Large Synoptic Survey Telescope

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Science Opportunities with LSST

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The LSST will carry out a ten-year imaging survey of 18,000 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 twice per night, with an effective depth of r = 24.5 (AB), and revisited every three nights on average. The resulting petabytes of data will be made available for scientific investigations ranging from the properties of near-Earth asteroids, to characterizations of dark energy from strong and weak gravitational 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 411 members to date, with membership open via an application process administered by NOAO. Full end-to-end LSST image simulations are a useful resource for exploring science capability.

LSST Science Drivers

In the past decade, large-scale sky surveys have become increasingly important. As a sensitive, well-calibrated, 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. Four of the many science themes that LSST will address are used to optimize the system design:

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.

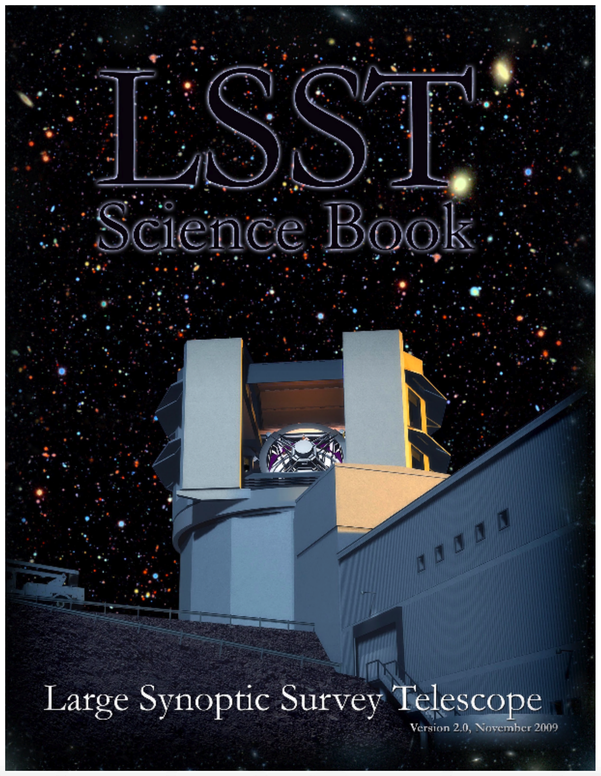
Taking an Inventory of the Solar System
and extending the boundaries of our reach in distance and detectable size of potentially hazardous asteroids. LSST will detect and characterize over 80% of 140m or larger hazardous asteroids, several million main-belt asteroids, and over 100,000 trans-Neptunian 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 the sky at a variety of frequencies: two back-to-back exposures of 15 seconds each; the entire sky every three nights; ~1000 re-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.

A Dedicated 10-Year Survey

- **Main survey will cover 18,000 square deg, with a median visit distribution of 824 per sky patch across 6 optical filters 320 to 1050 nm**
- **5 sigma point source depth after two 15 sec exposures: 23.9 (*u*), 25.0 (*g*), 24.7 (*r*), 24.0 (*i*), 23.3 (*z*), 22.1 (*y*)**
- **Depth at end of survey: 26.1 (*u*), 27.4 (*g*), 27.5 (*r*), 26.8 (*i*), 26.1 (*z*), *24.9* (*y*)**
- **~10% of time devoted to specialized cadences like *"deep drilling fields"***
- **Median delivered image quality of 0.67 arcsec FWHM in *r***
- **Probes of variability on timescales from 15 seconds to 10 years**
- **Stellar photometric calibration to 1% or better. Stellar repeatability to 0.5%**
- **Astrometry to 10 mas per visit, allowing proper motion uncertainty of 1 mas/year, and parallax uncertainty of 3 mas to *r* = 24 (and matching Gaia's performance at *r* = 20) over the course of the survey**
- **20 trillion observations of 20 billion objects**



Eleven Science Collaborations and their chairs:

Solar System: *Michael Brown & R. Lynne Jones*
Stellar Populations: *Kevin Covey & Knut Olsen*
Milky Way Structure and the Local Volume: *Marla Geha & Beth Willman*
Transients and Variable Stars: *Josh Bloom & Lucianne Walkowicz*
Galaxies: *Harry Ferguson*
Active Galactic Nuclei: *Niel Brandt*
Supernovae: *Richard Kessler & Michael Wood-Vasey*
Strong Lensing: *Phil Marshall*
Large-Scale Structure: *Eric Gawiser & Hu Zhan*
Weak Lensing: *Bhuvnesh Jain & David Wittman*
Informatics and Statistics: *Kirk Borne*

Three main classes of LSST data products

Level 1 data products are generated continuously **every observing night**, including alerts for a million objects per night 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 parameterization. Each of the 20 billion objects in the database will have hundreds of attributes.

Level 3 data products will be **created by science teams** external to the project using suitable Application Programming Interfaces 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 petascale downloads.

LSST data products will be made available to the U.S. and Chilean scientific communities with no proprietary period. An innovative 20PB Database will enable rapid efficient searches and correlations, in time and space. Alerts, and derived data products for the general public, will be made available worldwide. We are working with foreign partners to make LSST science data products more broadly available. The software which creates the LSST database will be publicly available and open source.

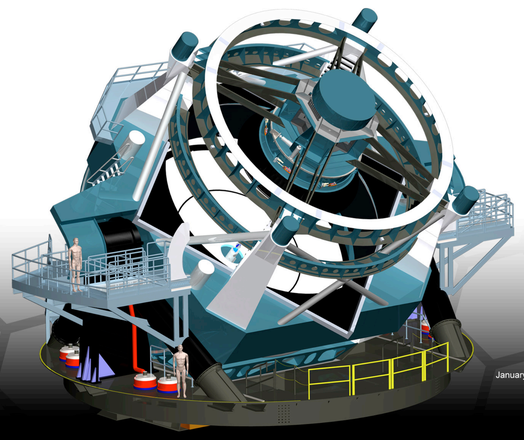
OPEN DATA, OPEN SOURCE

To learn more:
- Read the posters in this session
- Visit the LSST booth
- Visit http://www.lsst.org
- Talk to anybody in the Collaborations!
- If you can contribute now to the science capability analysis or technology, apply to join a LSST Science Collaboration

LSST Science Book:

598 pages, 245 co-authors, describing scientific capabilities of the survey in detail.

Available at
http://www.lsst.org/lsst/scibook



January 2012

LSST is a public-private partnership. Design and development activity is supported in part by the National Science Foundation. Additional funding comes from private gifts, grants to universities, and in-kind support at Department of Energy laboratories and other LSSTC Institutional Members.