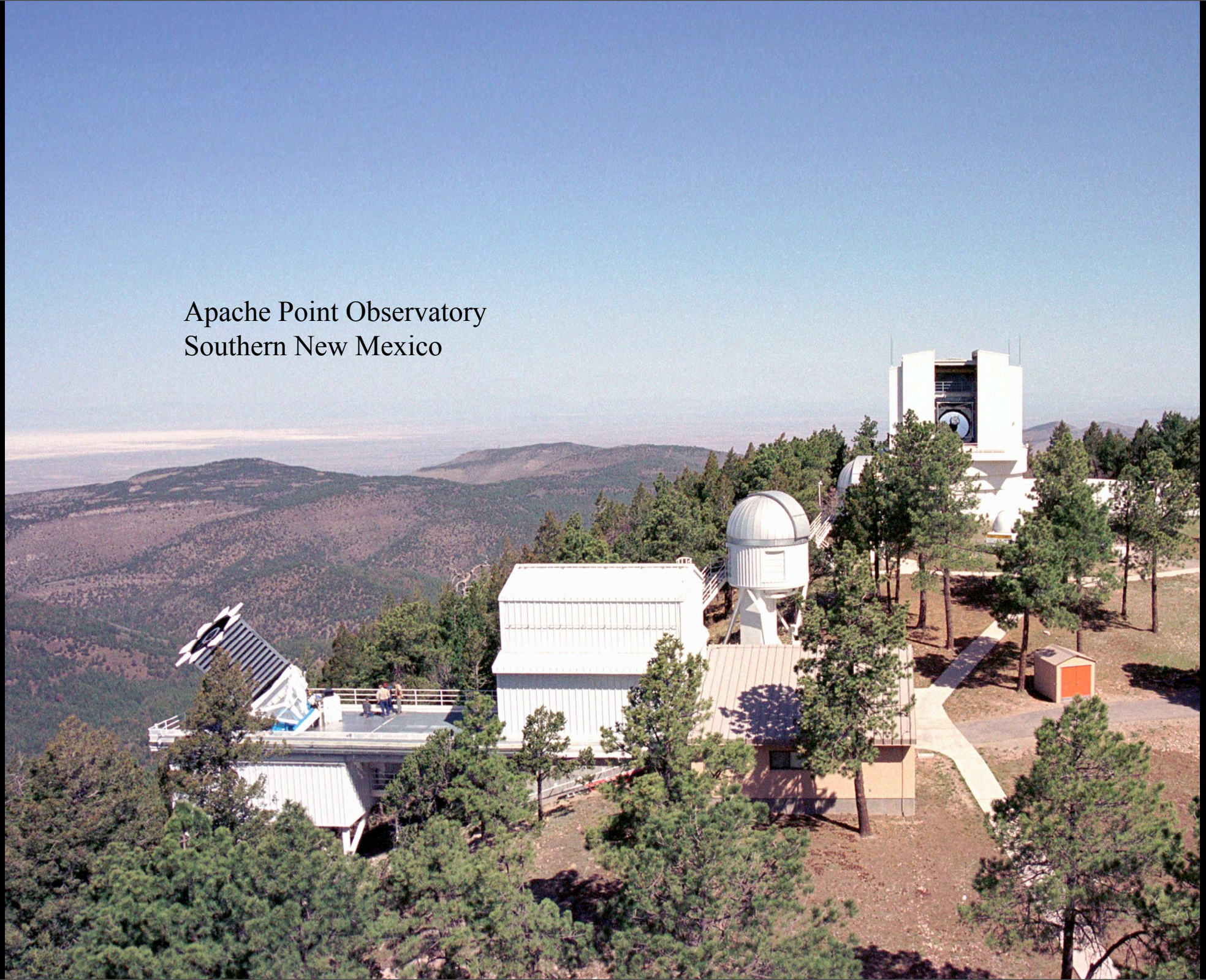
Survey Geometry On the Sky:

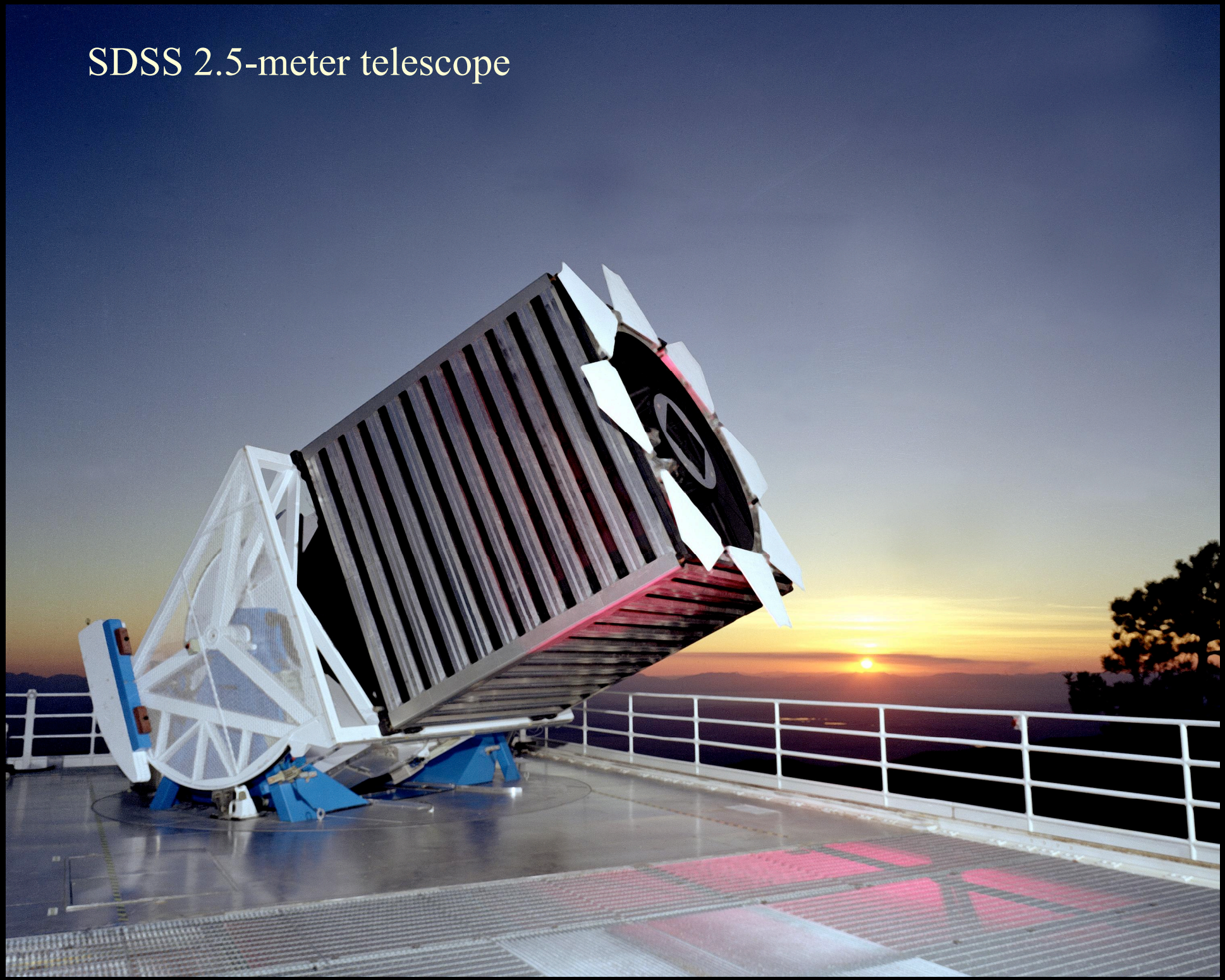
Northern Survey: ~1/4 the sky

Southern Survey: 3 slices

(Look away from the Milky Way)




Apache Point Observatory
Southern New Mexico


SDSS 2.5-meter telescope

SDSS Digital Camera

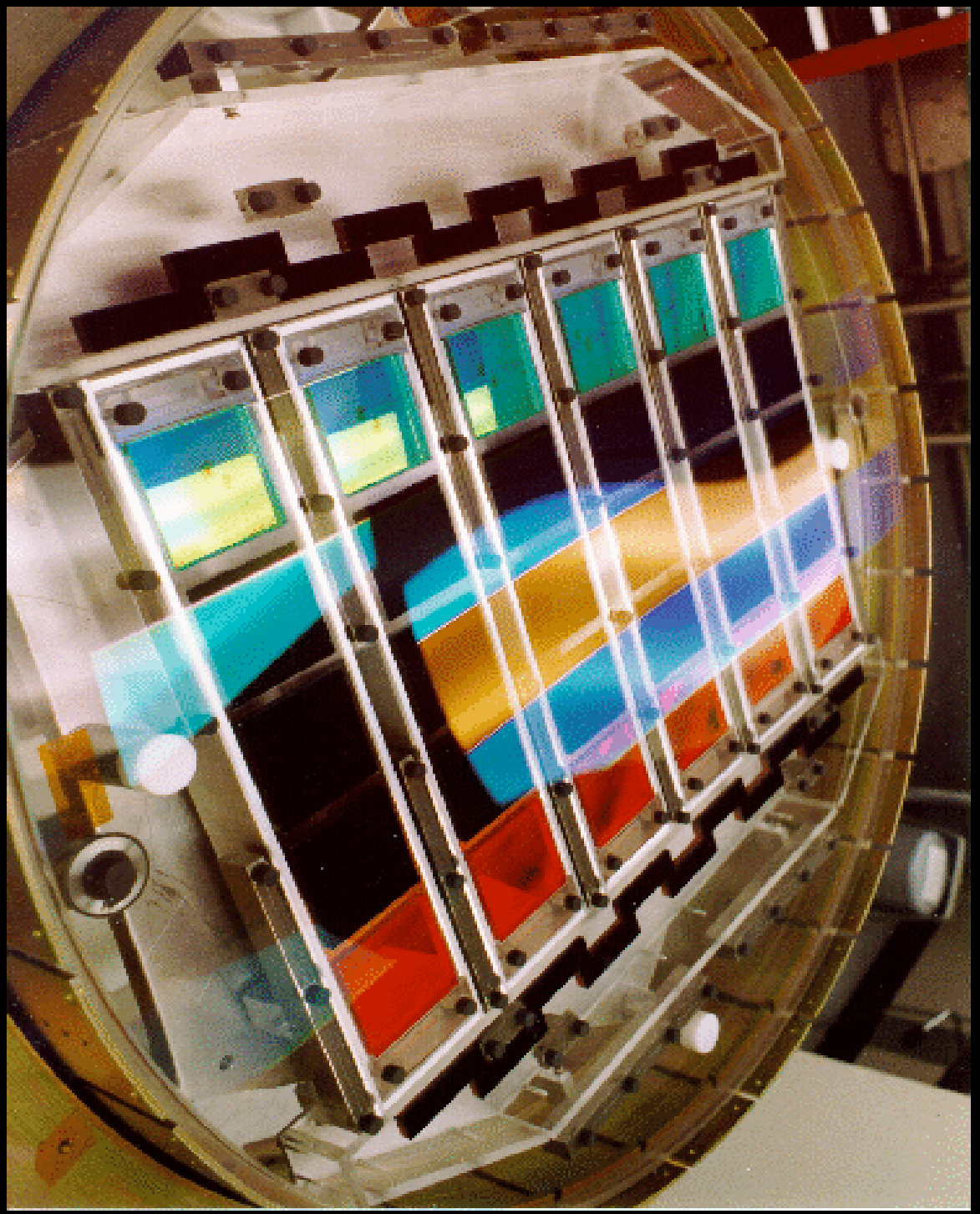
Top to bottom:

g’
z’
u’
i’
r’
filters

Drift Scan Mode

120 Megapixels

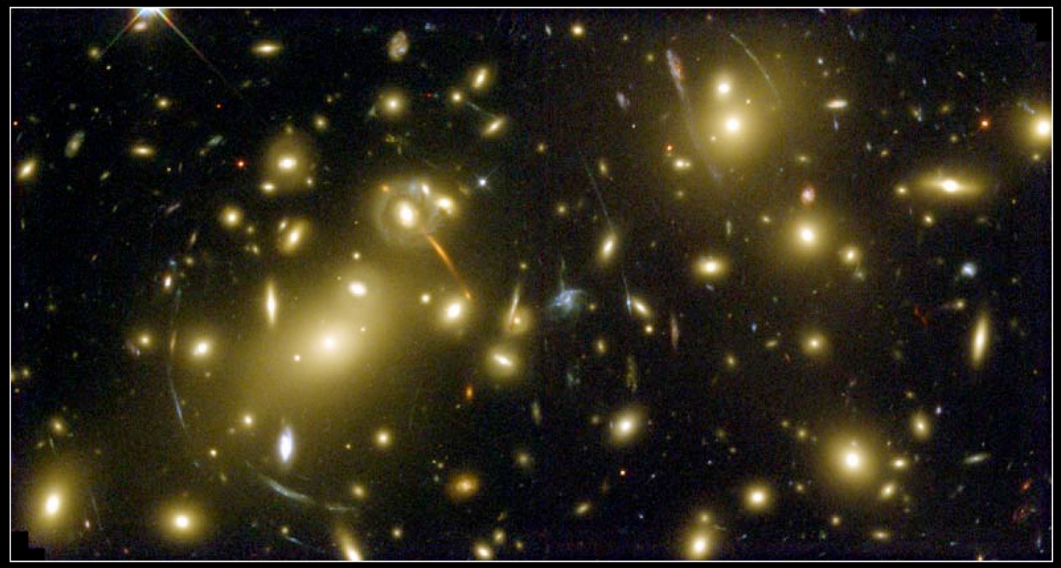
Cooled to –200 degrees



Spectroscopic Plates for Redshift Survey 640 Fibers per Plate

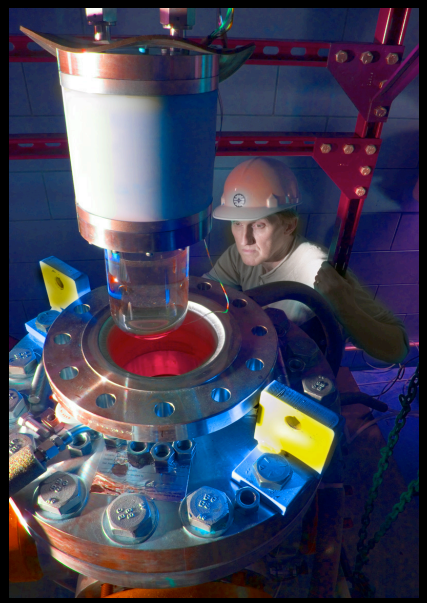
sdss DR 4 Movie

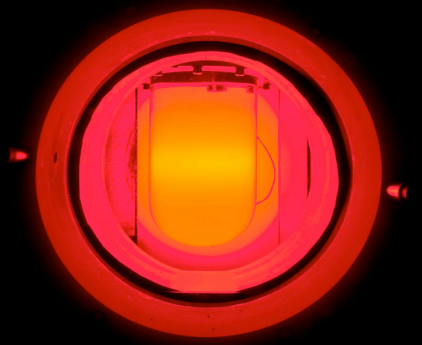
Dark Matter - Direct Mapping/ Detection

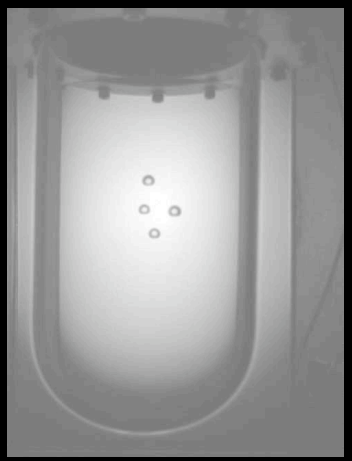


Galaxy Cluster Abell 2218 **HST** • WFPC2

NASA, A. Fruchter and the ERO Team (STScI) • STScI-PRC00-08







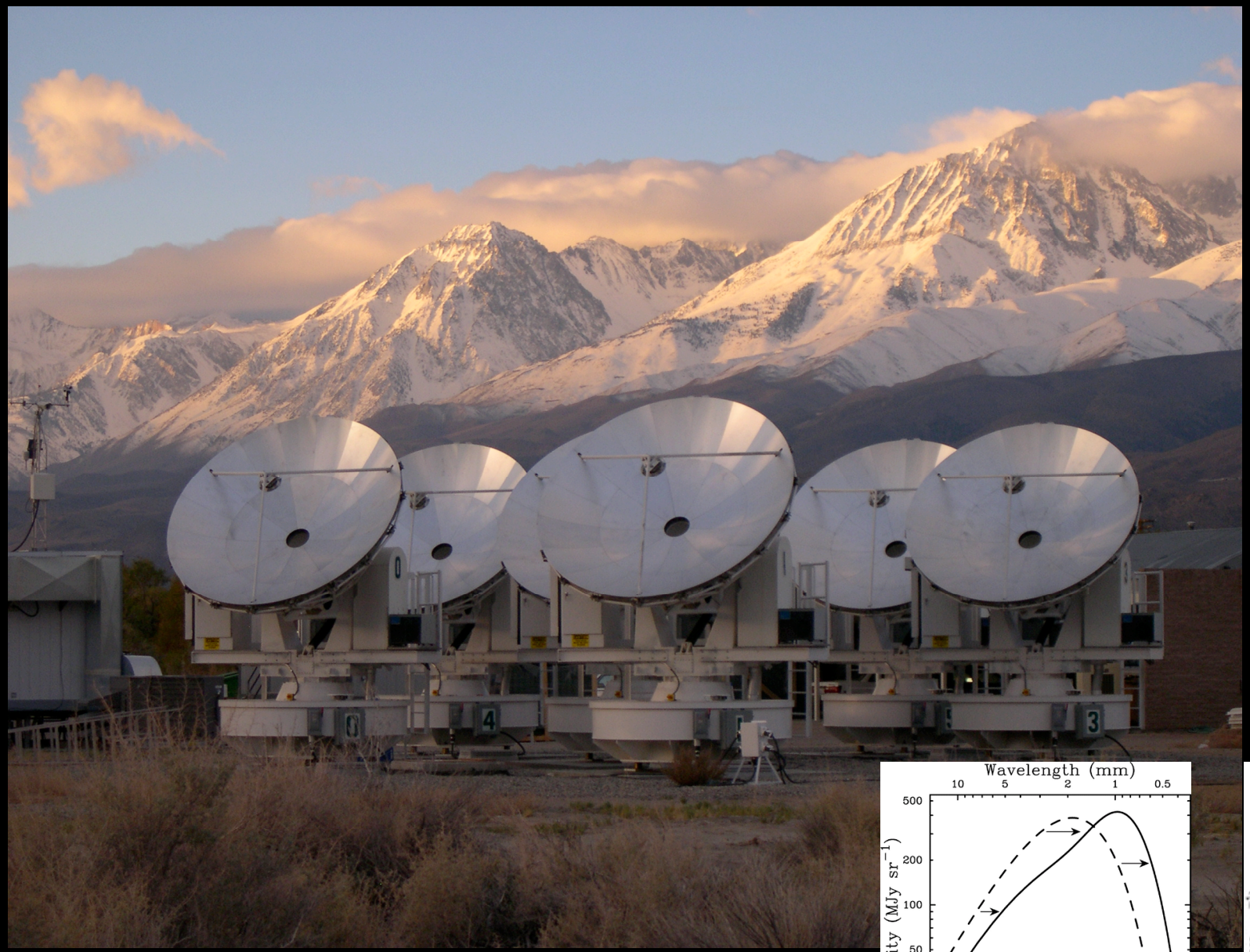
Z=40.52

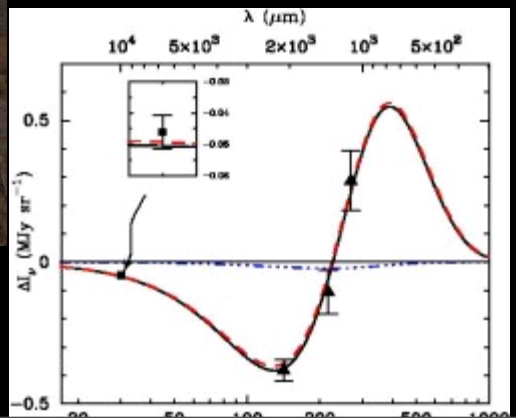
Dark Energy (Map Maker) I


PMT
AIRFLOW

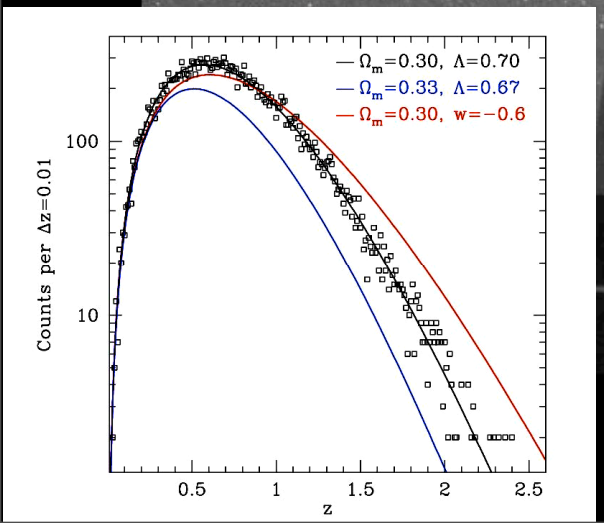
arrival at South Pole
Video

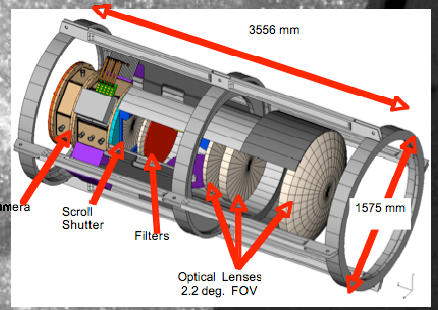
Dark Energy II

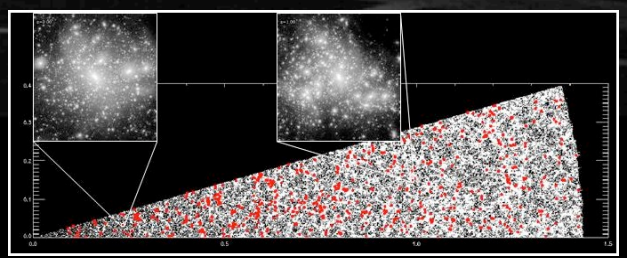




Dark Energy III





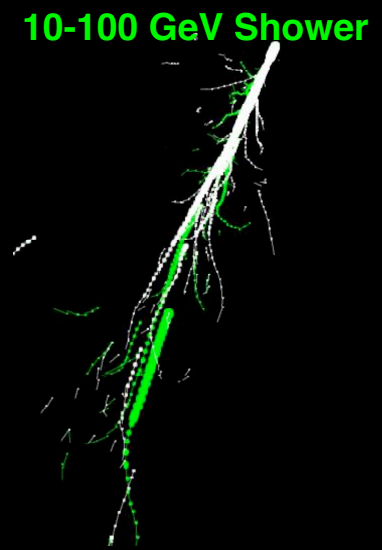


Particles from Space Ultra High Energy Cosmic Rays

- Pierre Auger Observatory (Malague, Argentina)
- VERITAS (AZ)

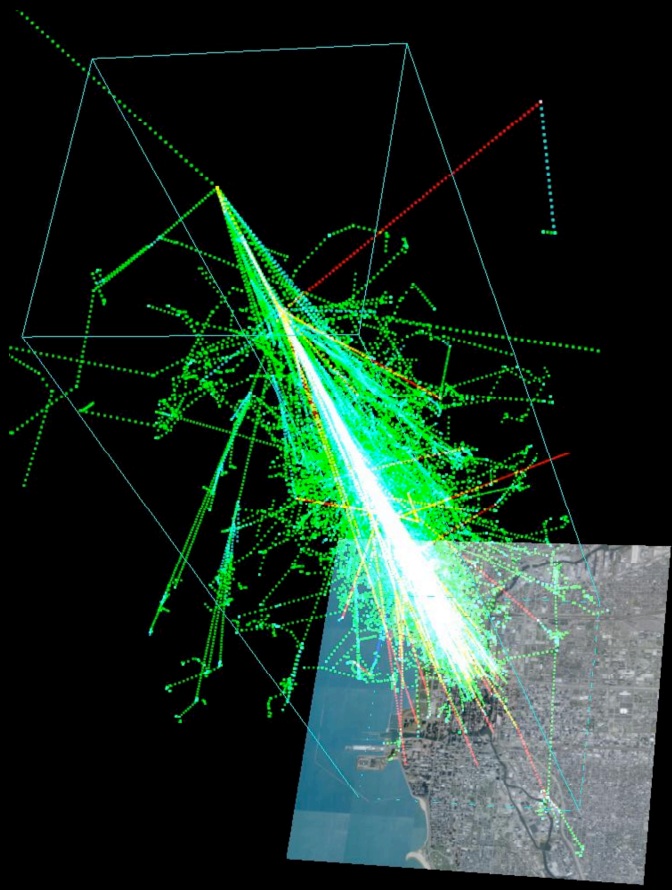
VERITAS

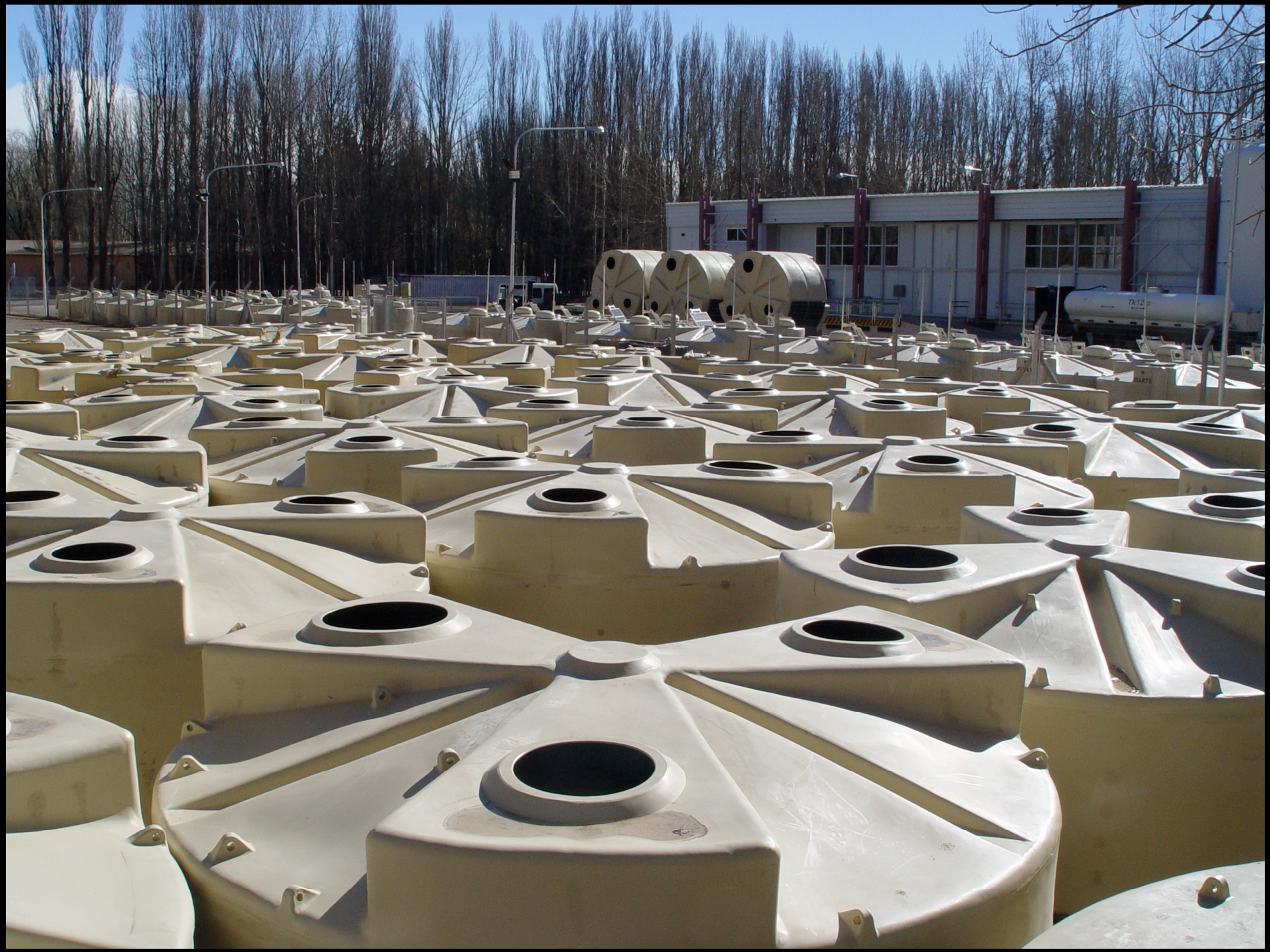
- Gamma Ray Telescope - Arizona
- Seven - 36 feet dishes w/ 315 mirrors each
- Will search for very high energy gamma rays from:
  - black holes
  - pulsars,
  - gamma-ray bursts
  - supernova remnants
  - globular clusters
  - galaxies including our own



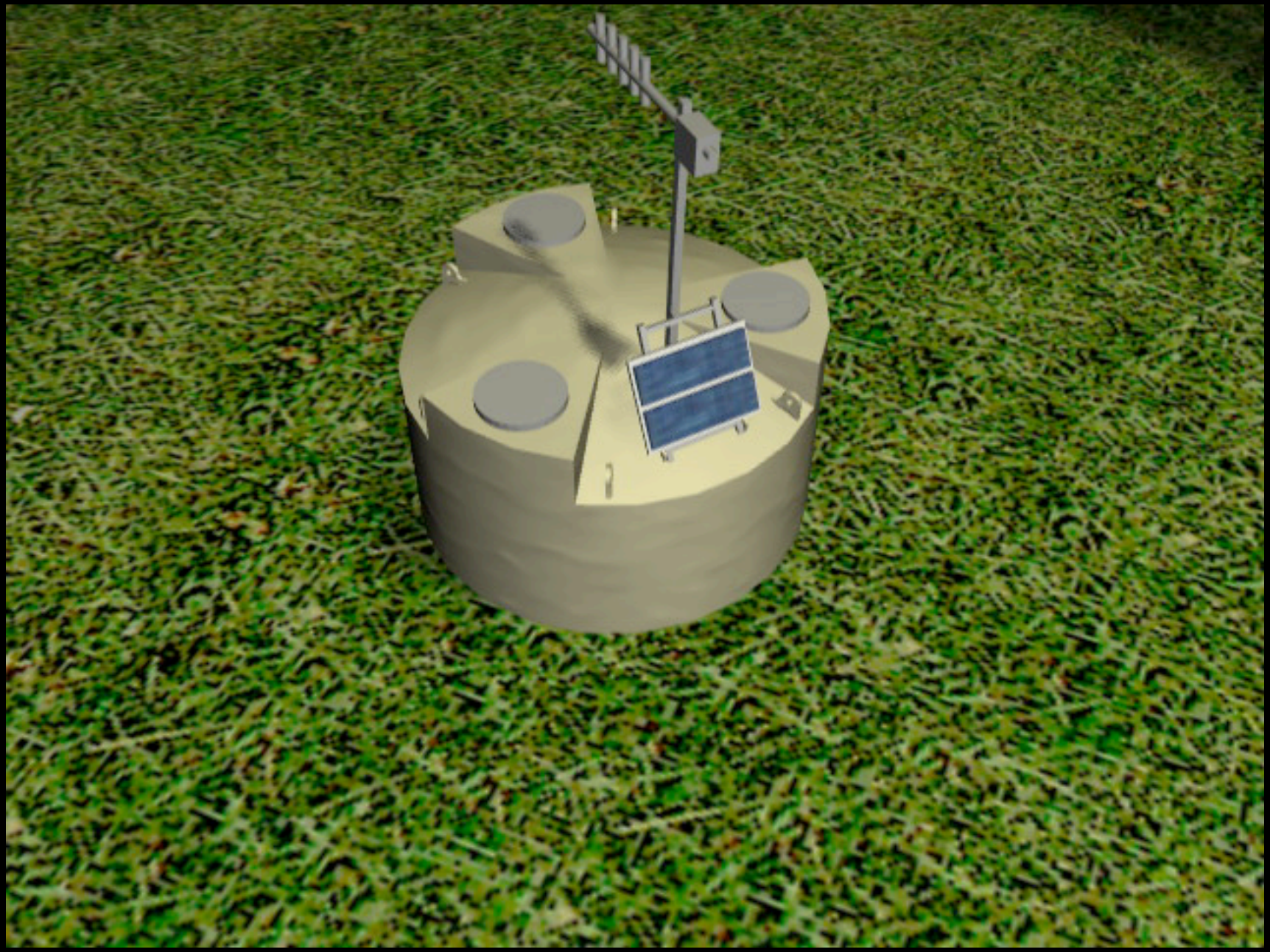
Auger Observatory - Pampas of Argentina

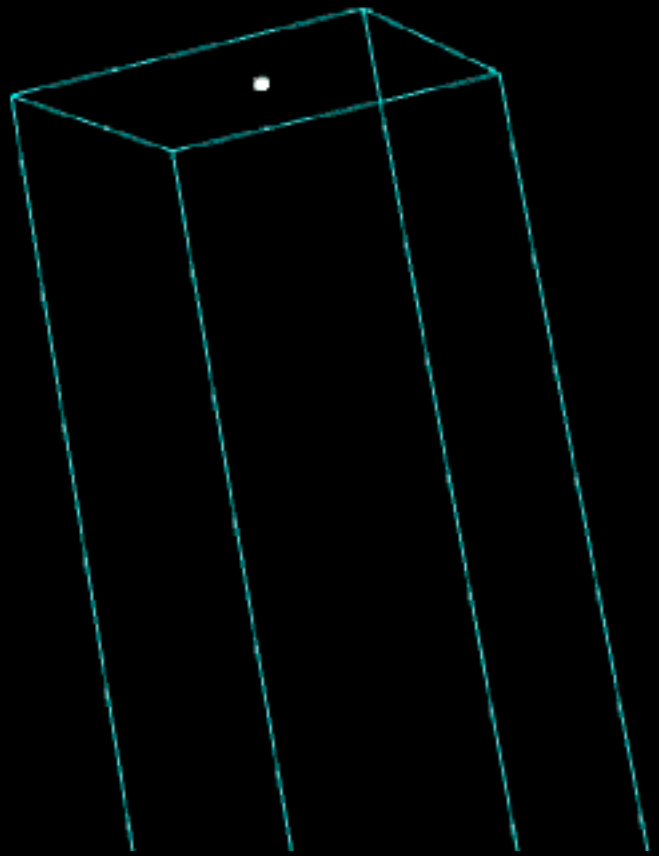
- Ultra-High Energy Cosmic Rays [10^{20}eV] expect 1/km^2/century
- Size of Rhode Island
- Lead by Jim Cronin – Noble Laureate
- 10^{20}eV impact produces 10^{11} particles over 20km^2





Stereo Photo





purple-gammas
yellow -electrons-positrons
red muons
green pions
cyan neutrons
blue protons

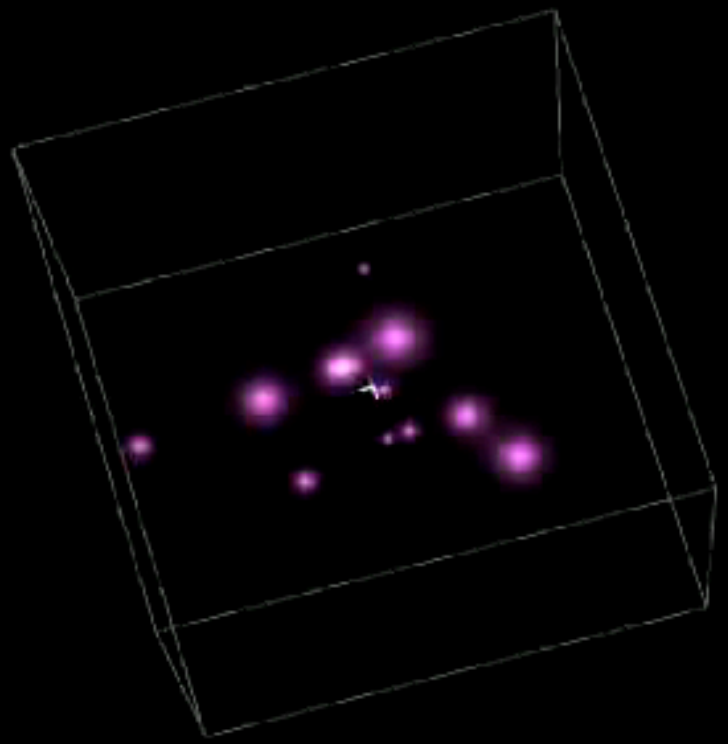
Black Hole - Center of Milky Way Galaxy

- DATA
  - Observation of Central Stars
  - Multiple Years
  - Using AO

- From Motions & Freshman Physics Deduce - **SUPER MASSIVE OBJECT**
- Can Predict Future Orbits
- Andrea Ghez (UCLA)
- Basis for Textbook Problems

Year: 1995.2

The Acceleration of Stars Orbiting
the Milky Way's Central Black Hole
(Ghez et al, Nature 407:349, 2000)



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

UCLA Galactic Center Group

Where to Look for This Eye Candy

- **Cosmus Website**
  - http://astro.uchicago.edu cosmus
- YouTube
- GoogleVideo
- South Pole Telescope Website (SPT)
  - spt.uchicago.edu or google spt
- KICP NSTA Website
  - http://kicp.uchicago.edu/nsta

Thanks To

- Kavli Institute of Cosmological Physics
  - Kavli Foundation
  - National Science Foundation (NSF)
    - NSF PHY-0114422
- Mark SubbaRao (UC/Adler)
- Dinoj Surendran (UC CS)

The End