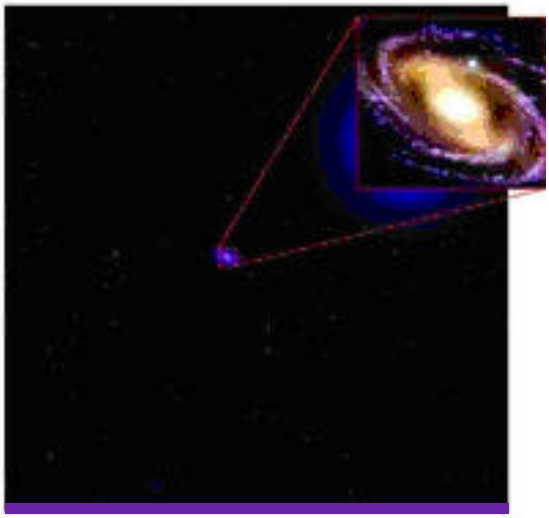
Celestial Cinematography:
Research Corporation Helps Start LSST Project



MOVE OVER STANLEY KUBRICK, George Lucas and Steven Spielberg! You can take credit for the greatest space movies of the twentieth century, but a new telescope—the Large Synoptic Survey Telescope (LSST)—may generate an epic series of movies in the twenty-first century. Research Corporation is playing a major role in the LSST project.

What is the LSST?

The word "synoptic," like its root "synopsis," is defined as "a summary of the principal parts or a general view of the whole." The goal of the LSST project, then, is to regularly survey the entire sky.

Astronomers, of course, have been studying and mapping the sky for centuries. Today's most advanced sky survey, the Sloan Digital Sky Survey, has been collecting data since 1998; it has proven to be a treasure trove of new discoveries for atronomers.

When it's completed in late 2012, the LSST, however, will be able to collect data to a deeper and wider field at a rate more than 250 times faster than the Sloan. Technological developments in three key areas are making this possible, bringing together a powerful wide-field telescope, the world's largest digital camera, and a data management system capable of handling one of the world's largest databases.

Capable of sweeping the entire night-time sky every four days, the LSST will build up a huge database of snapshots that can be used to identify and then study time-dependent phenomena, such as exploding supernovae and Earth-approaching asteroids. By assembling these snapshots into a time-dependent series of images, astronomers will open up—in a systematic way for the first time—a movie-like window on the time domain of the universe.

Scientific Frontiers for the LSST

J. Anthony Tyson, LSST Director and professor of physics at the University of California at Davis, says,

Funding the Development of a New Telescope: the Role of Private and Public Partners

With an estimated price tag of $300 million, the financial challenge of the LSST project is nearly as daunting as its science, technology and engineering challenges.

While federal funding from the National Science Foundation (NSF) and the Department of Energy (DOE) is likely to play a very important role over the long term, the private sector has been key in getting the LSST project started.

Research Corporation has made a commitment of up to $10 million over the life of the LSST project, and this up-front commitment has helped drive the project through its formative stages. Project Manager Donald Sweeney says, "Without Research Corporation, this project would not exist."

Earlier this year, a generous, private donation by Arizona businessman Richard Caris helped move the LSST off the drawing board and into production. In January, 2005, at the American Astronomical Society national meeting, the LSST Corporation announced that it has awarded a $2.3 million contract to the University of Arizona Steward Observatory Mirror Lab to purchase the glass and begin engineering work for the 8.4-meter diameter main mirror.

Commenting on the important role of private funding at these early stages, LSST President and former Research Corporation President John Schaefer says, "The NSF and DOE have their funding processes, and it's a competitive appropriation scenario. It's likely to take two, three, four years before a strong commitment is made, and that's time wasted in terms of development of the telescope. By providing money up front, we can do a lot of the basic research to prove the concept and begin manufacturing parts of the telescope. When federal funding does kick in, we'll have already made quite a bit of progress."

Throughout its history, Research Corporation (RC) has played a major role in the advancement of astronomy and the development of new telescopes. Among RC's important contributions have been support for Grote Reber and the birth of radio astronomy in the 1930s and 1940s, for the operation of the 12-meter radio telescope at Kitt Peak, and for the development of the Large Binocular Telescope (dedicated in October, 2004, see more details at http://medusa.as.arizona.edu/lbto/).

Now that the LSST project is up and running, thanks to private funding, the public funding is starting to become a reality. The Department of Energy is involved through its National Laboratories, three of which are members of the LSST Corporation. And on September 1, the LSST project received the first year of a four-year, $14.2 million award from the National Science Foundation. This award will allow engineers and scientists to complete design work already under way so that the LSST can begin construction in 2009.

"LSST will change the way we observe the universe by mapping the visible sky deeply, rapidly and continuously. It will open entirely new windows on our universe, yielding discoveries in a variety of areas of astronomy and fundamental physics."

A strong scientific case for the LSST has been put forward by the astronomy and physics communities in a number of recent reports, including the NAS/NRC decadal survey titled "Astronomy and Astrophysics in the New Millennium (2001)," the NAS/NRC report titled "Connecting Quarks with the Cosmos (2003)," and the High Energy Physics Advisory Panel report titled "Quantum Universe (2004)." Although the most interesting scientific discoveries may come in areas yet unimagined, here are some important scientific frontiers that will be advanced by the LSST.

LSST Corporation

The design, development and construction of a major telescope involves hundreds of experts from dozens of institutions. The organization that provides the focus and leadership for these individuals and institutions is the LSST Corporation (www.lsst.org). The LSST Corporation currently has twelve institutional members:

- Research Corporation*
- Association of Universities for Research in Astronomy Inc.*
- University of Arizona*
- University of Washington*
- Brookhaven National Laboratory
- Harvard-Smithsonian Center for Astrophysics
- Johns Hopkins University
- Lawrence Livermore National Laboratory
- Stanford Linear Accelerator Center
- Stanford University
- University of California at Davis
- University of Illinois at Urbana-Champaign

** denotes Founding Member*

A number of other organizations (such as Google, Lucent, and Microsoft) are also participating in various components of the project. And in the coming months, additional institutions will be joining the group.

Probing Dark Energy and Dark Matter

First discovered in 1998 by two independent groups studying Type 1a supernovae, Dark Energy is now thought to make up 70 percent of the universe. Yet the exact nature of Dark Energy, which is driving the accelerating expansion of the universe, remains a mystery. Michael Turner, a cosmologist at the University of Chicago and the assistant director for mathematical and physical sciences at NSF, served as chair of the NAS/NRC committee that wrote "Connecting Quarks with the Cosmos." Turner is credited with coining the term "Dark Energy." Speaking earlier this summer at the 2005 Cottrell Scholars Conference, Turner said, "The nature of Dark Energy is the most important question facing science today."

The LSST will allow astronomers and physicists to use a technique known as weak gravitational lensing to obtain a three-dimensional mass map of the universe. By measuring the number and speed of mass clusters over the last half of the age of the universe—at the time when Dark Energy apparently had its greatest influence—scientists will probe the nature of Dark Energy and Dark Matter.

Detecting and Studying Near-Earth Objects

Astronomers estimate that there are tens of thousands of Near-Earth Objects (NEOs) of significant size. While the frequency of NEO impacts on Earth is exceptionally low, the damage they can cause is immense. A 300-meter diameter asteroid impact would be equivalent to 1,600 megatons of TNT. In an ocean basin, the resulting tsunami could devastate coastal margins. The LSST will find virtually all 1-kilometer NEOs in less than a year. In a decade of operation, it will find 90 percent of all objects down to 250 meters in diameter, and nearly 80 percent of all objects down to 125 meters. The LSST will play a major role in protecting Earth from the threat of asteroid collisions. (For more information on NEOs, visit NASA's NEO website at neo.jpl.nasa.gov)

Studying Optical Transients

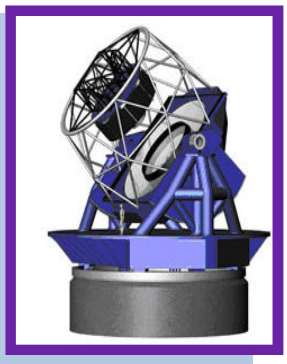
Before the availability of a telescope like the LSST, it has simply not been possible to study astronomical phenomena on this rapid time scale. In its ongoing survey of the sky, the LSST can be expected to see 1,000 exploding supernovae every night. As soon as an optical transient is identified, a real-time alert can be sent to the worldwide community of professional and amateur astronomers, allowing them to initiate their own studies with other telescopes.

Studying the Outer Solar System

With its capability for studying faint and moving objects, the LSST will be used to investigate the solar system beyond Neptune and to better understand the Kuiper Belt. By studying

the extent and nature of outer solar system, astronomers will not only clarify the formation history of our own solar system, but they'll also gain new knowledge about how stars and other solar systems form.

LSST Facts and Figures



- Size of primary mirror: 8.4 meters
- Size of secondary and tertiary mirrors: 3.4 meters and 5.0 meters
- Size of camera: 3 billion pixels (3 gigapixels)
- Readout time: 2 seconds for each exposure
- Amount of data generated: 30 terabytes of data each night (the amount of data on 5,000 DVDs)
- Field of view: 3.5 degrees (10.0 square degrees, approximately 50 times the area of a full moon)
- Wavelength coverage: 400 nm to 1040 nm
- Etendue: 318 m^2 deg^2, a 50-fold increase over the best wide-field capability currently available. (Also known as "throughput," etendue is a figure of merit calculated as the product of the telescope capture area in square meters and the camera field of view in square degrees.)
- First light (planned): end of 2012
- Total cost (estimated): $300 million ($30 million for design and development and $270 million for construction)
- Site of telescope: Three candidate sites are under consideration; two are in Chile (Las Campanas and Cerro Pachon) and one is in Mexico (San Pedro Martir in Baja California)

The Technology behind the LSST

Donald Sweeney, the LSST Project Manager and an engineer in the Physics Directorate at Lawrence Livermore National Laboratory, smiles when he calls the LSST the "Maserati" of telescopes. Like an exotic sports car, it will be a masterpiece of design, science and technology.

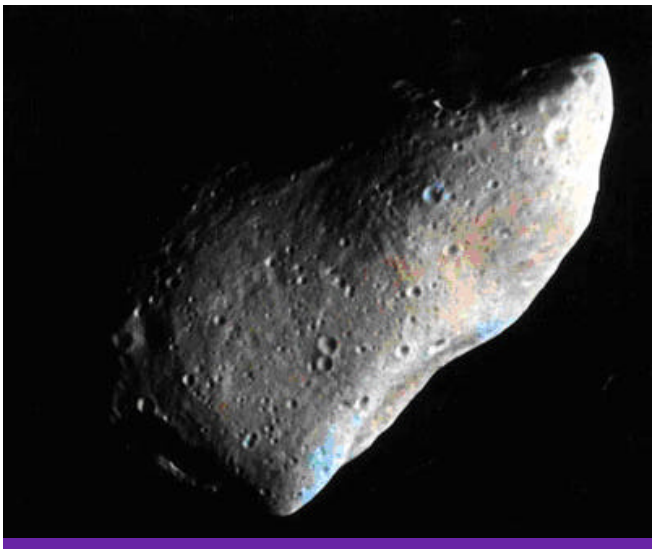
According to Sweeney, the LSST, when it's operational, will work its way across the night sky—quickly, smoothly, and precisely moving its gaze to a new location every 30 seconds. When it reaches a new location, it will take only 5 seconds to settle (other telescopes might take a minute or two). It will then collect data (a pair of 15-second exposures) with its 3-gigapixel camera. The data from the detector will be read into a high speed network in two seconds after each exposure. Then the telescope will swing quickly to point to the next location in the sky within five seconds. By the end of a typical 10-hour winter night, the system will have recorded about 1,000 exposures, mapped 25-30 percent of the sky, and collected 30 terabytes of data.

A Telescope for Everyone

One of the most intriguing and exciting features of the LSST project is to make all data collected immediately available online to everyone—scientists, amateur astronomers, students, anyone with internet access. This will allow astronomers everywhere access to high-quality scientific data, without regard to their nationality or the wealth of their home institution. Software tools will allow individuals of all levels of expertise and interest to open their own window on the universe.

LSST planners envision that scientists could place their own computers next to LSST mass storage facilities (sometimes called "disk farms") located around the world, for data mining and analysis. In museums and planetariums, "video walls" will show LSST's wide-sky dynamic view of the changing universe. At home, the public will have web access to up-to-date digital movies of the changing sky. And in school, a fifth-grade class will adopt a piece of the sky, observing it periodically to search for change and discovering for themselves new supernovae, asteroids or comets.

Brought to you by the LSST, "celestial cinematography" is coming soon to a theater—or a computer—near you. This epic series of movies, featuring a panorama of stars, may change your view of the universe. Stay tuned for further developments.



The LSST will detect and identify Near-Earth Objects such as asteroids and comets. This image of asteroid 951 Gaspra was taken from the Galileo spacecraft. The object is about 19x12x11 kilometers in size, similar to those whose impacts cause mass extinctions on Earth. (Image courtesy of NASA)