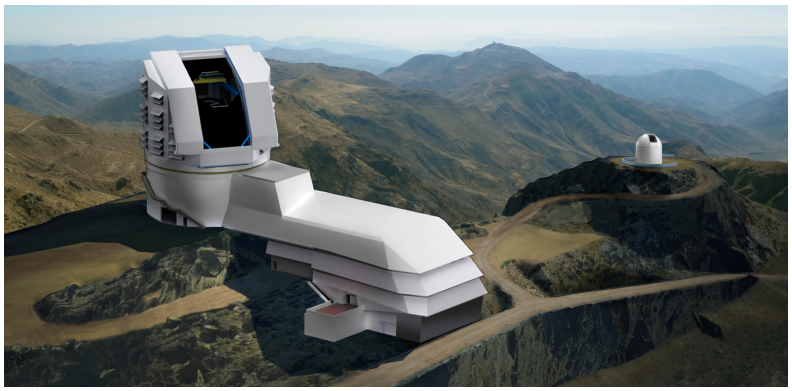
National Science Foundation
Directorate for Mathematical & Physical Sciences (MPS)

LSST: A NEW ERA FOR ASTRONOMY



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"We find them smaller and fainter, in constantly increasing numbers, and we know that we are reaching into space, farther and farther, until, with the faintest nebulae that can be detected with the greatest telescopes, we arrive at the frontier of the known universe."
-- Edwin Hubble

Astronomy and astrophysics turned a corner when Edwin Hubble discovered nebulae beyond the Milky Way and proved the existence of galaxies besides our own and comparable in scale. Using the 100-inch Hooker Telescope at Mount Wilson Observatory, he opened a door to a breadth of previously unimaginable possibilities for researchers and stargazers everywhere. Ever larger and more powerful telescopes continue to push our view and understanding of the universe to new limits.

We can now see our way to a remarkable new instrument that will bring unique capabilities to that view. In August the National Science Board authorized the National Science Foundation to fund the construction of the Large Synoptic Survey Telescope (LSST), a tool that will qualitatively transform astronomy and astrophysics. The plan is for LSST is to see first light in 2019 and begin full operation in 2022, after calibration of its many components.

Enabling discovery and innovation

LSST is effectively a 6.7-meter, wide-field survey telescope designed to image the entire visible sky several times a week, providing an unprecedented amount of information as it repeatedly visits the same locations in rapid succession. It will open a new era in "time-resolved astronomy" as its 3-billion pixel digital camera and wide field of view enable previously impossible studies of the variable sky. Because the compact three-mirror design incorporating an integrated primary and tertiary mirror allows the rapid movement required to image the sky in only a few days, LSST can observe transient events such as exploding stars and the motion of asteroids. Combining these abundant images also traces billions of remote galaxies to provide new insights into dark matter and dark energy.

LSST is a long-standing dream, and the 2010 National Academy of Sciences decadal survey in

astronomy and astrophysics identified it as the highest priority ground-based initiative. The bottomline is that LSST promises qualitatively new data on transient events that are dauntingly hard to capture, and its repeated observations will build a powerful dataset. I have even heard LSST described as an enormous database with a telescope attached.

'Big data,' new challenges

The LSST survey will produce prodigious amounts of data at rates of more than 30 terabytes per night, growing to more than 100 petabytes of raw data in 10 years of observation. These are truly "big data" that produce both a challenge and an opportunity for data analytics. Fundamental ideas developed to understand these data will influence research in diverse areas such as climate science and genomics, and the reverse will occur as well with astronomers working on LSST data appropriating techniques from other fields. Providing data to astronomers and astrophysicists around the world as well as to citizen scientists is integral to the plans for LSST. Educational opportunities abound, and the project intends to give classrooms each "a little bit of the sky" to examine.

Collaboration, a cornerstone of LSST

LSST is a notable partnership of government agencies and private foundations, with the Department of Energy being our key federal partner. In this partnership, NSF supports development of the site, telescope, educational outreach and the extensive data management system while DOE supports construction of the digital camera at the heart of the telescope. The two agencies will share operational costs to meet their respective science goals, and international partners will also participate in LSST.

Private donors, particularly the Charles and Lisa Simonyi Fund for Arts and Sciences, and Bill Gates, the Research Corporation for Science Advancement, the Keck Foundation, and Google's Eric Schmidt, have played a critical role in the development of LSST. The approximately $700 million in construction costs comes 70% from NSF, 24% from DOE, and 6% from private donors. The flexible, private funding played a pivotal role at the beginning of the project, enabling early, high-risk activities, such as casting the main mirror.

The journey to the beginning of LSST construction on a mountaintop in Chile has required immense intellectual effort, organization, insight, tenacity, and technical virtuosity from the many people involved. Completing this marvelous instrument will require more of the same, and those involved are undaunted as they seize the opportunity to transform the face of astronomy and astrophysics. At the end of the day, it is always the talent and determination of dedicated individuals that propel science forward, and LSST is a grand example.

I look forward to sharing more news periodically and welcome your emailed comments at: **mpsperspective@nsf.gov**

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Find more perspectives from the Assistant Director for Mathematical and Physical Sciences