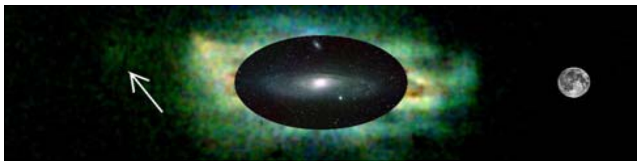
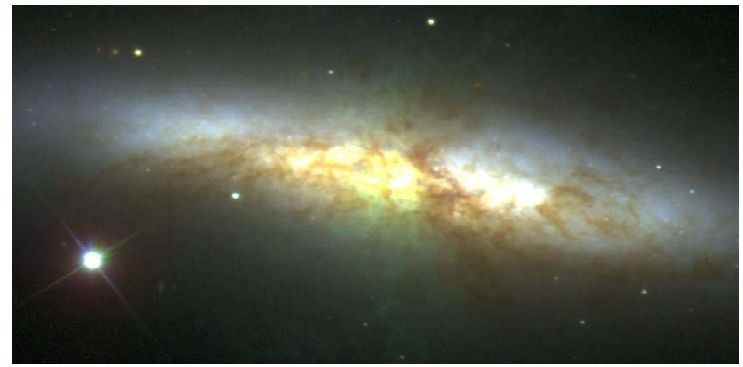
Experimental Astrophysics Group: SDSS and JDEM R&D



Stephen Kent
March 24, 2004



- **Experimental Astrophysics Group (CD) and SDSS (Sloan Digital Sky Survey)**
- **To the future: SDSS Extension**
- **To the future: SNAP/JDEM**
- ***To the future: DES (Dark Energy Survey)***

Experimental Astrophysics Group

- Staff Scientists
  - Stephen Kent
  - Chris Stoughton
  - Jim Annis
  - Rich Kron
  - Huan Lin
  - (John Peoples)
  - Douglas Tucker
  - Brian Yanny
  - John Marriner
- Postdocs
  - Hubert Lampeitl
  - Sebastian Jester
- Computing Professionals
  - Jen Adelman
  - Nikolai Kuropatkine
  - Dan Yocum
  - John Hendry
  - John Inkmann
  - Vijay Sekhri (NVO/iVDGL)
- Students
  - Brian Wilhite (UC)
- Visitors/Guests
  - Susan Kayser

Sloan Digital Sky Survey (E885)

Goal:

Conduct fundamental research in cosmology, particularly formation & evolution of galaxies and large scale structure

Approach:

Digital map of ¼ of sky in 5 bands

Spectra of 1 million galaxies, 100,000 quasars

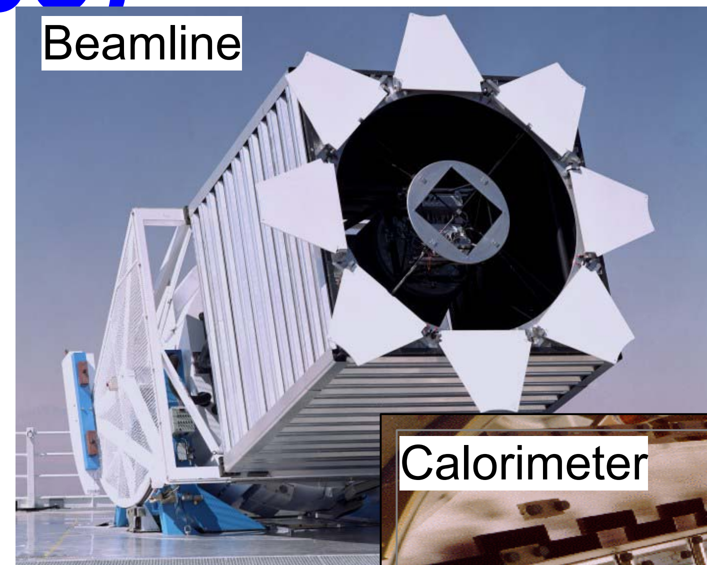
Resources:

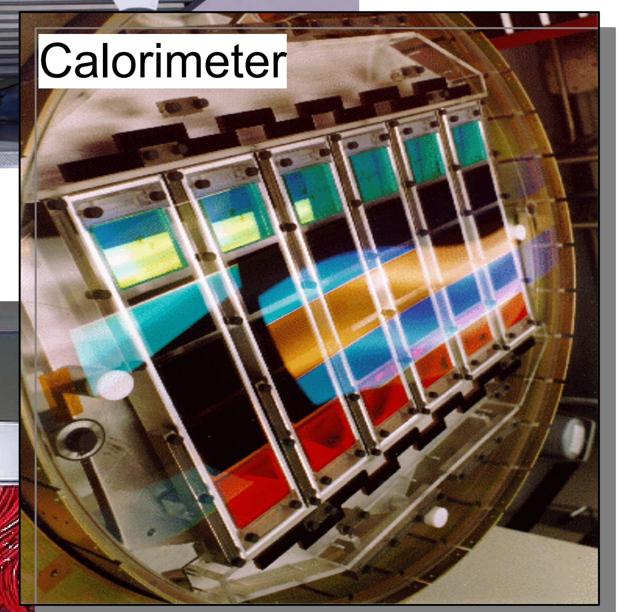
2.5 m telescope in New Mexico

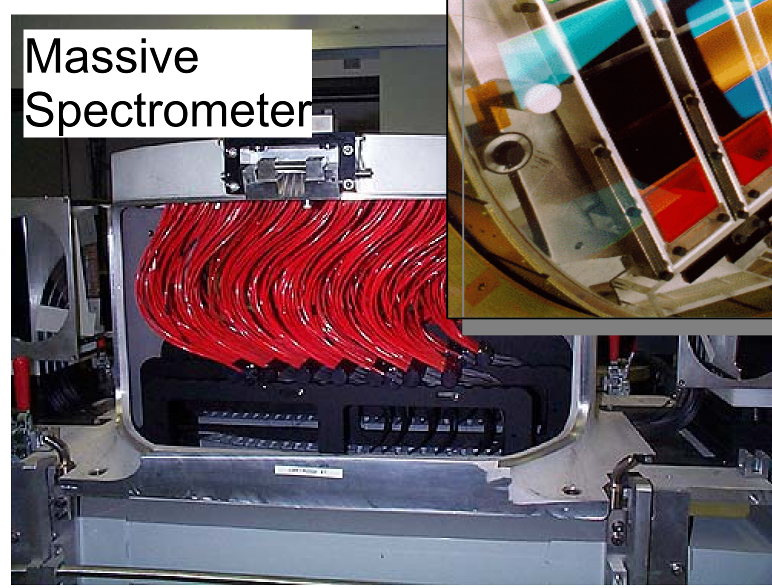
Large CCD camera

640 fiber spectrograph

11 partner institutions







FNAL in SDSS

Role:

- Data acquisition
- Data processing
- Survey Planning
- Data distribution
- Support telescope and instrument systems

Science:

- Galaxy angular correlation functions (Dodelson)
- Weak lensing (Annis)
- Galaxy clusters (Annis, Kent, Tucker)
- Milky Way halo structure (Yanny, Kent)
- Galaxy evolution (Lin)
- QSO luminosity functions (Stoughton)
- Near Earth Asteroids (Kent)

Participants

EAG

TAG

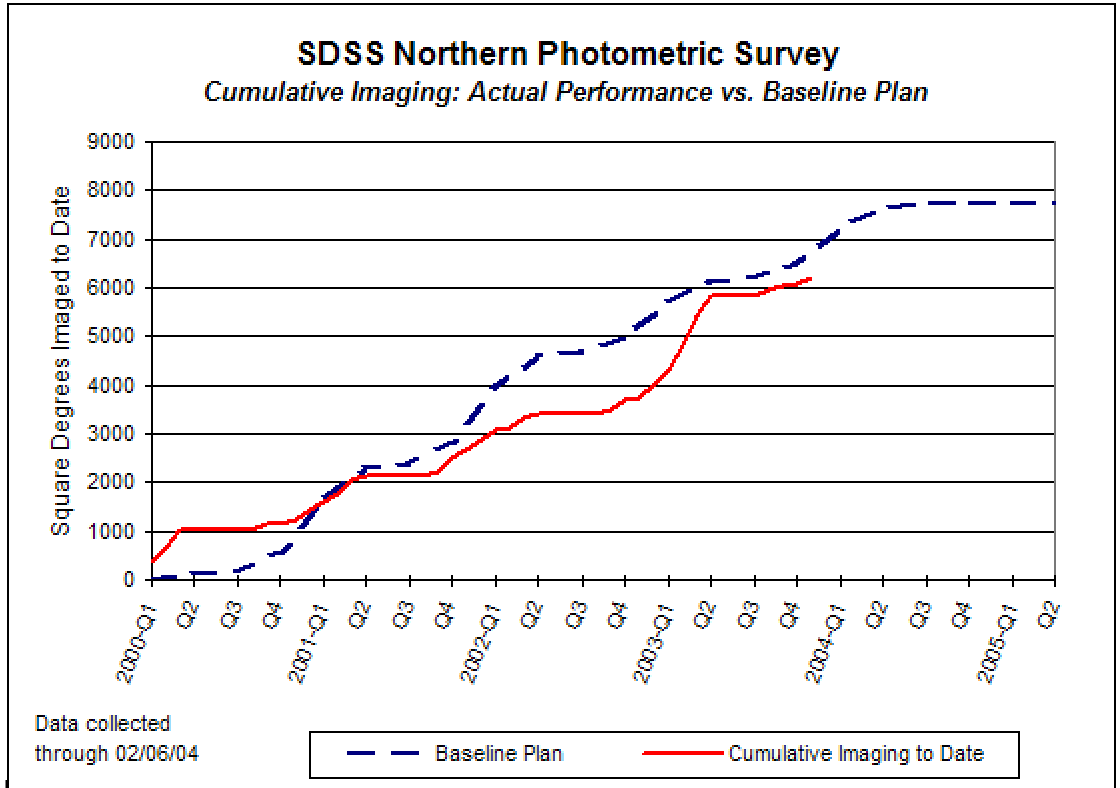
PPD

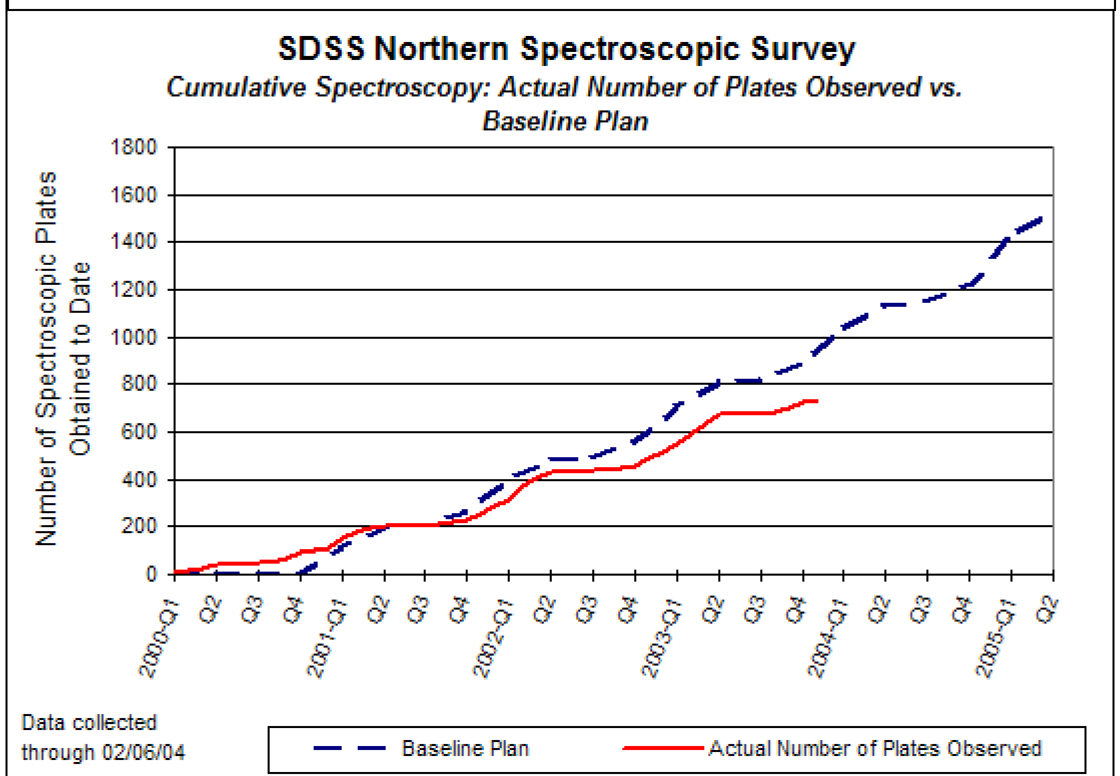
- Bill Boroski
- French Leger
- Carlos Gonzalez
- Steve Bastian
- Wendell Jordan

Comp. Comm. Fab. (CD)

- Don Holmgren
- Eric Neilsen
- Ron Rechenmacher

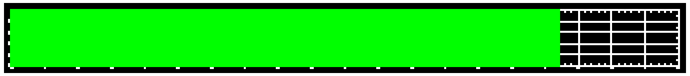
"Integrated Luminosity" vs. 5 Year Baseline



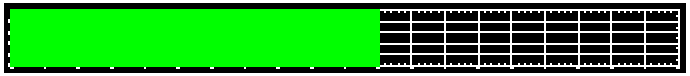


SDSS Current Status (Mar 2004)

Imaging: 82% as of March 11, 2004

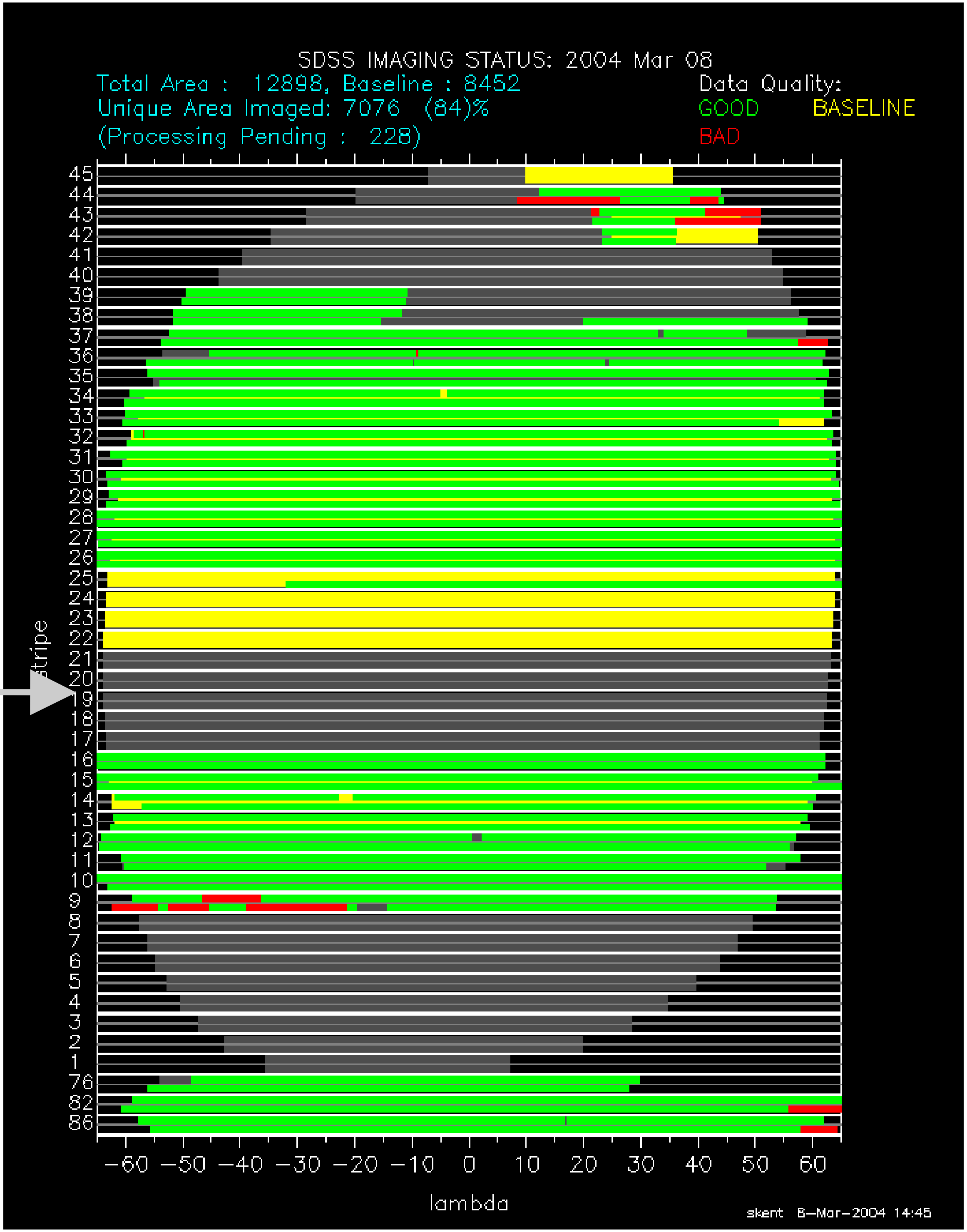


Spectroscopy: 55% as of March 11, 2004



Current operations funded thru June, 2005

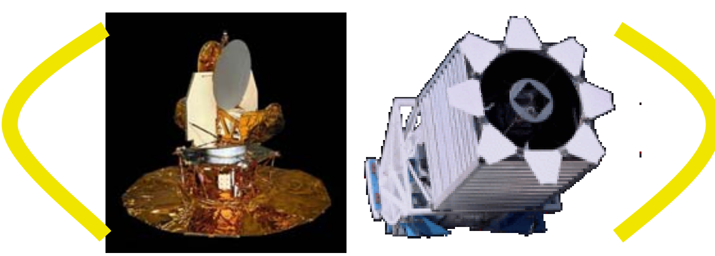
A proposal is being developed to continue operations for another 3 years (fill the gap).

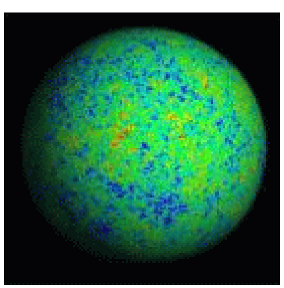


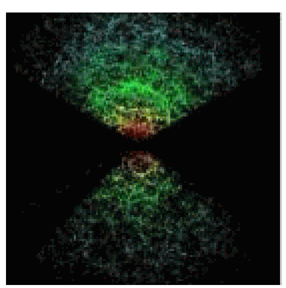
Research Highlights

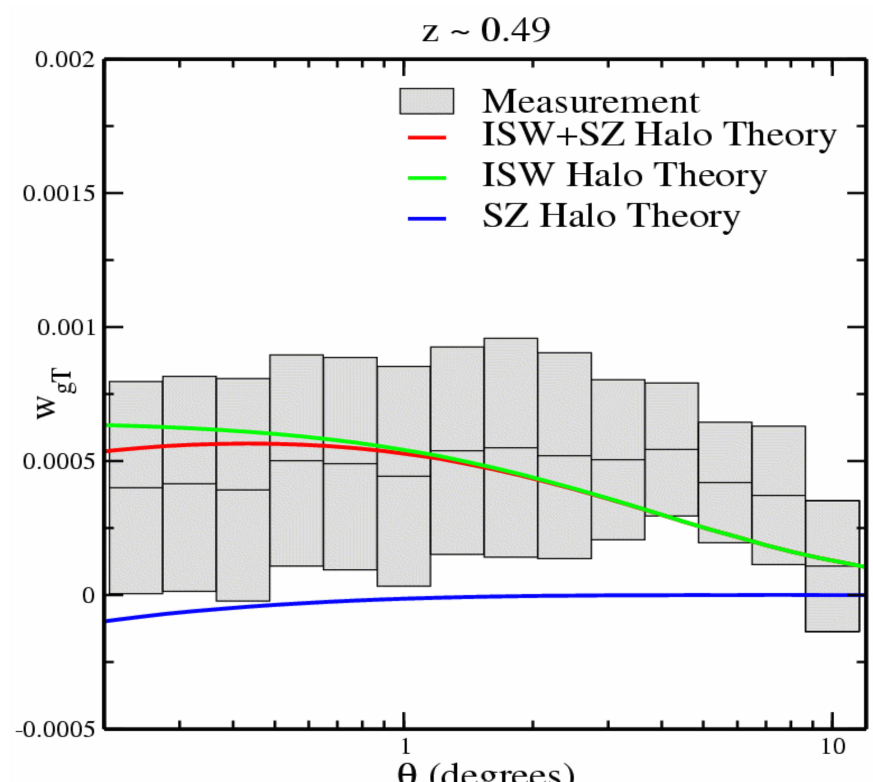
- **50 papers submitted by collaboration in past year.**
- **40 papers submitted by noncollaboration based on publicly released data (EDR and DR1)**
- **Correlating SDSS with WMAP (Scranton et al 2003)**

Integrated Sachs-Wolfe Effect



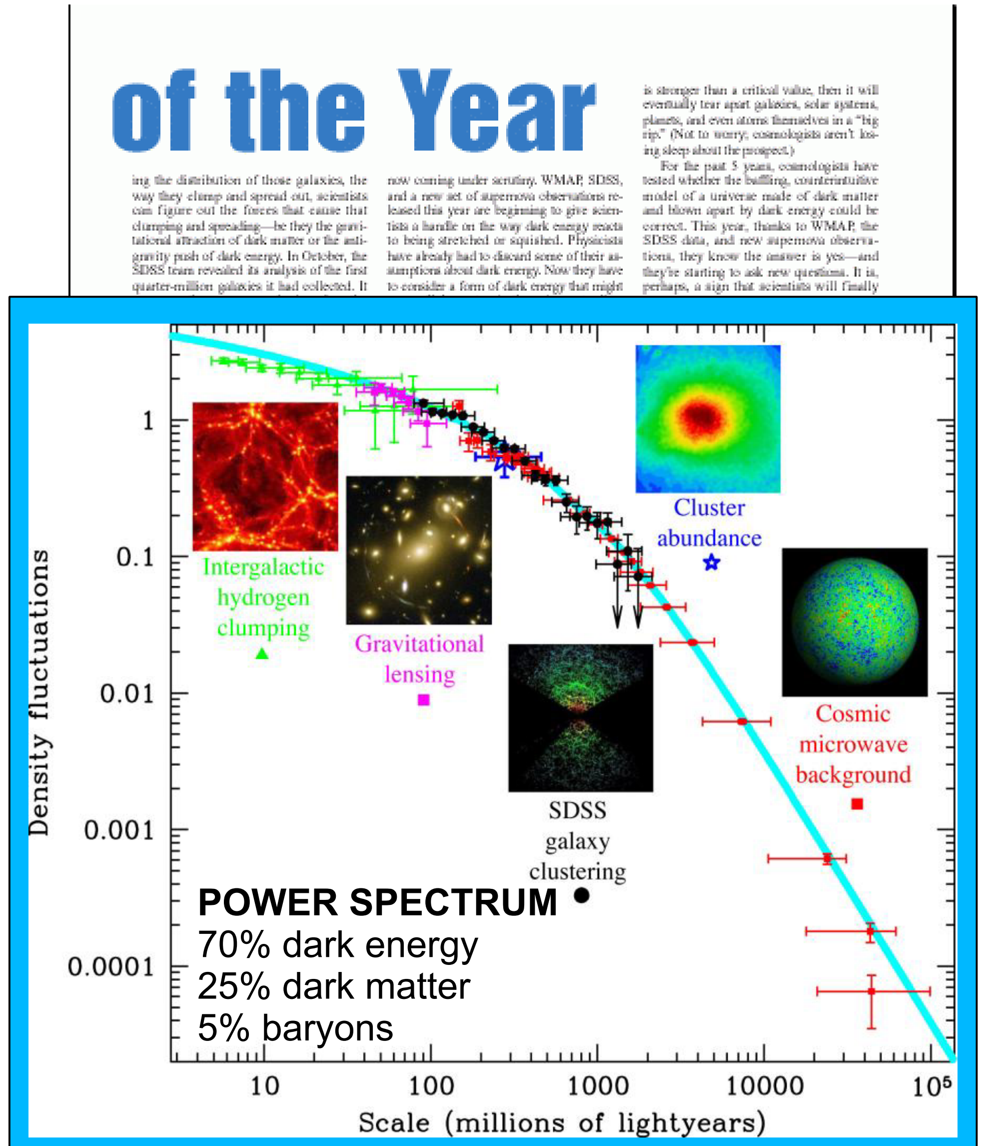






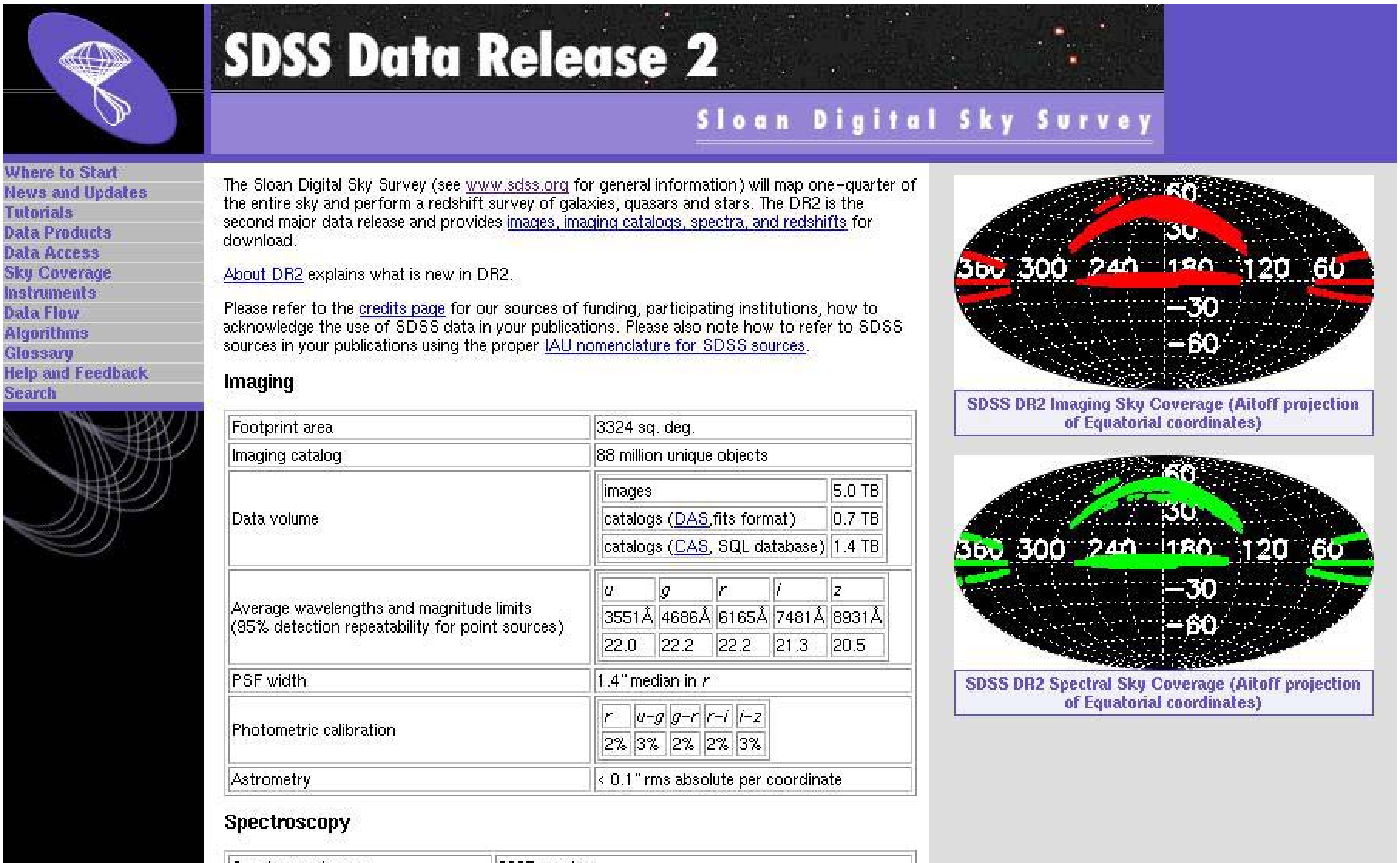
Science Magazine

(Dec 2003)



Data Release 2 to public

All data through June 30, 2002



SDSS Data Release 2

Sloan Digital Sky Survey

- Where to Start
- News and Updates
- Tutorials
- Data Products
- Data Access
- Sky Coverage
- Instruments
- Data Flow
- Algorithms
- Glossary
- Help and Feedback
- Search

The Sloan Digital Sky Survey (see www.sdss.org for general information) will map one-quarter of the entire sky and perform a redshift survey of galaxies, quasars and stars. The DR2 is the second major data release and provides images, imaging catalogs, spectra, and redshifts for download.

About DR2 explains what is new in DR2.

Please refer to the credits page for our sources of funding, participating institutions, how to acknowledge the use of SDSS data in your publications. Please also note how to refer to SDSS sources in your publications using the proper IAU nomenclature for SDSS sources.

Imaging

Footprint area	3324 sq. deg.
Imaging catalog	88 million unique objects
Data volume	images: 5.0 TB; catalogs (DAS,fits format): 0.7 TB; catalogs (CAS, SQL database): 1.4 TB
Average wavelengths and magnitude limits (95% detection repeatability for point sources)	u: 3551Å, 22.0; g: 4686Å, 22.2; r: 6165Å, 22.2; i: 7481Å, 21.3; z: 8931Å, 20.5
PSF width	1.4" median in r
Photometric calibration	r: 2%; u−g: 3%; g−r: 2%; r−i: 2%; i−z: 3%
Astrometry	< 0.1" rms absolute per coordinate

Spectroscopy

Spectroscopic area	2627 sq. deg.

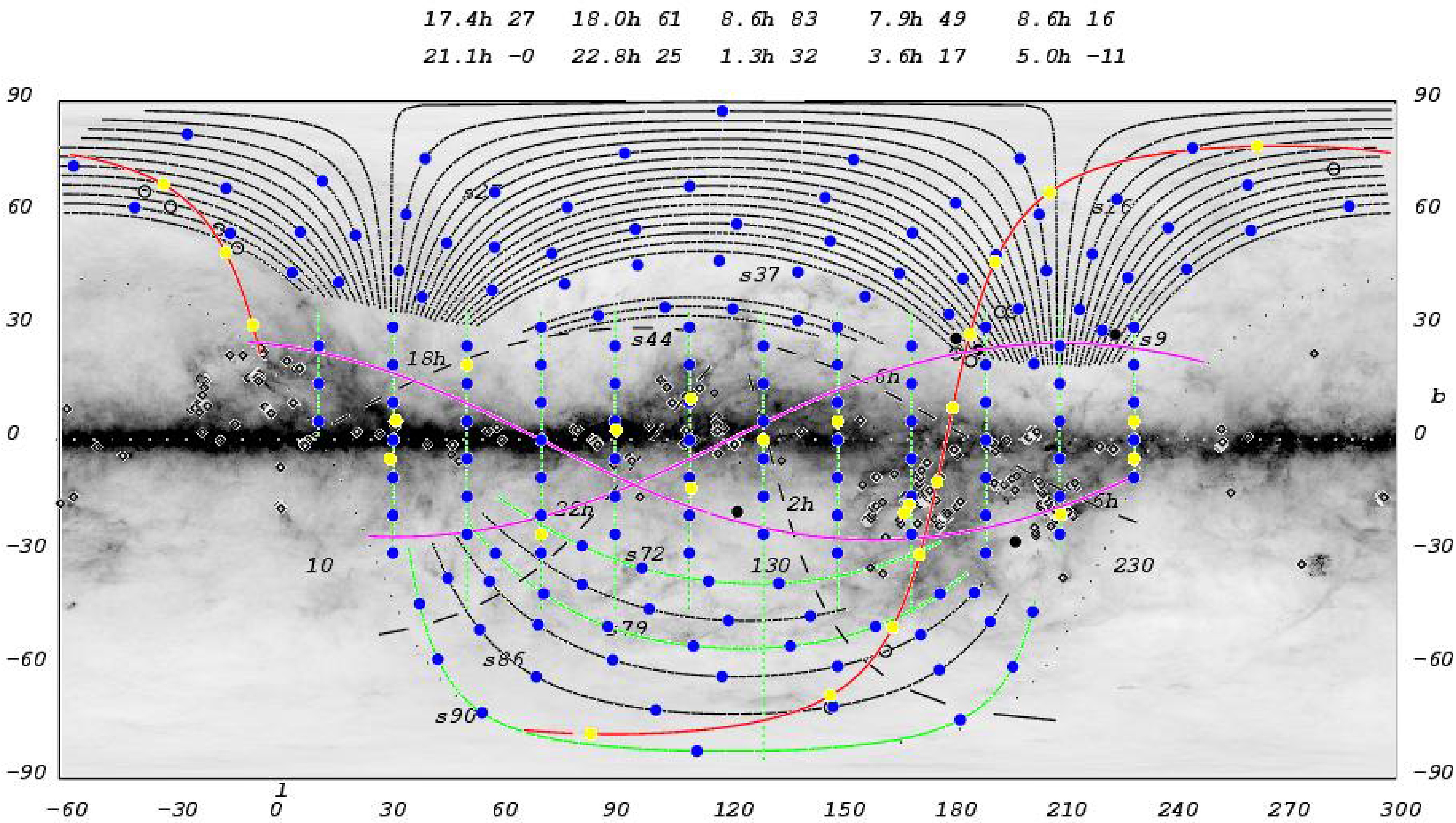
SDSS DR2 Imaging Sky Coverage (Aitoff projection of Equatorial coordinates)

SDSS DR2 Spectral Sky Coverage (Aitoff projection of Equatorial coordinates)

To the Future: SDSS Extension (2005-2008)

- **Why?**
  - **Will be short of goal of a FILLED survey after 5 years**
    - **762 sq deg (.5 yrs)**
    - **495 plates (2.1 yrs)**
  - **Unexpected discoveries offer opportunity for new science in Galactic Structure**
    - **3600 sq deg**
    - **520 plates**
  - **Realization that SDSS telescope provides unique capability for supernova detection.**
    - **10 months dedicated**

"Sloan Extension for Galactic Underpinnings and Evolution"



FNAL tasks and resources

- **Fermilab Interests**
  - **14 scientists (EAG, PPD, BD)**
- **Tasks**
  - **DAQ upgrade**
  - **Survey planning**
  - **Plugplate design**
  - **Legacy, SEGUE, SNe data processing**
  - **Data distribution**
  - **Project Mgmt.**
- **Required resources**
  - **4 FTE scientist**
  - **6.1 FTE CP, admin, tech.**
  - **$200K M&S/yr**
  - **$300K DAQ upgrade**
- **Funding**
  - **Expect significant cost sharing with SDSS project**

Dark Energy - A Problem for the Coming Decade

- **National Research Council Report, "Connecting Quarks with the Cosmos" (2003):**
  - ***Dark energy must be probed by multiple, complementary methods with independent systematic errors and different cosmological parameter degeneracies.***
- ***How?***
  - ***Supernovae - most accurate, fewest biases***
  - ***Galaxy Clusters, Weak Lensing, Galaxy correlation functions***
  - ***Ground is Good - Space is Better***

To the future ...What is SNAP?

- **SNAP is a proposed space-based mission to probe the nature of dark energy and the accelerating universe.**
  - ***A deep survey of Type Ia SNe, which are thought to be standard candles.***
    - **Expect to see ~2000 SNe Ia in 2-3 yrs**
  - ***A 300 sq. deg. wide-field survey to measure weak lensing Indepent measurement of dark energy***
- **http://snap.lbl.gov**
- **SNAP is an important goal for DOE in this decade.**
  - ***Centered at and managed from LBNL***

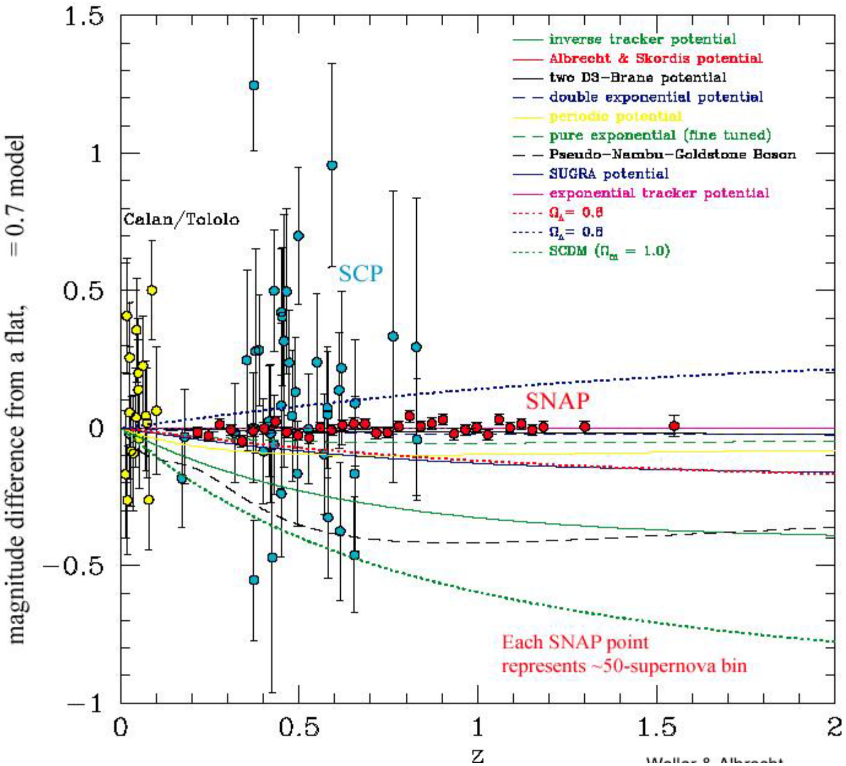
What will SNAP Measure?

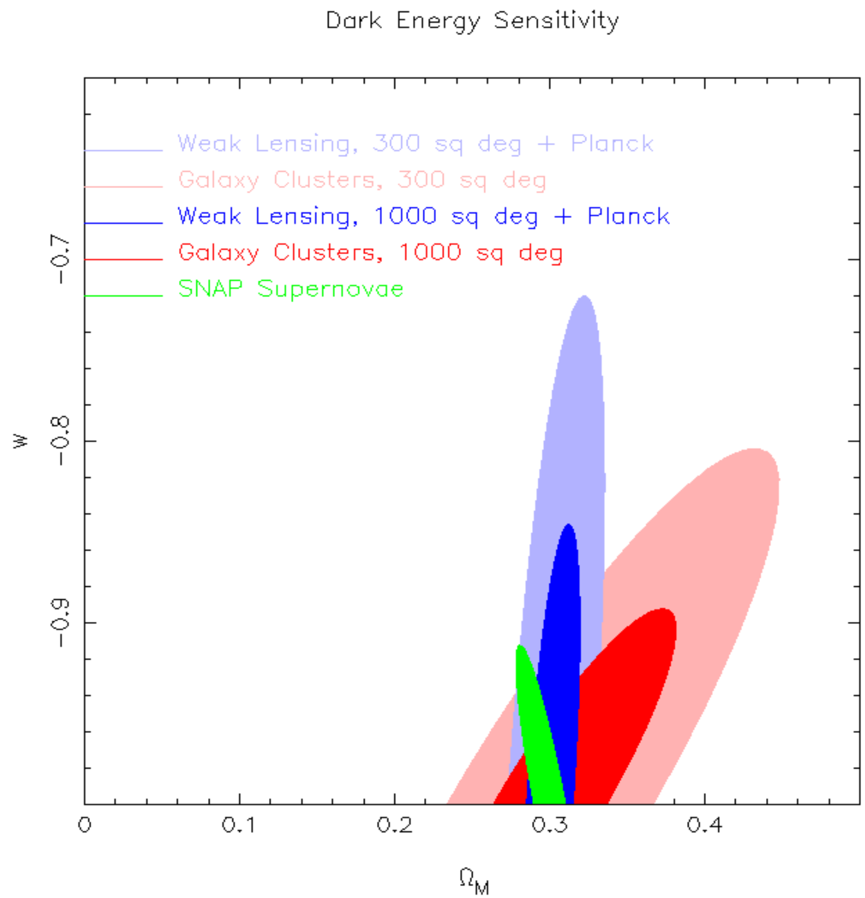
Dark Energy Eqn. of State

$$P = w\rho$$

***w* = *-1* Cosmological Constant**

***w* < *-1* Quintessence**





Supernovae are one of many techniques to measure Dark Energy

Contributions to R&D Program

- Science & Simulations
- Photometric Calibration
  - *Expertise due to SDSS work*
- Scientific Software & Archiving
  - *Expertise due to SDSS work*
- Electronics
  - *Solid-state recorder*
  - *Data compression hardware*
    - Both of above could help wide-field survey
- Radiation Shields
  - *Cosmic-ray, light baffle, thermal*
  - *Involved in all three; concentrate on cosmic-ray shield and integration*
    - Uses GEANT & MARS design tools
    - Serious mechanical & thermal engineering requires solid modeling and sophisticated FEA

Current Status

- 16 Fermilab scientists applied for and were granted admission to the SNAP collaboration.
- September 2003 - NASA and DOE announce Joint Dark Energy Mission as of three Einstein Probes.
    - *SNAP will be proposed as the Dark Energy Experiment for JDEM*
    - *SNAP is in R&D phase within DOE - proposal due ~January 2006*
- Jan 2004 President announces new initiative for robotic and manned missions to Moon and Mars
    - *NASA OSS budget to increase*
    - *New funding for JDEM not in NASA's current 5 year plan.*

To the Future - Dark Energy Survey

- **Proposal to construct mosaic camera for 4 meter telescope at CTIO (Chile)**
- **Receive ~ 600 nights observing time**
- **Conduct 4000 square degree imaging survey**
- **Overlap with Sunyaev-Zel'dovich Effect (SZE) cluster survey being done with South Pole Telescope - Measure dark energy using galaxy clusters**

Participants

- **Fermilab**
- **U. Chicago**
- **LBNL**
- **U. Illinois (U-C)**
- **Cerro Tololo Inter-American Observatory**
- **Fermilab Members**
  - Jim Annis
  - Brenna Flaugher
  - Huan Lin
  - Doug Tucker
  - John Peoples
  - Chris Stoughton
  - William Wester
  - Steve Kent
  - Josh Frieman
  - Albert Stebbins
  - Scott Dodelson

Fermilab Role

- **Lead for instrument construction**
- **Significant contributions to**
  - **Camera**
  - **Corrector (optics)**
  - **Mechanicals**
- **Contribute to data processing software**
- **Calibrations**

Current Status

- **Proposal, cost estimate in preparation. Deadline Aug 2004**
- **Schedule:**
  - **Deliver camera ~2008**
  - **5 year survey to 2013**

EAG Balancing Act

- **EAG currently has 8 scientists, 3.5 CP FNAL funded and working on astrophysics.**
- **Next few years**
  - **SDSS: 3 Scientists, 2.5 CPs**
  - **SNAP: 1.25 Scientists, 1 CP**
  - **DECAM: 1.5 Scientists, 0 CP**
  - **Research: 2.25 Scientists**
- **Remaining people for SDSS are either existing non-EAG scientists, existing CD people not in EAG or existing or planned CPs in EAG funded by ARC**