Dark Energy Spectroscopic Instrument early data release holds nearly 2 million objects

UC Irvine-led mission’s cosmic maps include galaxies, quasars and stars in the Milky Way

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The Dark Energy Spectroscopic Instrument sits atop the Mayall 4-Meter Telescope at Kitt Peak National Observatory in Tucson, Arizona. DESI’s early data gathered in 2020 and 2021 is now publicly available.

Picture Credit:

Marilyn Sargent / Berkeley Lab

Irvine, Calif., June 13, 2023 – The universe is big, and it's getting bigger at a faster rate every day, but astronomers don't understand why. To study the mysterious force known as dark energy behind this accelerating expansion of the universe, scientists at the University of California, Irvine are using the Dark Energy Spectroscopic Instrument to map more than 40 million galaxies, quasars and stars. Today, the DESI collaboration publicly released its first batch of data, with nearly 2 million objects for researchers to explore.

"This is the start of an ambitious five-year cosmic cartography project, and we are delighted it went so smoothly," said UC Irvine Professor of Physics & Astronomy David Kirkby, DESI principal investigator at UCI. "We are off to a great start in our quest to learn more about dark matter and dark energy, and we're excited to discover what our final cosmic maps will reveal."

According to Kirkby, DESI has a unique method of capturing the cosmic light from the far reaches of the universe. Instead of taking a single image of each portion of the sky, it uses 5,000 tiny robots to precisely position optical fibers to gather light from more than 100,000 galaxies each night and accurately measure their distance.

"Since this light has been traveling through the expanding universe for billions of years, DESI is able to peer back in time to study our cosmic history," said Kirkby.

"I am really grateful to have the opportunity to work hands-on with the DESI instrument and robots," says Abby Bault, a UCI Ph.D. candidate working with Kirkby. "I am helping to improve the robot software and looking forward to testing a new generation of robots for future experiments. Not many people have the opportunity to work on instrumentation and science during their Ph.D., and I am really excited that our group here at UC Irvine does both."

The UCI team designed an interactive virtual tour that provides an ant's eye view of the 5,000 robotic positioners, viewable on smart phones or through a web browser.

Today the collaboration released an 80-terabyte data set recorded during the six months of the experiment's "survey validation" phase in 2020 and 2021. In this period between turning on the instrument and beginning the official science run, researchers made sure their plan for using the telescope would meet their science goals.

The team also had to meet the challenges of COVID 19, which prevented scientists from working in groups at the telescope. There was also a large forest fire in June 2022 that surrounded the telescope and closed the only access road for months afterwards. Despite these obstacles, UCI scientists designed key components necessary for smooth and efficient operations, including a novel exposure-time calculator and a sky brightness monitor.

In addition to releasing the data set, the researchers published a papers related to the early data release, which include early measurements of galaxy clustering, studies of rare objects and descriptions of the instrument and survey operations. The new papers build on DESI's first measurement of the cosmological distance scale that was published in April, which used the first two months of routine survey data (not included in the early data release) and showed DESI's ability to accomplish its design goals.

The DESI early data release is now freely available for anyone to download and analyze. The software developed by DESI to process this data is also freely available for others to review and build upon.

"DESI sets a high standard for open and reproducible science," said Kirkby.

"In addition to the raw data, we are releasing a set of value-added catalogs of data with accompanying analysis to allow scientists to make use of data not provided in the official public data release," said Dylan Green, a UCI Ph.D. candidate in Kirkby's research group. "My job was to coordinate the release of these catalogs, which allowed me to interact with a lot of different people throughout the collaboration all working on very different science topics."

There is more of data yet to come from the experiment. DESI is currently two years into its five-year run and ahead of schedule on its quest to collect more than 40 million redshifts. The survey has already catalogued more than 26 million astronomical objects in its science run and is adding more than a million per month.

DESI is supported by the U.S. Department of Energy Office of Science and by the National Energy Research Scientific Computing Center, a DOE Office of Science user facility. Additional support for DESI is provided by the National Science Foundation, the Science and Technologies Facilities Council of the United Kingdom, the Gordon and Betty Moore Foundation, the Heising-Simons Foundation, the French Alternative Energies and Atomic Energy Commission, the National Council of Science and Technology of Mexico, the Ministry of Science and Innovation of Spain and by the DESI member institutions.

Kitt Peak National Observatory is a program of NSF's NOIRLab.

About UCI's Brilliant Future campaign: Publicly launched on Oct. 4, 2019, the Brilliant Future campaign aims to raise awareness and support for UCI. By engaging 75,000 alumni and garnering $2 billion in philanthropic investment, UCI seeks to reach new heights of excellence in student success, health and wellness, research and more. The School of Physical Sciences plays a vital role in the success of the campaign. Learn more by visiting https://brilliantfuture.uci.edu/uci-school-of-physical-sciences/.

About the University of California, Irvine: Founded in 1965, UCI is a member of the prestigious Association of American Universities and is ranked among the nation's top 10 public universities by *U.S. News & World Report*. The campus has produced five Nobel laureates and

is known for its academic achievement, premier research, innovation and anteater mascot. Led by Chancellor Howard Gillman, UCI has more than 36,000 students and offers 224 degree programs. It’s located in one of the world’s safest and most economically vibrant communities and is Orange County’s second-largest employer, contributing $7 billion annually to the local economy and $8 billion statewide. For more on UCI, visit www.uci.edu.

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