

First Takes of the Largest Astronomical Movie Ever

The Vera C. Rubin Observatory has released its first images—a small preview of a decadal survey that will observe an unprecedented number of stars and galaxies, helping researchers tackle the biggest mysteries in astrophysics and cosmology.

By **Matteo Rini**

Today, the NSF–DOE Vera C. Rubin Observatory unveils a sample of images and videos acquired in its first testing run, offering a tantalizing glimpse of what’s to come.

Perched high in the Chilean Andes, the observatory is designed to capture the most expansive view of the night sky ever recorded—creating a vast, time-lapse 3D movie of the Universe. The observatory will conduct a 10-year survey called the Legacy Survey of Space and Time (LSST). In its first year only, it will gather more data than have been collected in the entire history of astronomy. The imagery presented today was obtained in just 10 hours of test observations, in which the observatory captured millions of galaxies and Milky Way stars as well as thousands of asteroids. “This observatory represents a giant leap in our ability to explore the cosmos and unwrap the

mysteries of the Universe,” said Kathy Turner of the US Department of Energy at the “First Look” press conference held today.

The Vera C. Rubin Observatory, named after the scientist who provided early evidence for dark matter, sits in one of the world’s most privileged locations for astronomy—at the summit of Cerro Pachón in Chile, offering exceptionally clear skies, low levels of atmospheric turbulence, dry air, and little light pollution. With an 8.4-m-diameter primary mirror, Rubin won’t be the world’s largest telescope, but it will be unmatched in the ability to quickly observe large swaths of the sky. Each of its images will capture an area equivalent to 45 moons—for a comparison, the JWST space observatory’s field of view is slightly less than a full moon. What’s more, the telescope moves quickly with little wobbling, allowing it to wheel within a few seconds to a new observing spot—moving 10 to 100 times faster than any existing telescope. This combination of speed and field of view will allow the observatory to cover the whole Southern Sky every three to four nights. To acquire that bounty of images, the observatory is equipped with the largest camera ever built, a 3.2-gigapixel, car-sized camera whose output would require 400 ultra-HD TV screens to be displayed in full detail. With such resolution, the camera will deliver 20 terabytes of data every night—an information content comparable to that of all the books ever written.



Picture of the Rubin Observatory at Cerro Pachón in Chile.
Credit: NSF–DOE Vera C. Rubin Observatory

The repeated full-sky coverage will produce an ultra-high-definition, time-lapse record of the night sky, revealing a changing cosmic landscape. Astronomers expect to



Images of the Lagoon Nebula (at the center) and of the Trifid Nebula (at the top right) captured by the Rubin Observatory in just over seven hours of observation.

Credit: NSF–DOE Vera C. Rubin Observatory

detect a vast range of transient events, such as supernova explosions, pulsating stars, and passing comets or asteroids. The observatory will issue alerts—potentially millions per night—notifying the global scientific community about anything in the sky that moves, pulses, or flashes. These alerts will trigger observations from other telescopes that could further dissect those events through spectroscopy or higher-resolution imaging. Rubin’s observations will be relevant to many scientific areas in astronomy, astrophysics, and cosmology, with eight independent international collaborations focusing on different scientific aspects. These aspects include probing dark energy and dark matter, mapping the Milky Way, imaging dynamic events in the sky, and conducting a census of Solar System objects—such as asteroids that could threaten Earth and a “planet 9” that might lie beyond Neptune.

Among the first unveiled images is a hauntingly beautiful picture of the Lagoon Nebula and the Trifid Nebula, both residing in the Milky Way at a distance of 5000 and 4000 light-years from Earth, respectively. The picture results from the combination of almost 700 images that the Rubin Observatory captured in just over seven hours of observing time. Rubin, however, is primarily a survey observatory, so don’t expect that it will engage in a competition with the JWST and other telescopes for building spectacular cosmic galleries. The JWST excels at zooming in on specific targets such as



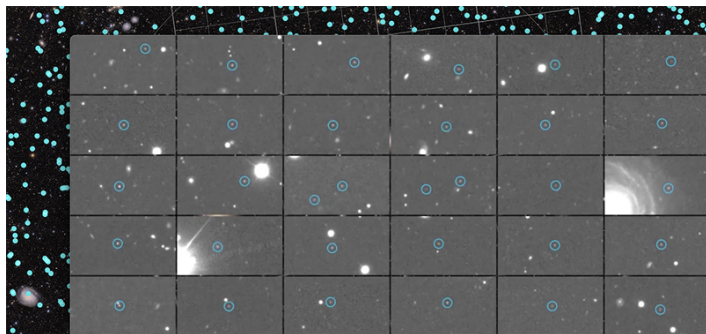
Excerpt from a longer video built from over 1100 images captured by Rubin. The video starts with a close-up of a spiral galaxy and then zooms out to reveal about 10 million galaxies.

Credit: NSF–DOE Vera C. Rubin Observatory

distant galaxies and exoplanets—which it can inspect through spectroscopic analysis. Conversely, the Rubin Observatory maps the “big picture,” thanks to its ability to observe an unprecedented number of astrophysical objects. The videos released today showcase this surveying power. One video, also obtained within the several-hour initial testing window, reveals about 10 million galaxies—roughly 0.05% of the 20-odd billion galaxies that the observatory is expected to capture during the 10-year LSST survey.

But arguably the most mesmerizing materials presented today were videos showing Rubin’s ability to bring the sky to life by observing transient events. One video shows a swarm of asteroids—seven of which are in near-Earth orbits—that were discovered in the telescope’s testing phase. Millions of new asteroids might be found within a couple of years of the LSST run. Another [video posted today](#) shows observations of the subtle pulsations of 46 variable stars.

After almost two decades of preparation, “it’s absolutely amazing how quickly things just turned on and worked,” says Telsa Jeltema of the University of California, Santa Cruz, who serves as the deputy spokesperson for the Dark Energy Science Collaboration. The Rubin Observatory will employ several strategies to probe the dark energy that drives the Universe’s accelerating expansion. For example, astronomers will measure distances using “standard candles” (supernovae), “standard



A swarm of asteroids was detected by Rubin.

Credit: NSF–DOE Vera C. Rubin Observatory

rulers” (baryon acoustic oscillations), and subtle galactic distortions induced by dark matter (weak lensing), and those data will help constrain models of dark energy. Previous observations, including those from the Dark Energy Survey and the Dark Energy Spectroscopy Instrument, have delivered intriguing hints of a breakdown of the standard cosmology model, suggesting, for instance, that dark energy may change with time (See [Research News: The Standard Cosmology Model May Be Breaking](#)). “But we are not convinced yet,” says

Jeltema. LSST will “get us to the point where we know for sure if there is something unusual going on or not,” she says.

Gabriela Gonzalez from Louisiana State University and the LIGO Scientific Collaboration is excited about the synergies between Rubin and gravitational-wave observatories. The LIGO-Virgo-KAGRA Collaboration has extended its ongoing fourth observing run so that it overlaps with Rubin’s observations for at least a few months, she says. Rubin would be particularly suitable to quickly follow up on gravitational-wave events such as neutron-star mergers, possibly getting “video coverage” to accompany the chirps and hums that gravitational-wave observatories are recording. Gonzalez is particularly excited about surprising detections that cannot be anticipated. “We never know what will happen when a new window of observation is opened!”

Selected data from the Vera C. Rubin Observatory can be visualized through its publicly accessible [Skyviewer](#).

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