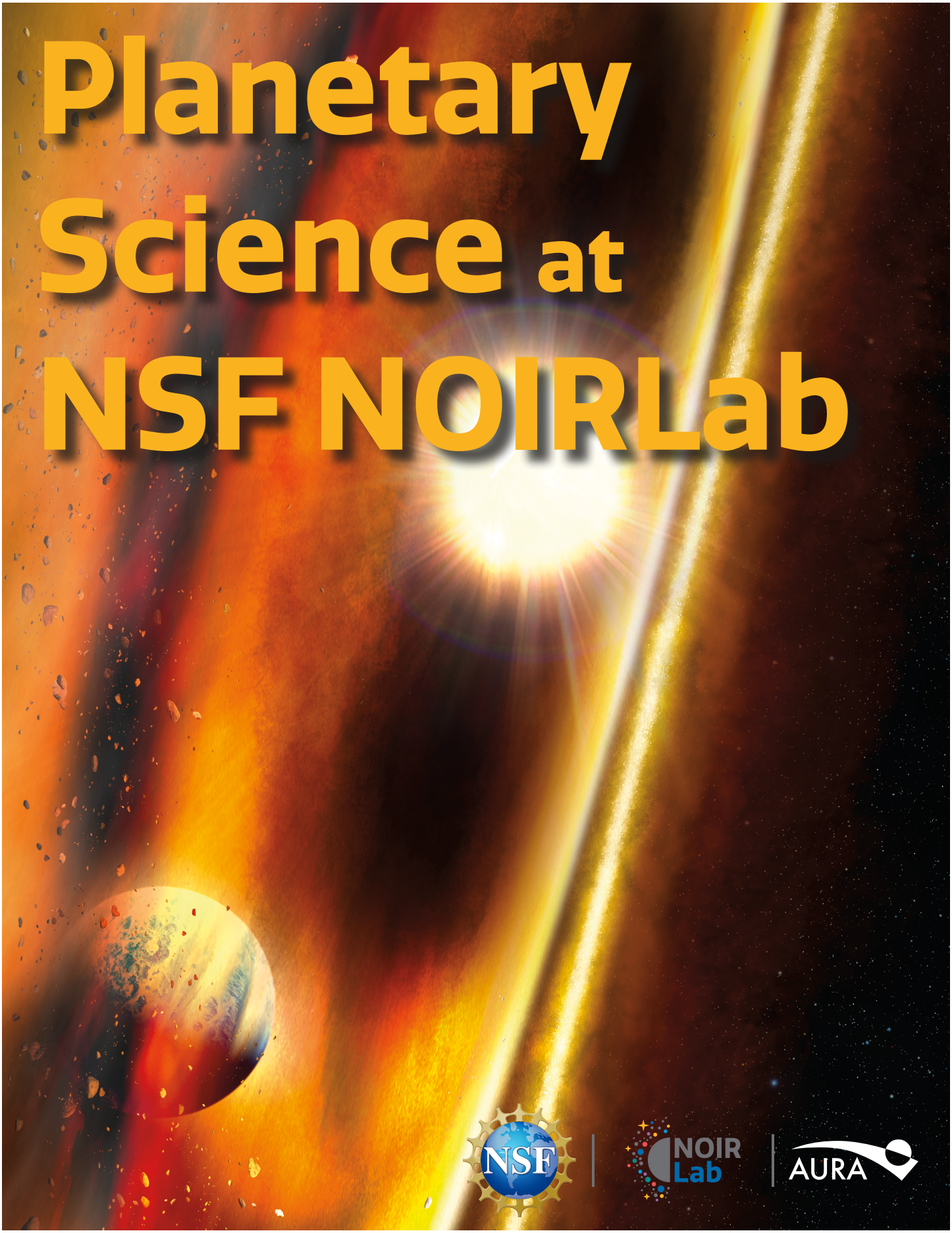
Planetary Science at NSF NOIRLab



Planetary Science at NSF NOIRLab

NSF NOIRLab's mission is to enable incredible new discoveries about the Universe, and empower astronomers to tackle the most pressing questions in astrophysics today. NOIRLab operates a suite of 70 nighttime observatories and data facilities in the darkest places in the world: the International Gemini Observatory, NSF–DOE Vera C. Rubin Observatory (jointly with SLAC), NSF Kitt Peak National Observatory, NSF Cerro Tololo Inter-American Observatory, and the Community Science and Data Center. Scientists from around the world use NOIRLab's telescopes to conduct their research. Scientists also pursue novel research through data mining within NOIRLab's petabyte-scale online data archive.

In the field of planetary science, astronomers have used NOIRLab's observatories and data facilities to discover exoplanets, comets, and asteroids, to study the expansion of the material ejected from the impact of NASA's DART spacecraft with asteroid Dimorphos, and to characterize the atmospheres of planets both in our Solar System and beyond. In addition, Vera C. Rubin Observatory's Legacy Survey of Space and Time (LSST) will discover and characterize vast numbers of Solar System small bodies and many interstellar visitors from other planetary systems, providing important clues and context for how our Solar System formed and has evolved over the past 4.6 billion years. NOIRLab is managed by the Association of Universities for Research in Astronomy, Inc. (AURA) under a cooperative agreement with the U.S. National Science Foundation.

SOAR Telescope Catches Dimorphos's Expanding Comet-like Tail After DART Impact

The 4.1-meter Southern Astrophysical Research (SOAR) Telescope at U.S. National Science Foundation Cerro Tololo Inter-American Observatory in Chile, operated by NSF NOIRLab, imaged the more than 10,000 kilometers-long trail of debris blasted from the surface of Dimorphos, the asteroid moonlet in the double-asteroid system of Didymos two days after the asteroid was impacted by NASA's Double Asteroid Redirection Test (DART) spacecraft on 26 September 2022.

These observations help scientists to understand the nature of the surface of Dimorphos, how much material was ejected by the collision, how fast it was ejected, and the distribution of particle sizes in the expanding dust cloud. Analyzing this information will help scientists protect Earth and its inhabitants by better understanding the amount and nature of the ejecta resulting from an impact, and how that might modify an asteroid's orbit. For more information, visit https://noirlab.edu/public/news/noirlab2223/.

Largest Potentially Hazardous Asteroid Detected in Eight Years and Fastest Orbiting Asteroid Discovered at NOIRLab's CTIO

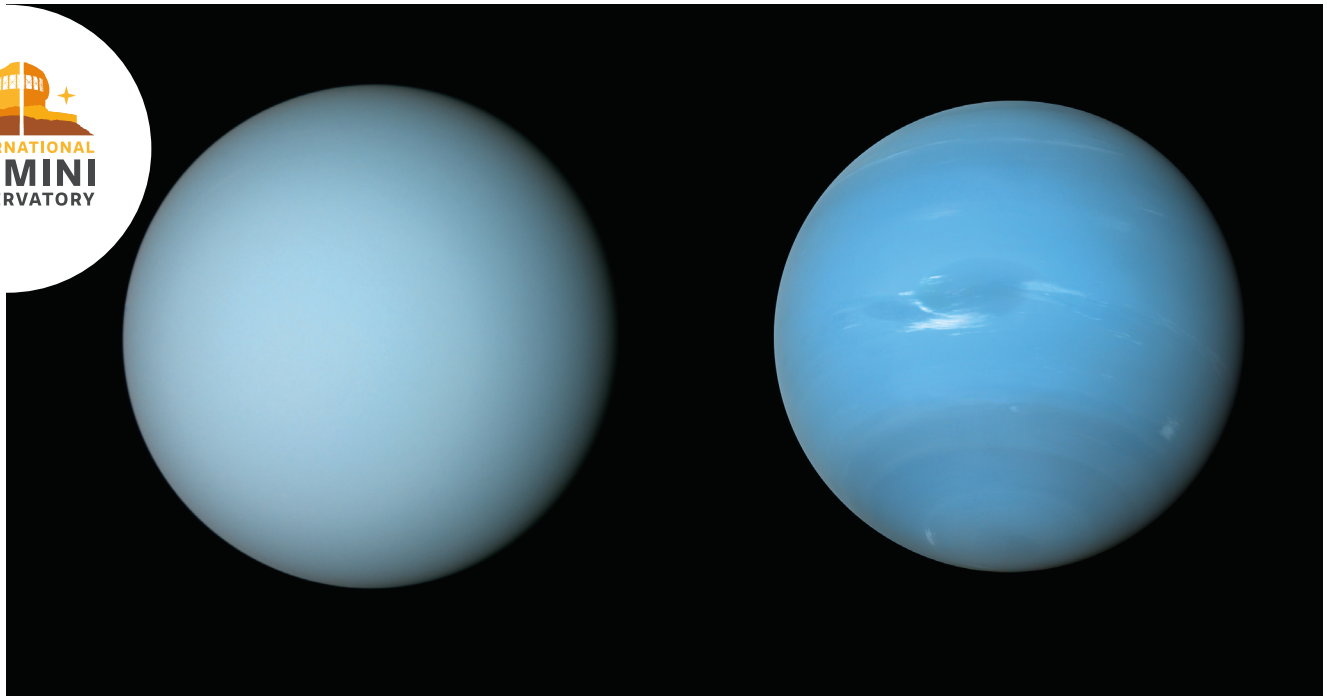
Twilight observations with the U.S. Department of Energy-fabricated Dark Energy Camera (DECam) mounted on the Victor M. Blanco 4-meter Telescope at the U.S. National Science Foundation Cerro Tololo Inter-American Observatory in Chile, a Program of NSF NOIRLab, have enabled astronomers to spot three near-Earth asteroids (NEA) hiding in the glare of the Sun. These NEAs are part of an elusive population that lurks inside the orbits of Earth and Venus. One is a 1.5-kilometer-wide asteroid called 2022 AP7, the largest object that is potentially hazardous to Earth to be discovered in the last eight years. The other asteroids, called 2021 LJ4 and 2021 PH27, have orbits that safely remain completely interior to Earth's orbit. Also of special interest, 2021 PH27 is the closest known asteroid to the Sun, making it the fastest-orbiting asteroid discovered to date.

As well as detecting asteroids that could potentially pose a threat to Earth, this research is an important step toward understanding the distribution of small bodies in our Solar System. Detecting these objects also allows astronomers to understand how asteroids are transported throughout the inner Solar System and how gravitational interactions and the heat of the Sun can contribute to their fragmentation. For more information, visit https://noirlab.edu/public/news/noirlab2226/ and https://noirlab.edu/public/news/noirlab2123/.

A Dizzying Show by Comet NEOWISE

When Comet NEOWISE (C/2020 F3) sped through the inner Solar System during the middle of 2020, astronomers and the general public watched in awe as this 'dirty snowball' shed gas and dust into space, producing a striking show visible to the naked eye. Images taken with the International Gemini Observatory, supported in part by the U.S. National Science Foundation and operated by NSF NOIRLab, show the materials escaping from the comet over time. One set of observations, obtained on 1 August 2020 from the Gemini North telescope on Hawai'i's Maunakea, displays a spiraling stream of molecular gas that reveals the rotation of the comet's nucleus. The timelapse sequence, compressed to only a few seconds, represents about one fifth of the approximately 7.5-hour rotation period of the comet. For more information, visit https://noirlab.edu/public/news/noirlab2021/.

Gemini North Telescope Helps Explain Why Uranus and Neptune Are Different Colors



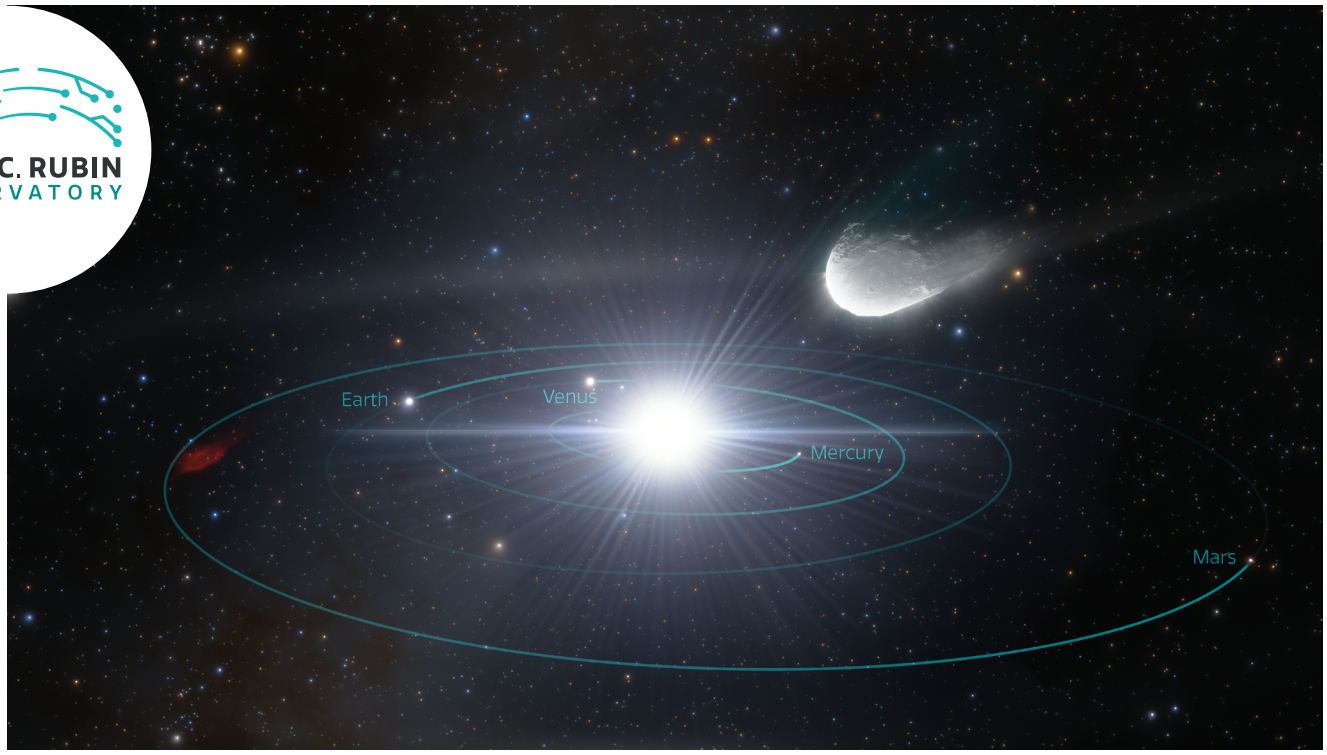
Astronomers may now understand why the similar planets Uranus and Neptune are different colors. Using observations from the Gemini North telescope, the NASA Infrared Telescope Facility, and the Hubble Space Telescope, researchers have developed a single atmospheric model that matches observations of both planets. The model reveals that excess haze on Uranus builds up in the planet's stagnant, sluggish atmosphere and makes it appear a lighter tone than Neptune. The model also helps explain the dark spots that are occasionally visible on Neptune and less commonly detected on Uranus. They are due to a darkening of the deepest aerosol layer of their model that would produce dark spots similar to those seen on Neptune and perhaps Uranus. For more information, visit https://noirlab.edu/public/news/noirlab2211/.

First Known Interstellar Visitor is an "Oddball"

In October 2017 astronomers were surprised by a visitor that came racing into our Solar System from interstellar space. After the object was discovered by Pan-STARRS1 on Haleakala in Hawai'i, both Gemini Observatory telescopes dropped everything to observe the object, named 'Oumuamua, for three nights as it quickly dimmed from view, providing key observations for characterizing the object visiting from outside our Solar System. When discovered, 'Oumuamua was only about 85 times the Earth-Moon distance away. The object's rapidly increasing distance from Earth and the Sun made it too faint to be studied by even the largest telescopes within a month of its discovery. 'Oumuamua was found to be a rapidly rotating, very elongated object that is at least the size of a football field and that changed quite dramatically in brightness as the object — with an aspect ratio of 10:1 — rotated, unlike anything we'd seen in our Solar System before.

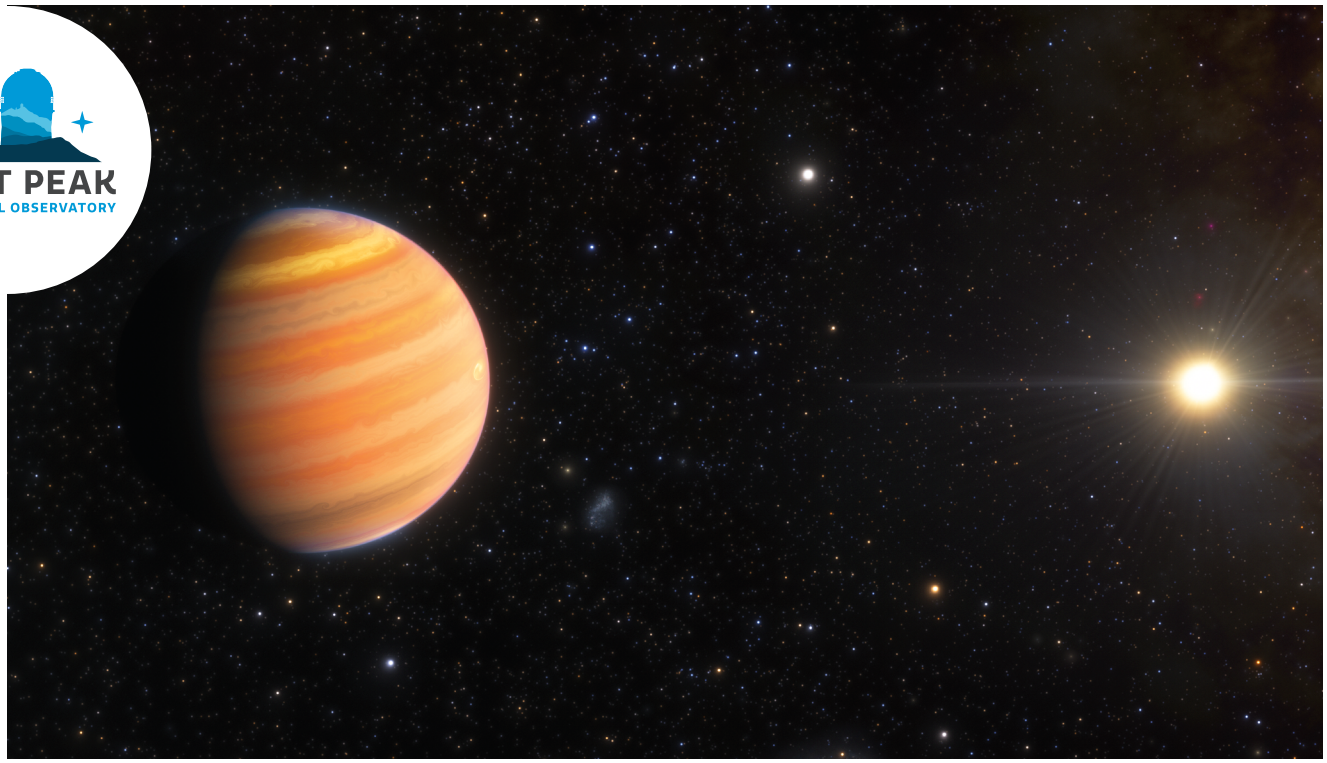
According to our current understanding of planet formation, our Solar System is believed to have ejected comets and asteroids as a result of interactions with the larger outer planets during the early stages of its evolution. It is presumed that other planetary systems do the same and that these visitors might be more common than previously thought. Studying these interstellar interlopers provides valuable insights into how our Solar System fits into the larger picture of planetary systems across the Milky Way. Surveys like Pan-STARRS and Vera C. Rubin Observatory's Legacy Survey of Space and Time (LSST; the observatory is currently nearing the end of construction near the Gemini South telescope in Chile) will undoubtedly increase the detections of these interstellar wanderers. For more information, visit https://noirlab.edu/public/news/gemini1710/.

Visitors from Distant Stars: Rubin Observatory Will Detect an Abundance of Interstellar Objects Careening Through Our Solar System



Many as-yet-undiscovered interstellar objects exist throughout our Milky Way Galaxy: comets and asteroids that have been ejected from their home star systems. Some of these objects pass through our Solar System, bringing valuable information about how planetary systems form and evolve. Currently, only two such interstellar visitors have been discovered: 1I/'Oumuamua and comet 2I/Borisov. Vera C. Rubin Observatory's 10-year Legacy Survey of Space and Time (LSST) will detect fainter interstellar objects than we've ever seen before. Additionally, Rubin's fast-moving telescope can scan the entire visible sky every few nights, capturing a timelapse view of interstellar objects on their fast journeys through our Solar System. While we call both 1I/'Omuamua and 2I/Borisov interstellar objects, they differ in just about every way we can measure. Within the first year of Rubin Observatory's 10-year LSST, scheduled to begin in 2025, scientists expect the many interstellar object discoveries to improve our understanding of what the larger interstellar object population looks like. As interstellar objects could come from stars all across the Milky Way, these discoveries will allow scientists to directly study how planetary systems form at distant stars throughout our galaxy's history — including at ancient stars that no longer exist. For more information, visit https://noirlab.edu/public/news/noirlab2322/.

WIYN 3.5–meter Telescope at Kitt Peak Discovers Extremely Strange Orbit of Rare Exoplanet



Using the WIYN 3.5-meter telescope at the U.S. National Science Foundation Kitt Peak National Observatory (KPNO), a Program of NSF NOIRLab, astronomers have discovered the extreme orbit of an exoplanet that's on its way to becoming a hot Jupiter. This exoplanet, named TIC 241249530b, not only follows one of the most drastically stretched-out orbits of all known transiting exoplanets with an eccentricity of 0.94 but is also orbiting its star backwards. How hot Jupiters end up in such close orbits to their host star is a mystery, but astronomers postulate that they begin in orbits far from their star and then migrate inward over time. It's expected that the initial highly eccentric orbit and extremely close host-star approach of exoplanets like this one will shrink and 'circularize' the planet's orbit over time as tidal forces on the planet sap energy from the orbit. The early stages of this process have rarely been observed, but with the new analysis of this exoplanet before this migration has taken place, crucial insight is lent into how hot Jupiters form, stabilize, and evolve over time. For more information, visit https://noirlab.edu/public/news/noirlab2418/.

Largest Collection of Free-Floating Planets Found in the Milky Way

Using observations and archival data from several of NSF NOIRLab's observatories through NOIRLab's Astro Data Archive and Astro Data Lab Science Platform operated at the Community Science and Data Center (CSDC), together with observations from telescopes around the world and in orbit, astronomers have discovered at least 70 new free-floating planets — planets that wander through space without a parent star — in a nearby region of the Milky Way. The data include 247 images from the NEWFIRM extremely wide-field infrared imager at Kitt Peak National Observatory in Arizona, 1348 images from the same NEWFIRM instrument after it was relocated to Cerro Tololo Inter-American Observatory (CTIO) in Chile, 2214 images from the Infrared Side Port Imager that was previously operating on the Víctor M. Blanco 4-meter Telescope at CTIO, and 3744 images from the Dark Energy Camera.

This is the largest sample of such planets found in a single group and it nearly doubles the number known over the entire sky, shedding light on the origin of free-floating planets. Some scientists believe these planets can form from the collapse of a gas cloud that is too small to lead to the formation of a star, or that they could have been kicked out from their parent system. However, the actual mechanism remains unknown. It is expected that Vera C. Rubin Observatory could find many more free-floating planets when it begins scientific operations this decade. For more information, visit https://noirlab.edu/public/news/noirlab2131/.