Large Synoptic Survey Telescope

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LSST Observatory and Science Opportunities

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The LSST design is driven by four science themes: dark energy and matter, Galactic structure, transient objects, and the Solar System inventory. The LSST will carry out a ten-year imaging survey of 20,000 sq.deg. of the sky in six broad optical bands, with a deep stack reaching r~27.5 (5 sigma, point source). The LSST design, with an 8.4m (6.7m effective) primary mirror and a 9.6 square degree field of view, will allow about 10,000 square degrees of sky to be imaged to an effective depth of r=24.5 every three nights. The resulting petabytes of data will be made available to the US and Chilean communities for scientific investigations ranging from the properties of near-Earth asteroids, to characterizations of dark energy from strong and weak lensing, galaxy clustering, and distant supernovae. Eleven LSST Science Collaborations are actively laying the groundwork for first light: working on image analysis algorithms and database design, exploring cadence choices, developing commissioning plans, and outlining scientific opportunities. These Collaborations have over 200 members to date, with membership open to the US and Chilean communities via an application process administered by NOAO.

LSST Science Drivers

Major advances in our understanding of the universe have always come from dramatic improvements in our ability to "see". In the past decade, large-scale sky surveys have become increasingly important. As a sensitive, multicolor survey over most of the sky, LSST will dramatically impact nearly all fields of astronomy and many new areas of fundamental physics. The essence of LSST is to go wide, fast, and deep, and this strategy will enable an extremely broad range of scientific investigations. The main science themes that LSST will address, and that are used to optimize the system design, are:

Constraining Dark Energy and Dark Matter
using a variety of probes and techniques whose synergy will fundamentally test our cosmological assumptions and gravity theories; LSST will provide a sample of 3 billion galaxies with excellent photometry and shape measurements, over 100,000 clusters of galaxies, and a sample of several million Type Ia SNe,

Taking an Inventory of the Solar System
and extending the boundaries of our reach in distance and detectable size of potentially hazardous asteroids; LSST will detect and characterize over 80% of 140m or larger hazardous asteroids, several million main-belt asteroids, and over 100,000 trans-Neptunian objects (e.g., Sedna-like objects will be detectable to beyond 200 AU),

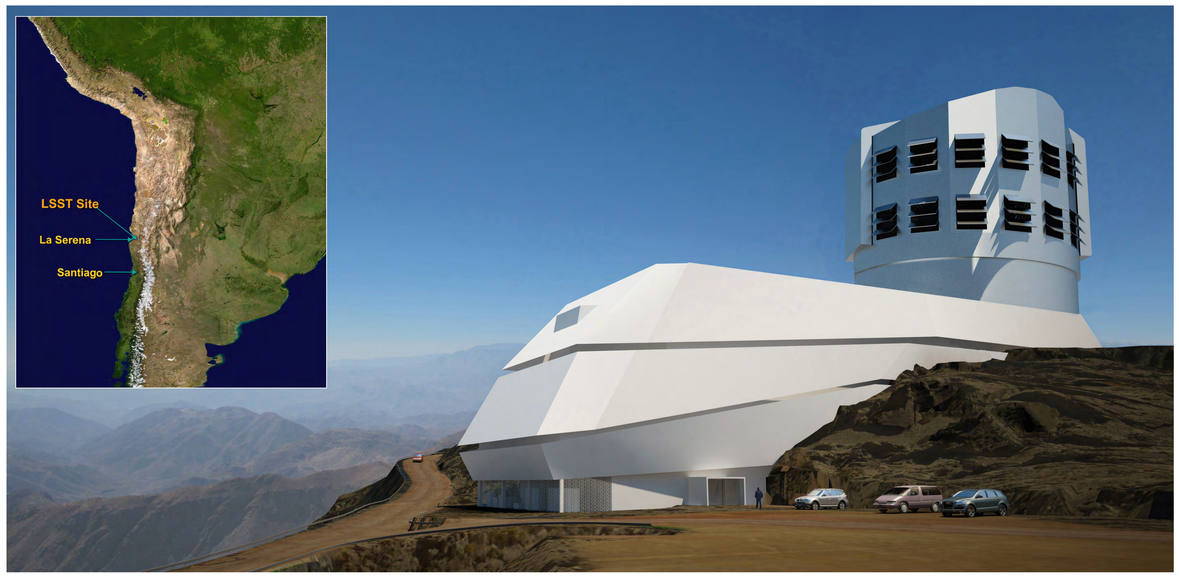
Exploring the Transient Optical Sky
by characterizing known classes of objects and discovering new ones; LSST will sample a variety of time scales ranging from 10 sec, to the whole sky every 3 nights, with 1000 visits distributed over 10 years

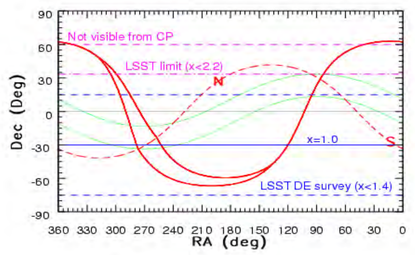
Mapping the Milky Way
all the way to its edge with high-fidelity; main-sequence stars will be detected to 100 kpc, RR Lyrae to 400 kpc, and geometric parallaxes will be measured for all stars within 300 pc

THE LSST BASELINE DESIGN AND SURVEY PARAMETERS

Quantity	Baseline Design Specification
Optical Config.	3-mirror modified Paul-Baker
Mount Config.	Alt-azimuth
Final f-Ratio, aperture	f/1.234, 8.4 m
Field of view, étendue	9.6 deg^2, 319 m^{2}deg^2
Plate Scale	50.9 μm/arcsec (0.2" pix)
Pixel count	3.2 Gigapix
Wavelength Coverage	320 – 1050 nm, *ugrizy*
Single visit depths[a] (5σ)	23.9, 25.0, 24.7, 24.0, 23.3, 22.1
Mean number of visits	70, 100, 230, 230, 200, 200
Final (coadded) depths[a]	26.3, 27.5, 27.7, 27.0, 26.2, 24.9

[a] The listed values for 5σ depths in the *ugrizy* bands, respectively, are AB magnitudes, and correspond to point sources and zenith





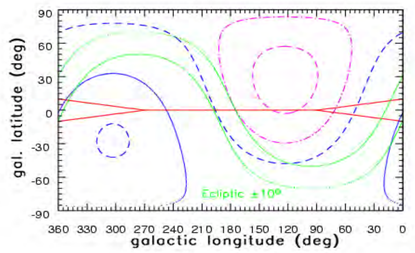


Figure above: A summary of LSST sky coverage, in equatorial (top panel) and Galactic (bottom panel) coordinates. The two dashed blue lines outline the 24,000 deg^2 region for which minimum airmass reaches values less than 1.4. The galactic plane regions with the highest stellar density are enclosed by solid red lines and include 1000 deg^2. The green lines show a 20 degree wide band around the Ecliptic. The main deep-wide-fast survey area will include about 20,000 deg^2.

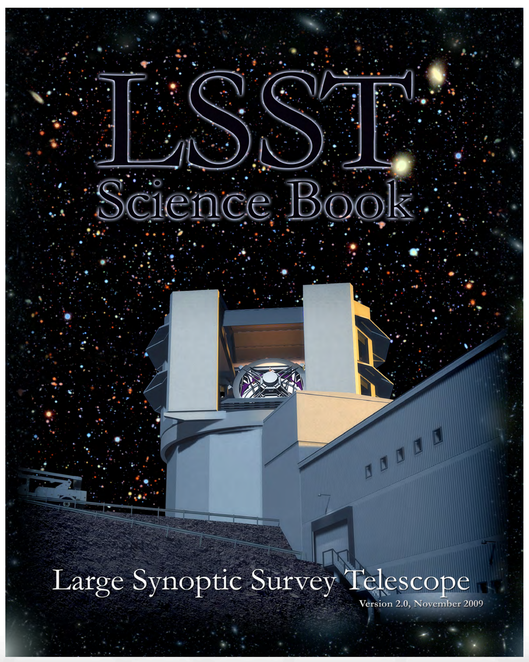
Figures above: An example of improvements in image quality and depth. The left panel shows a random 8x8 square arcmin patch of sky as imaged by the Sloan Digital Sky Survey (r<22). The middle panel shows the same patch of sky as imaged by the Deep Lens Survey to about the same depth as a single LSST visit (30 sec exposure, r<24.5). The right panel shows a co-added Deep Lens Survey image that is still a magnitude shallower (r<26) than anticipated co-added LSST images (and with about a factor of two worse seeing).

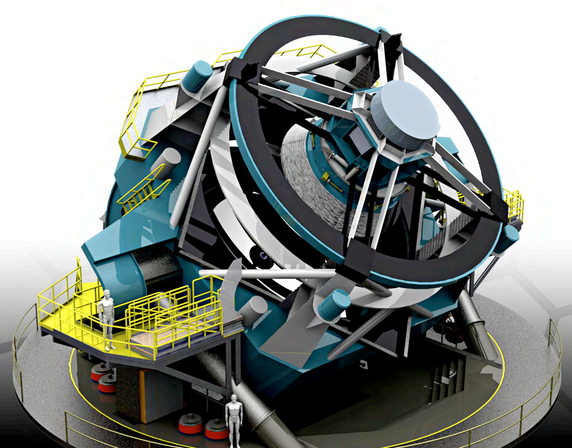
LSST Sky Coverage

The LSST will be sited on Cerro Pachon in northern Chile. From that site, sky regions with Dec < 33.5 degrees can be observed at an airmass of 2.2 or smaller, a limit that is used to define the LSST Survey. This airmass results in a 0.6 mag loss of sensitivity at 500 nm compared to an observation in zenith (due to both seeing degradation and atmospheric absorption), and corresponds to an observable area of 31,000 square degrees. Sky regions with -75^o < Dec < +15^o can be observed at an airmass of 1.4 or smaller, providing especially good image quality for weak lensing and other science investigations that require it. The total accessible solid angle in this range exceeds 20,000 square degrees, outside of the confusion-affected parts of the galactic plane. Figure above summarizes these constraints in equatorial and galactic coordinates. In addition to the main deep-wide-fast survey, about 10% of the observing time will be devoted to specialized programs that will utilize different cadences.

LSST Science Book:

598 pages, 245 co-authors, describing scientific capabilities of the survey in detail. Available at http://www.lsst.org/lsst/scibook





Three main classes of LSST data products

Level 1 data products are generated continuously **every observing night**, including alerts for objects that have changed flux or position, that will be released within 60 seconds (and will include measurements of positions and fluxes, as well as images).

Level 2 data products will be made available as **annual Data Releases** and will include images and catalogs with measurements of positions, fluxes, and shapes, as well as variability information such as orbital parameters for moving objects and light curve parametrization.

Level 3 data products will be **created by science teams** external to the project using suitable Applications Programming Interfaces (APIs) that will be provided by the LSST Data Management System. The Data Management System will also provide about 50 teraflops of user-dedicated processing capability and 12 PB of user-dedicated storage. The key aspect of these capabilities is that they will reside "next to" the LSST data, avoiding the latency associated with downloads.

LSST data products will be made available to the U.S. and Chilean scientific communities with no proprietary period. Derived data products for the general public will be made available worldwide. We are working with foreign partners to make LSST data more broadly available. The software which creates the LSST database will be publicly available and open source.

To learn more:

- Read the posters in this session
- Visit the LSST booth
- Visit http://www.lsst.org
- Apply to join an LSST Science Collaboration
- Talk to the co-authors of this poster, or anybody else in the project!

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