

Kavli Institute for Particle Astrophysics and Cosmology

Presentation to DOE Program Review
June 02, 2004

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Kavli Institute for Particle Astrophysics and Cosmology

* Recent News

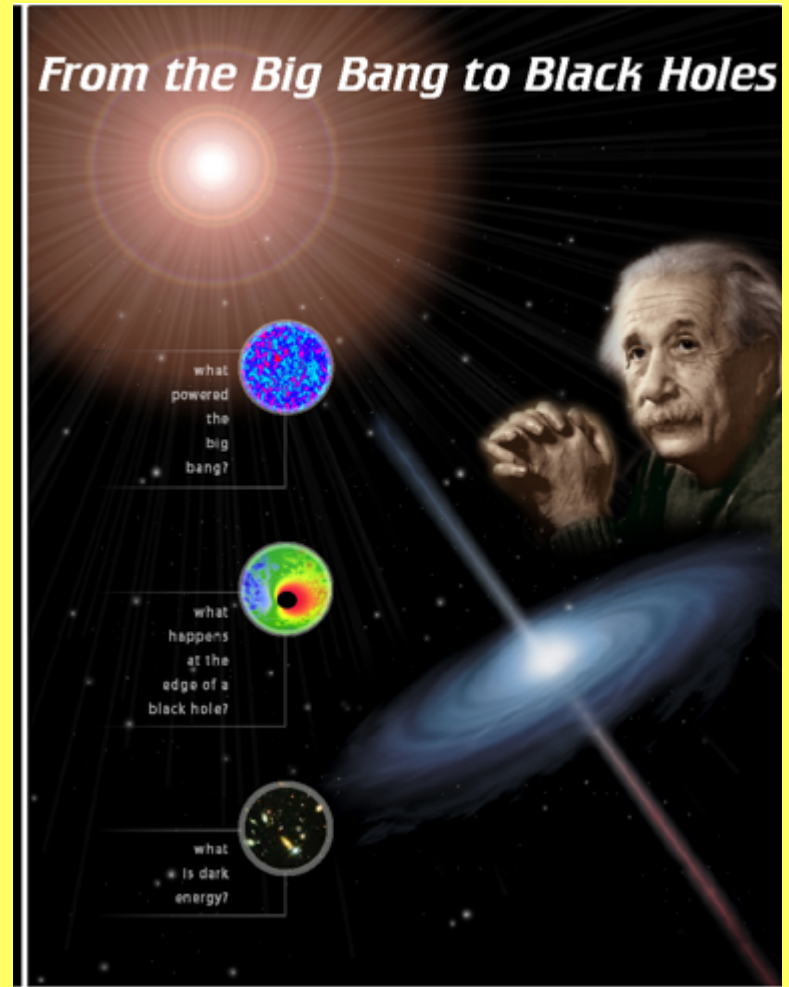
- Dec 03 2 junior faculty searches
- Jan 04 4 postdocs hired
- Jan 04 Pierre R. Schwob Computing and Information Center
- Feb 04 X-ray Polarimetry Conference
- Mar 04 9 Kavli Institutes
- Apr 04 Stanford Community Day
- Apr 04 Independent Lab status
- May 12-15 Beyond Einstein Meeting



Beyond Einstein Meeting

Over 260 participants
Excellent talks and presentation of
Science
Journalistic attention

Political prognosis uncertain due
to NASA redirection.



Kavli Institute for Particle Astrophysics and Cosmology

* Upcoming Events

- June 28 Fred Kavli Building Groundbreaking
- Aug 2-13 SLAC Summer Science Institute
- Oct Varian 2 Ground Breaking?
- Dec 11-17 Texas Symposium



Varian 2 Building



KIPAC Membership

- **Director, Deputy Director**

- Blandford, Kahn

- **Administration**

- Formichelli, Nafke+2

- **KIPAC New Faculty (Joint SLAC- Campus)**

- +2?

- **SLAC Faculty and Senior Staff**

- Bloom, Kamae, Michelson, Craig, Madejski, Marshall +2

- **Campus Faculty**

- Cabrera, Church, Linde, Petrosian, Romani, Wagoner

- **'03 Postdocs**

- Baltz, Frolov, Gu, Ho, Lyutikov, Marshall, Peterson, Sako, Spitkovsky

- **'04 Postdocs**

- Bowden, Bradac, Granot, Zhang

- **Visitors**

- Dekel, Eichler, Greehill, Rephaeli, Weiler

- **Students**

- Amin, Broderick, Morganson, Muller, Rathore, Suyu, Zheng



Administration and Organization

- KIPAC-HEPL Joint administration on campus
 - Varian 2
 - NASA+NSF
 - Hiring Manager
- SLAC administration
 - DOE
- KIPAC administration
 - 2 + 1 staff

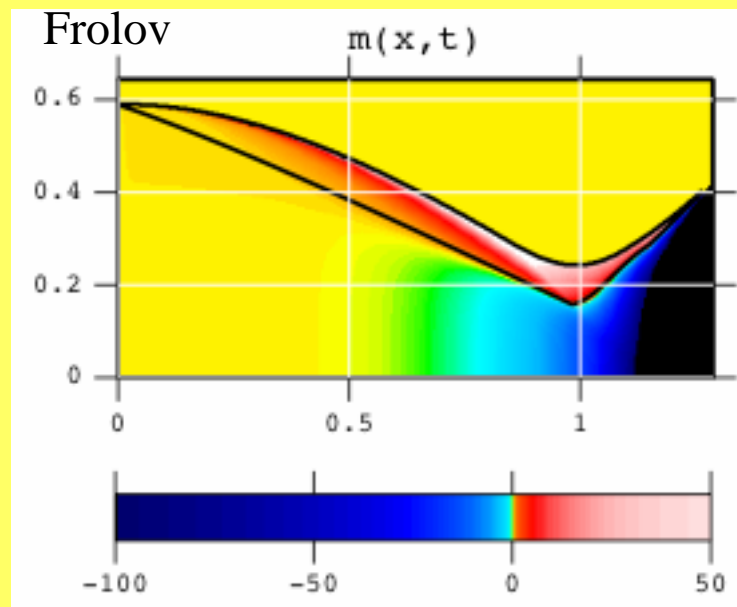
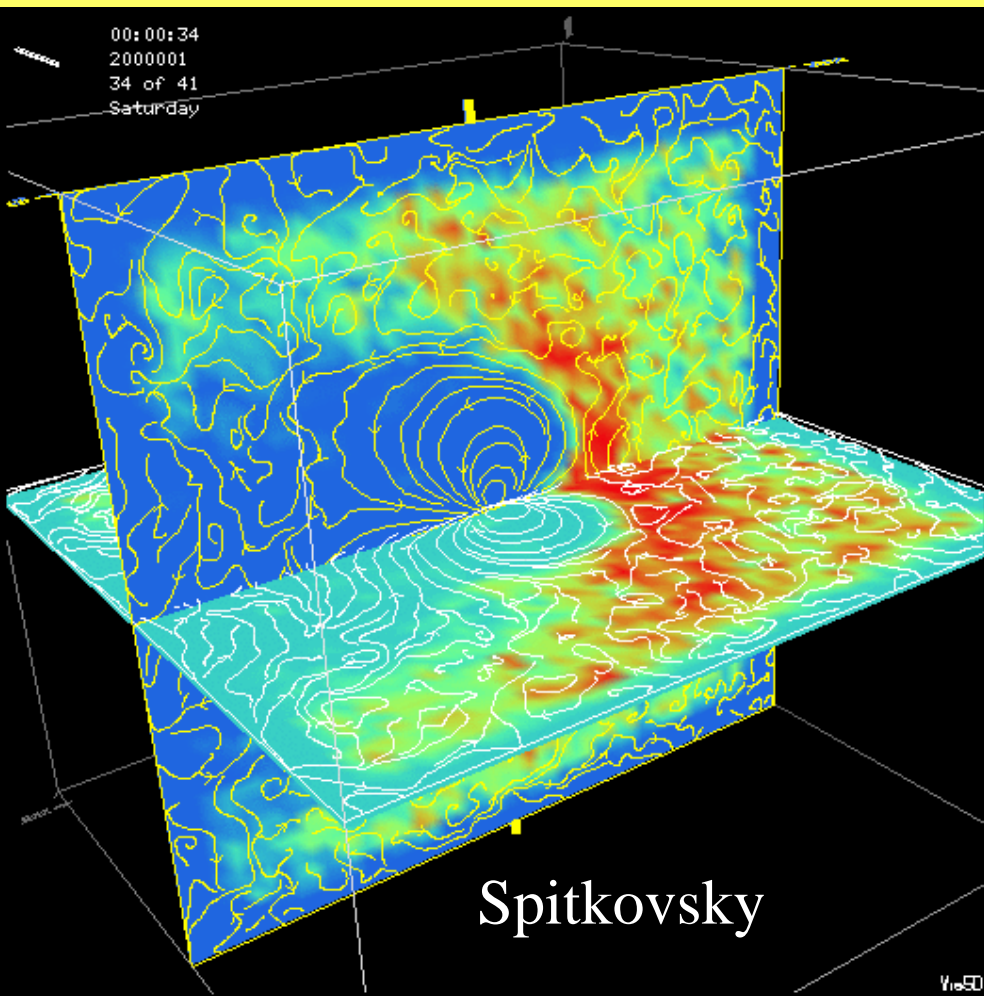


Computing Plans

- Schwob Center
- Data Handling from Large Observational Projects
 - LSST 30PB of data
 - Computing Services Division
- Computational Astrophysics
 - Large scale numerical simulations
 - Cosmology
 - Pulsar Magnetospheres
 - Black Holes
 - New graphical output tools
- DOE Huge Memory Computing Proposal
- Vendor discussions



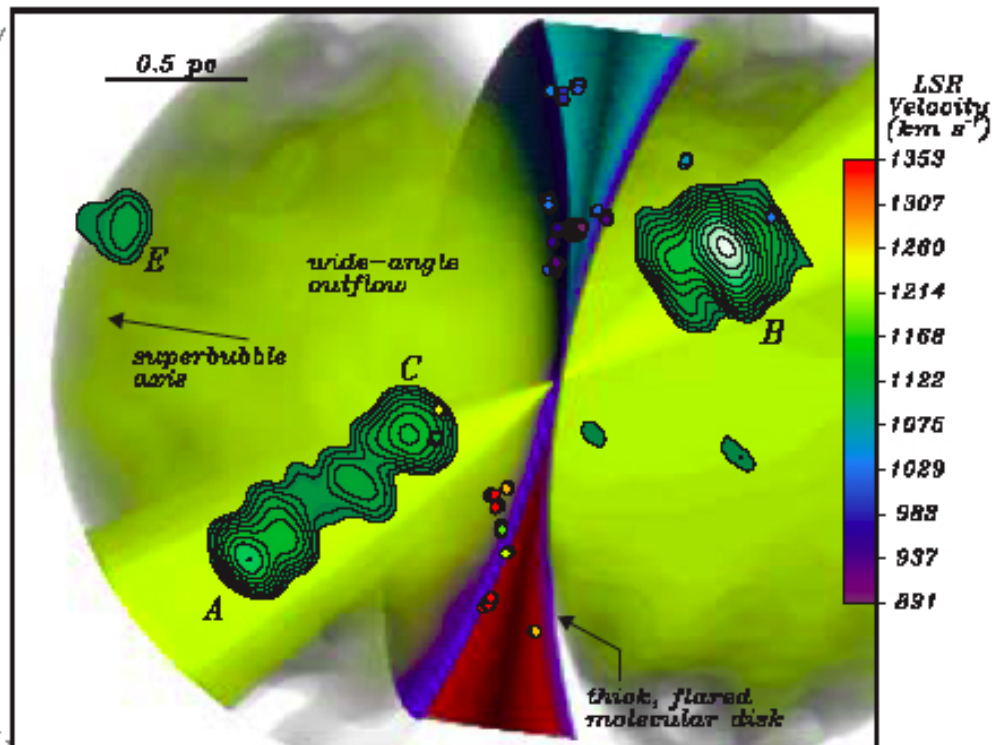
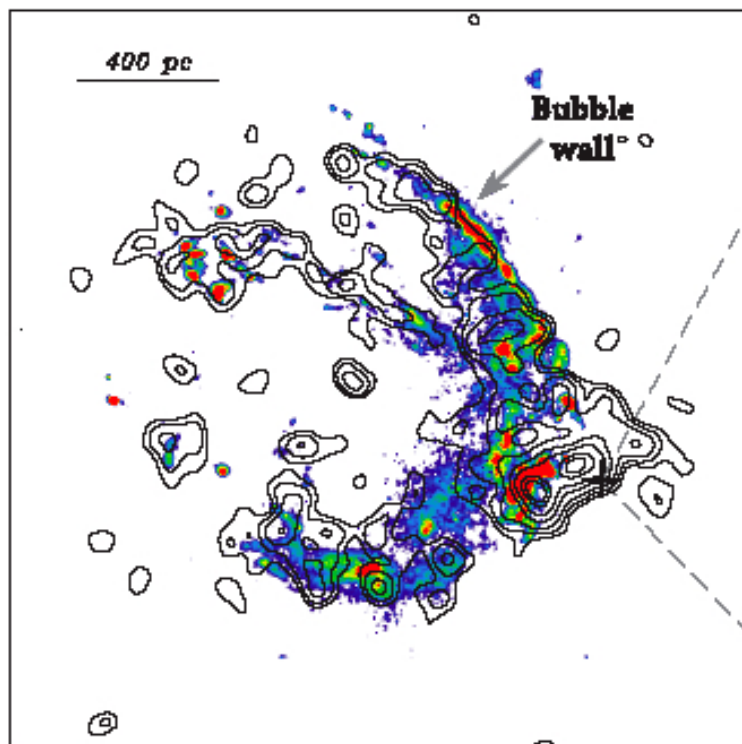
Science Highlights



~50 papers (inc. proceedings)
~50 talks
excluding new members

Science Highlights

Greenhill

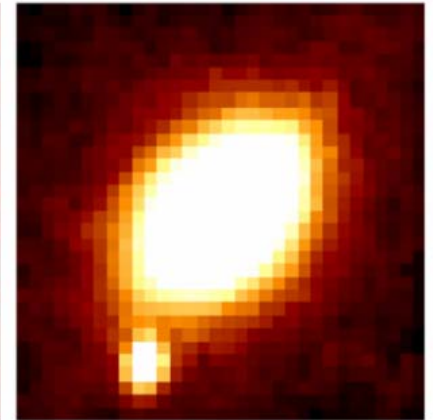
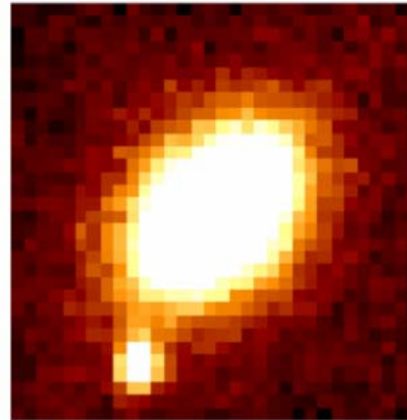
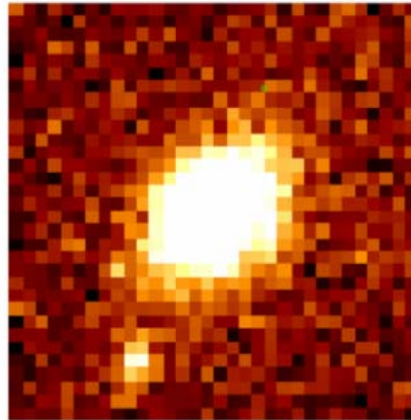


Science Highlights

Marshall + RB... V (1-3)

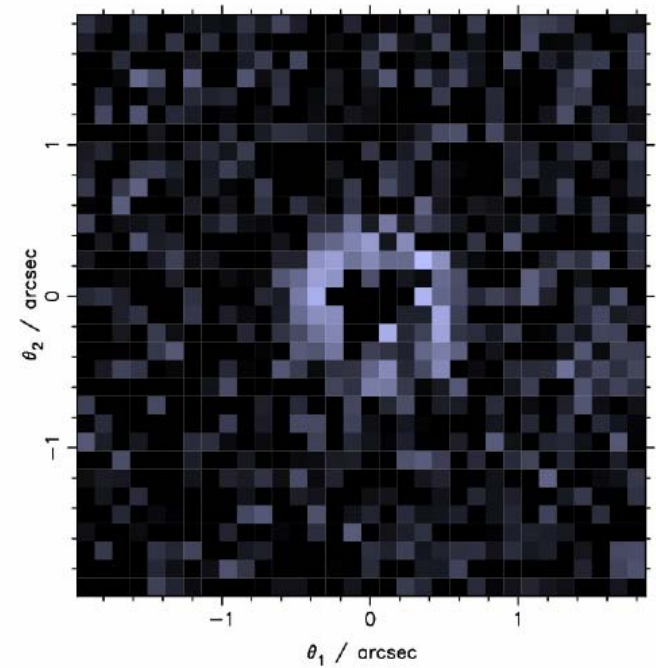
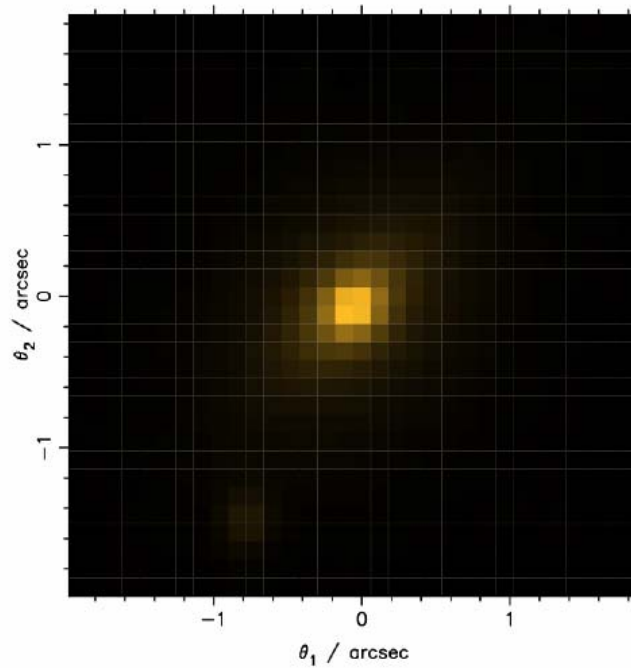
R ... I (4-6)

IR (7-9)



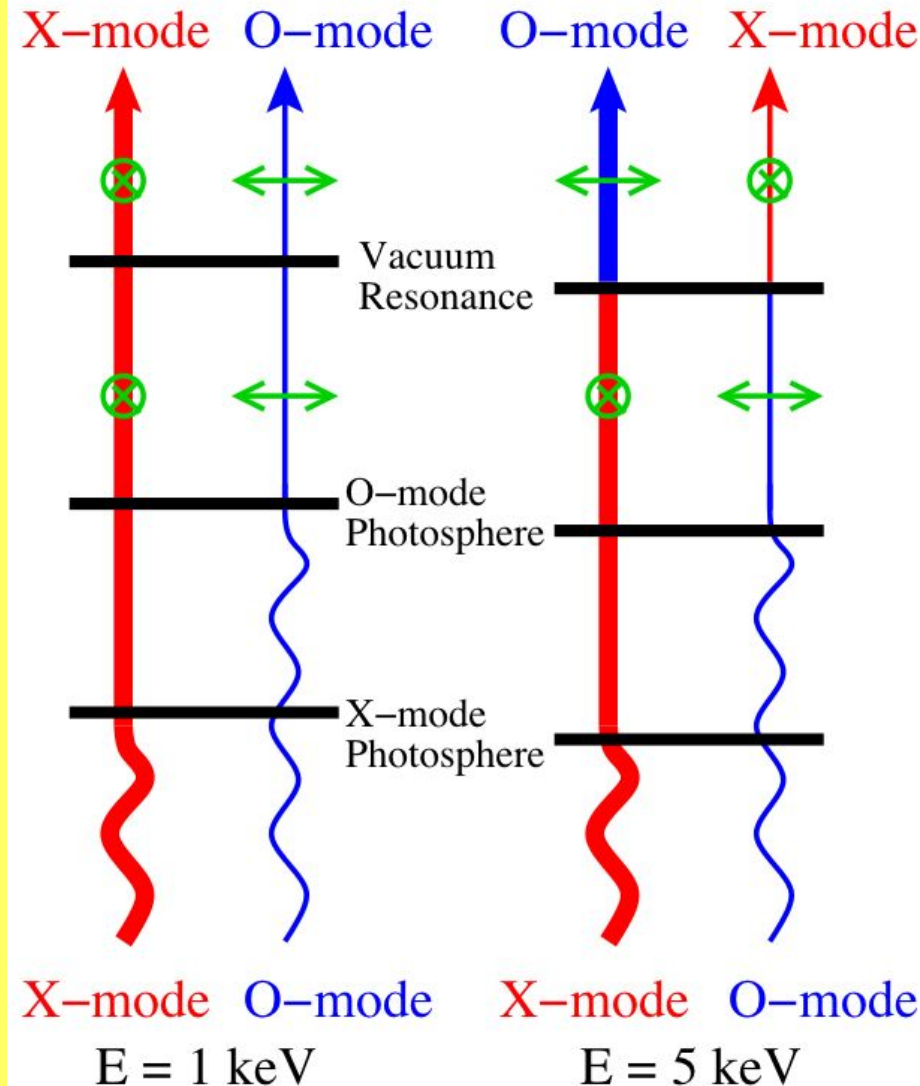
Reconstructed lens galaxy

Reconstructed source



Science Highlights

Ray Propagation in Neutron Star Magnetosphere (Ho et al)
Also similar physics in relativistic magnetoionic theory study by Broderick and Blandford



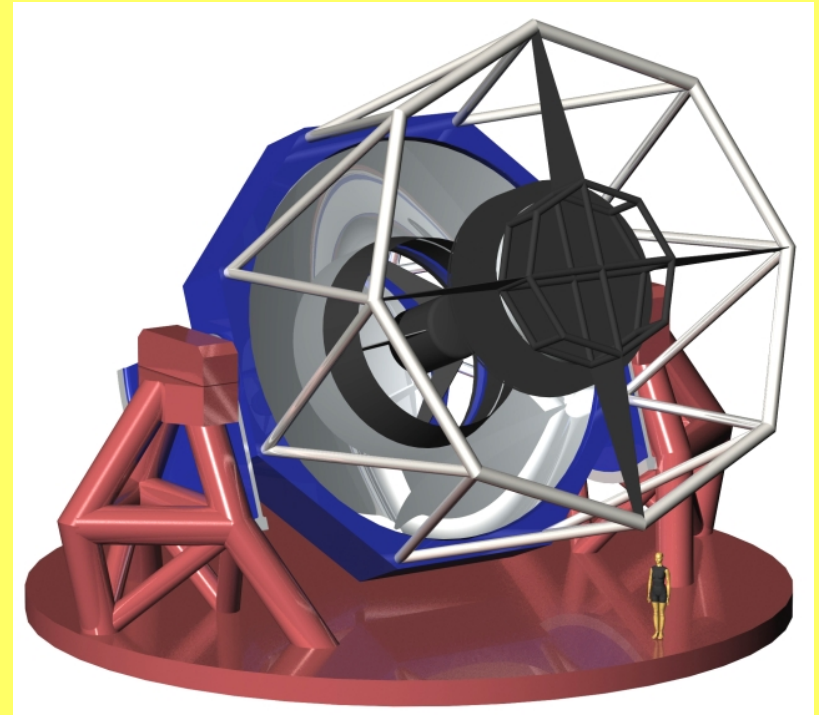
New Projects at SLAC Associated with KIPAC

- * Medium-Term Focus on Understanding “Dark Energy”.
 - Described as the most significant discovery in physics in the last 50 years!
 - Our current cosmological model is in a similar state to the “standard model” of HEP 10 –15 years ago: It is clearly “correct”, but it has several very surprising elements suggesting “new physics” yet to be unraveled.
 - Progress will come from probing this model on multiple “fronts”, i.e. not only constraining parameters but testing for internal consistency via disparate measurement techniques.

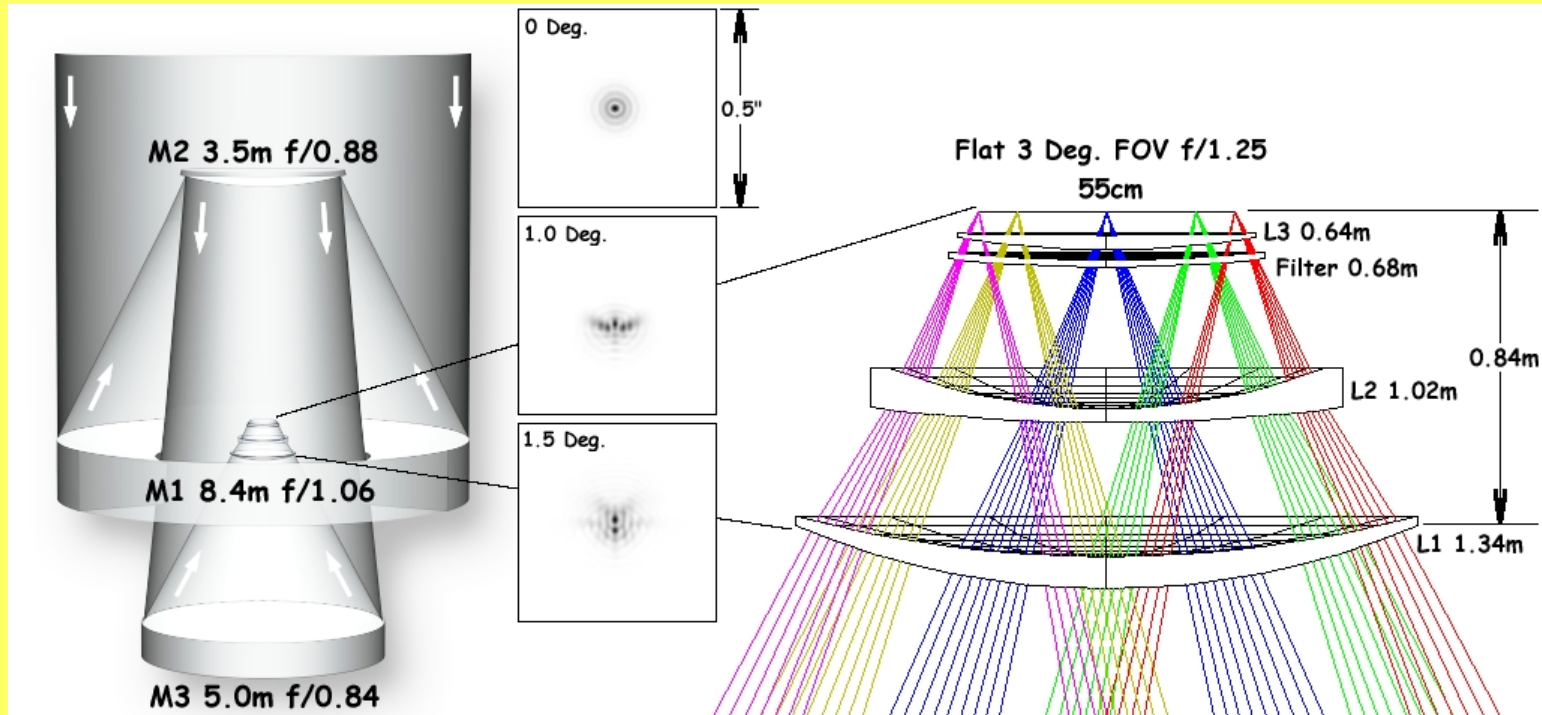


The Large Synoptic Survey Telescope

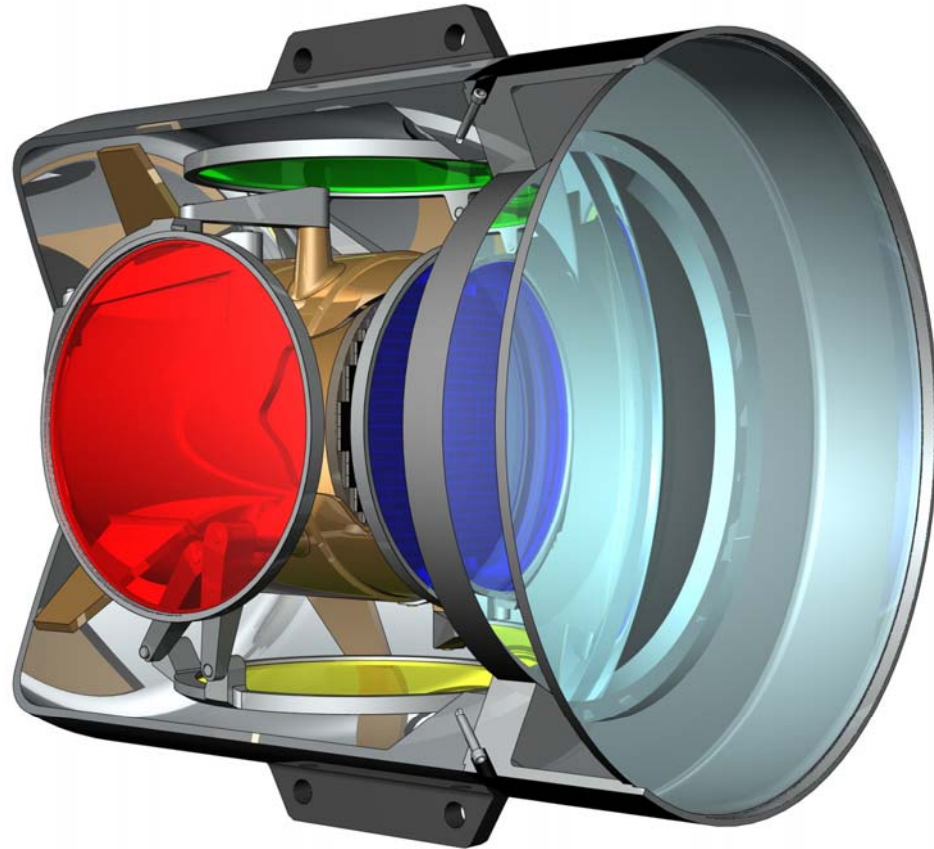
- * Will probe DE primarily via measuring the growth of structure in the dark matter distribution through weak lensing.
- * Planned to be operational by 2012.
- * A large, wide-field, ground-based telescope that will survey the whole sky with 10 s integrations every few days.
- * Proposed as a joint NSF/DOE initiative, with DOE providing the 2.8 Gpixel camera, the DAQ, and a share of the software.
- * DOE effort will be led by SLAC, with significant hardware and software contributions from BNL, LLNL, and HEP university groups.
- * Presented to EPAC, SAGENAP, LSST Board



LSST Optical Design



LSST Camera



Camera Components

- * Focal plane array
 - 10 μm pixels \rightarrow 0.2 arcsecond/pixel ($\sim 1/3$ seeing-limited PSF)
 - 55 cm diameter \rightarrow 3° FOV
 - \rightarrow 2.3 Gpixels
 - integrated front-end electronics
 - 16 bits/pixel, 2 sec readout time \rightarrow 2.3 GB/sec
 - \rightarrow Parallel readout
- * Housings (environmental control)
- * Filters
- * Optics
- * Mechanisms
 - L2 position varies with wavelength (filter)
 - Filters insertion
 - mechanical shutter



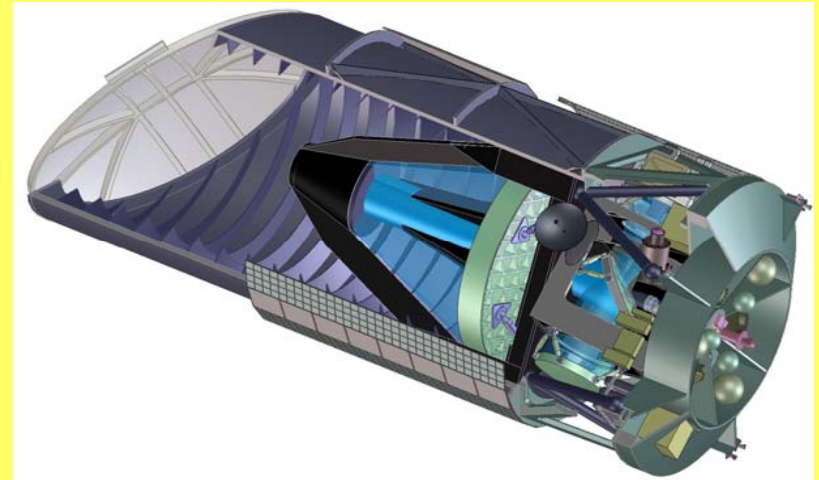
DOE Participation in LSST

- * A collaboration of DOE-funded institutions has been formed to pursue participation in LSST. This collaboration has been working closely with other LSST participants under the coordination of the LSST Director and Project Manager.
- * The DOE “deliverable” will be the LSST camera system.
- * SLAC will lead the development of the camera, with significant contributions coming from BNL, LLNL, and DOE-funded university groups (e.g. Harvard, UIUC).
- * Scientists and engineers at these institutions will also participate in the data acquisition system, the development of pipeline software, and the scientific interpretation of the results.



The NASA/DOE Joint Dark Energy Mission

- * Will probe DE primarily via measurement of Type 1a SNe to constrain the d_L versus z relationship, and through weak lensing.
- * Joined SNAP collaboration
- * Plan is for SLAC to design and develop the Observatory Control Unit and associated flight software – builds well on SLAC experience in GLAST.
- * Strong lensing science
- * The recent NASA/DOE cooperative agreement makes it clear that the SLAC experience in working with both agencies will be a key asset for this project.



BE Program deferred



Fit Within SLAC's Current Program?

- * OCU development requires a unique blend of skills...
 - Data Acquisition
 - Detector Monitoring and Control
- * SLAC has extensive experience in these areas...
 - Successful, lead role within 2 major HEP experiments:
 - SLD
 - BaBar
- * SLAC has space heritage...
 - Lead role in both Electronics and Flight Software for GLAST
 - Demonstrated collaboration with NASA based labs
- * SLAC has long history of successful collaboration with LBL
 - Physical proximity will be important for such a highly integrated role
- * Phases well with GLAST and BaBar program
 - BaBar no longer in development
 - GLAST moving out of design/development stage



Science Role for SLAC in SNAP - Strong Lensing Program

- * Multiple imaging by galaxies, groups and clusters
- * Ancillary program - complementary to:
 - Supernova cosmography
 - Weak lensing study of large scale structure
 - Galaxy-galaxy lensing study of galaxy halos
- * Telescope nearly ideal for strong lensing because of
 - 9 filters
 - 0.1(0.05)'' pixels
 - 4 day cadence
 - Deep (15 sq deg) and Wide (300 sq deg) surveys
- * Lensing rate 0.001-0.002 => ~300,000 “events”
 - Quantitative, identification pipeline (cf CLASS)
 - Emphasize standard elliptical galaxy “scattering” with $0.5 < z < 1$
- * Complementary to LSST and Square Kilometer Array



Scientific Goals of Strong Lensing Program

* Source Population

- Study the faintest galaxies – building blocks of normal galaxies
 - redshift distribution
 - luminosities
 - star formation rates etc
- AGN microlensing
- Rare high magnification events

* Lens Population

- Galaxy substructure out to $R \sim 10\text{kpc}$
- Cluster substructure
 - Cosmography

* Propagation Effects

- Time delays -> small scale dark matter distribution
- Quasar absorption lines etc



NuSTAR

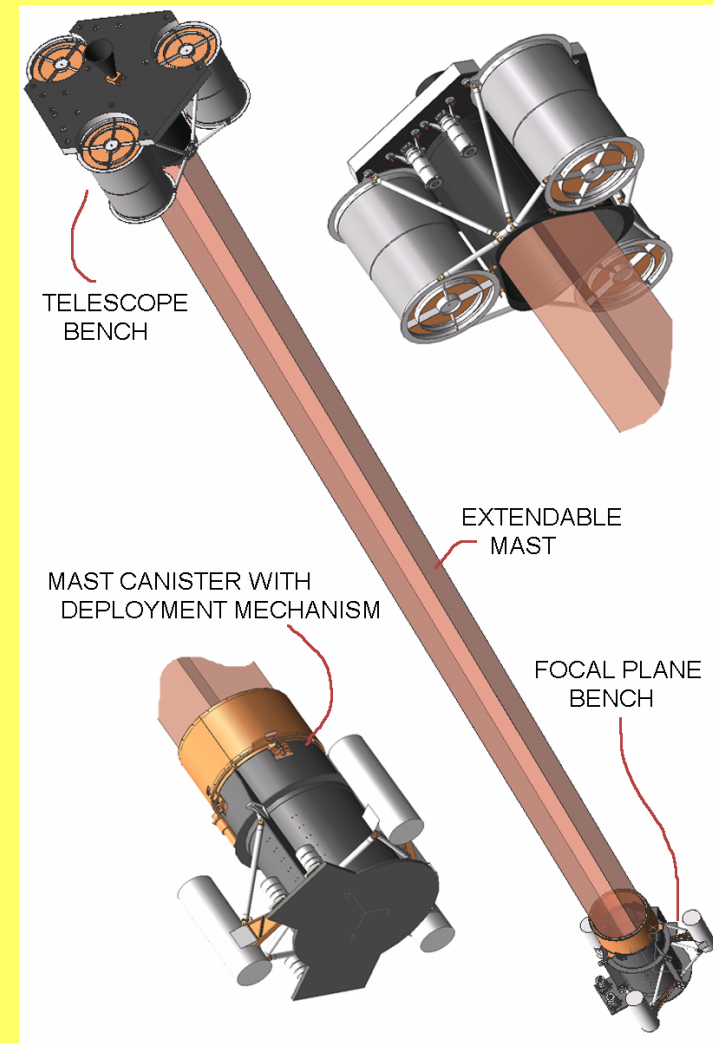
NASA

- * KIPAC is heavily involved in the SMEX Phase A Concept Study of the Nuclear Spectroscopic Telescope Array: NuSTAR.
 - First hard X-ray focusing mission
 - 1000x increase in sensitivity in 10-100 keV band.
 - AGN Survey
 - Nucleosynthesis
 - GLAST blazar observations
 - Pathfinder for Beyond Einstein missions

Also Constellation X

Astro-E 2 and NEXT (Japan)

Also ACT, X-ray Polarimetry



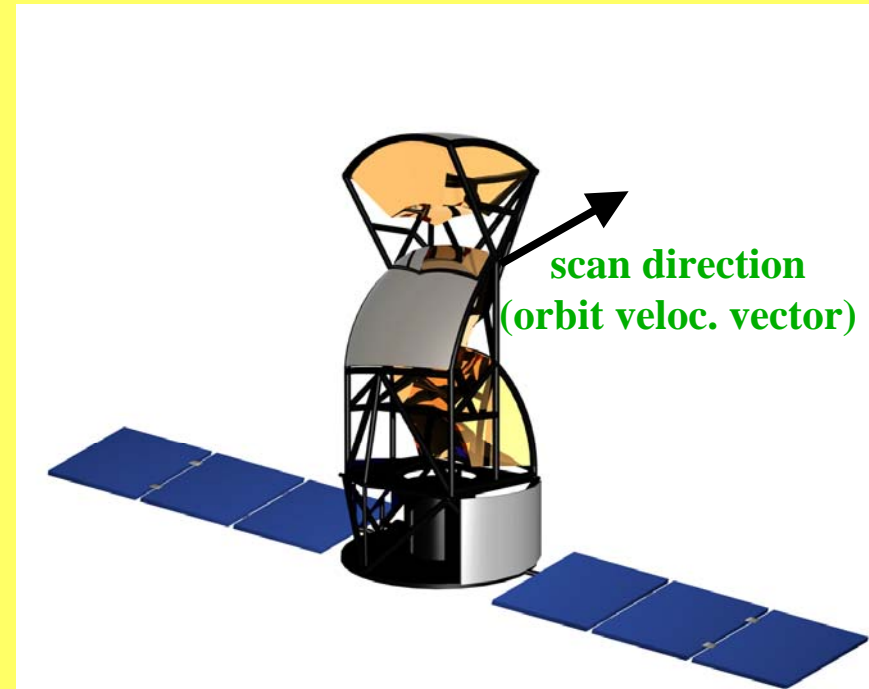
EXIST Mission Concept

Free-Flyer (500km, $i \sim 20^\circ$):

- Zenith pointer (Survey mode)
- 3-axis pointer (Observatory *and* survey)
- 3 coded aperture telescopes ($60^\circ \times 75^\circ$ each)

Mission Parameters: $180^\circ \times 75^\circ$ fan beam: all sky/orbit

- CZT tiled arrays: 8m^2 total area
- Passive and active shielding
- $25^\circ \times 20^\circ$ collimation/module
- Mass, power, telemetry:
8500kg, 1200W, 1.2mbs (X-band)
- Delta-IV launch



Implications of Mars-Moon Initiative

- * Beyond Einstein program exists but heavily cut back
 - LISA delayed by 2 yr -2014
 - C-X to 2015
 - Einstein Probes (including SNAP, EXIST) indefinitely postponed
- * Explorer Program halved
 - Will delay/preclude NuSTAR
- * Actively engaged in repairing this collateral damage



Summary

- KIPAC still on track
- Tremendous support at Stanford (esp SLAC)
- New areas of interest
 - Neutrinos, gravitational waves astrophysics
 - Large Scale Computing
- New faculty hires critical
- NASA re-organisation a major challenge to our program

