Cosmic Acceleration

Left: One of the meter-scale lenses for the DOE's Dark Energy Spectroscopic Instrument, now installed at NSF's Kitt Peak National Observatory.

Background image credit: NASA, Wilkinson Microwave Anisotropy Probe and Hubble Space Telescope.

The Confounding Mystery of Cosmic Acceleration

Recent discoveries suggest that there may be new, unexplained forces of nature at work in the Universe. When we throw a ball up in the air, we expect the Earth's gravity to pull it back. But when it comes to the Universe as a whole, what goes up does not always come down: an unknown force dubbed Dark Energy is causing the Universe to expand faster and faster, the equivalent of the ball shooting up into the sky rather than falling to the earth. The data also suggest there was a similar period of accelerated expansion early in the history of the Universe. Cosmic acceleration is one of the biggest unsolved mysteries in science today, and understanding it is the focus of several new experiments.

Observing the Universe

Studying cosmic acceleration requires diverse but complementary observations. We use the cosmic microwave background, the earliest light we receive, to fingerprint the early Universe. We survey the sky, using the patterns in the clustering and shapes of billions of galaxies to trace the more recent details of our cosmic composition and evolution. And we use supernovae and the echoes of cosmic sound waves to chart the expansion history of the Universe. For our experiments, we build and operate world-leading telescopes and instruments, involving teams of hundreds of scientists. Our telescopes are sited to take advantage of the best locations on Earth to observe our Universe, including the mountains of Hawaii and Arizona, the Chilean Andes and the South Pole.

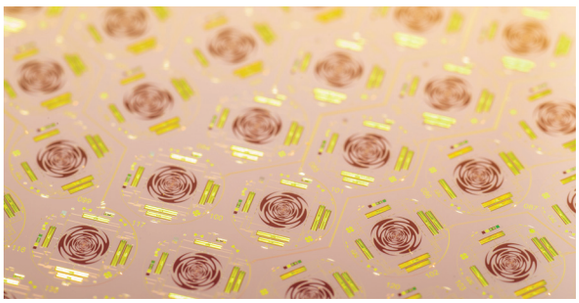
LSST, Cerro Pachon, Chile (photo credit: Gianluca Lombardi, LSST/NSF/AURA)

Technology, Data Science, and the American Workforce

Our experiments require novel combinations of instrumentation, high performance and high throughput computing, machine learning, and theoretical physics and applied mathematics. Our collaborations train the next generation of creative and skilled experts in these critical areas. We work together with national and international industry partners to develop cutting-edge sensors, superconducting electronics, and ultrafast computing resources. Our scientists drive the frontier forward in all of these areas, creating new technologies and methods that find applications in other domains. Our students, with their unparalleled big-data science and technical training are in demand to power cutting-edge industries and start-ups.

What's next?

Over the next decade, we will carry out the most powerful surveys of the Universe ever attempted. By generating maps of unprecedented detail of both the very early and the recent Universe, we seek fundamental answers to explain the astonishing behavior of cosmic acceleration and look for new forces of nature.



CMB detectors: Extremely sensitive cosmic microwave background detectors designed, fabricated and tested by researchers at U.S. National Labs and Universities (photo credit: Reidar Hahn, Fermilab).

Dark Energy Survey at the Blanco Telescope, Cerro Tololo Inter-American Observatory, (photo credit: Reidar Hahn, Fermilab)

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