

DECADAL SURVEY ON ASTRONOMY & ASTROPHYSICS

ASTRO**2020** BACKGROUND FOR MEDIA

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U.S. EXTREMELY **LARGE**
TELESCOPE PROGRAM

What is the Decadal Survey?

What is the US-ELTP?

What is the Decadal Survey and what is its significance to the US-ELTP?

The Decadal Survey on Astronomy and Astrophysics is a study carried out by the National Academy of Sciences, Engineering, and Medicine to identify the top science priorities in astronomy and astrophysics for the next decade. While the survey is sponsored by NASA, NSF, and DOE, it is driven by input received from the US science community.

The Decadal Survey for the 2020s (Astro2020) will produce a report presenting a broad vision for enabling transformative science and will provide guidelines and recommendations to scientists, policy makers, and federal agencies to develop comprehensive and strategic scientific investments for the next decade.

The United States Extremely Large Telescope Program (US-ELTP) actively participated in the Astro2020 process. In the initial phase of Astro2020, members of the US science community described the scientific advances that will be uniquely achieved by the next generation of extremely large telescopes (ELTs) and a plan for making the capabilities of both the Giant Magellan Telescope and Thirty Meter Telescope (TMT) accessible to the US community through NOIRLab. Other independently submitted recommendations touched on the science related to ELTs.

The National Academies had an opportunity to review the full US-ELTP scope through our detailed written responses to requests for information, which spanned topics from technical challenges to benefits to US astronomers to the cost and schedule of the components of the program. In addition, in February 2020 we spent half a day in person with the panel at the National Academies' headquarters in Washington, DC. During that session, members of the US-ELTP gave a series of presentations and answered questions from the panel.

The recommendations from the Astro2020 report will shape the future of the US-ELTP.

What is the US-ELTP?

The US-ELTP is a joint initiative to provide the entire US astronomical community with nationally-funded access to the Giant Magellan Telescope in the southern hemisphere and the TMT in the northern hemisphere. Through investment in construction and operations costs from the National Science Foundation (NSF), the goal of the US-ELTP is to provide US scientists at least 25% of the observing time on each telescope through an open peer-review process, facilitated by NSF's NOIRLab, operated by the Association of Universities for Research in Astronomy, Inc. (AURA). With the completion of this project, scientists anywhere in the US will be able to create and lead projects that take advantage of full-sky coverage and diverse instrumental capabilities to carry out transformational research on topics ranging from the characterization of exoplanets and their atmospheres to the formation and evolution of structure in the Universe.



What are the advantages of the US-ELTP?

The bi-hemispheric, two-telescope US-ELTP will offer significant scientific benefits that will provide particular advantages to US astronomers in the global ELT era, including:

All-sky coverage.

Complementary features of the Giant Magellan Telescope and TMT designs.

The opportunity to deploy a greater number and diversity of instruments.

Substantial (~50%) sky overlap between the Giant Magellan Telescope and TMT designs, enabling complementary, sequential, or simultaneous observations with both telescopes.

Longitudinal separation enables longer opportunities for continuous observation, temporal monitoring, and time-critical science.

Opportunities for collaboration with global partners of the Giant Magellan Telescope and TMT.

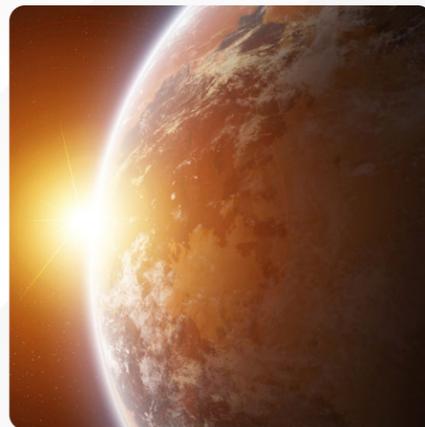
At least 25% observing nights on both telescopes available to US astronomers.

Centralized telescope proposal submission and data access through NOIRLab.

Science enabled by the **US EXTREMELY LARGE TELESCOPE PROGRAM**

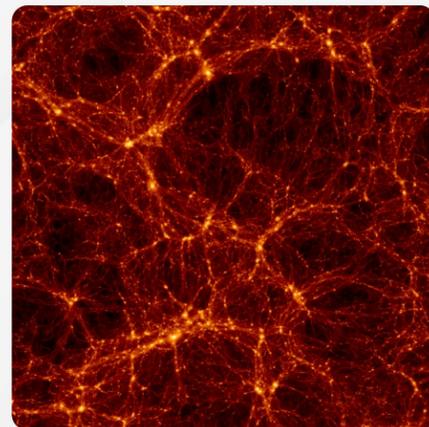
Do the atmospheres of worlds around other stars show the chemical signatures of habitability, or even of life itself?

The Giant Magellan Telescope and TMT can image planets in the temperate zones around nearby stars, and measure atmospheric biomarkers that can indicate whether a planet might harbor life.



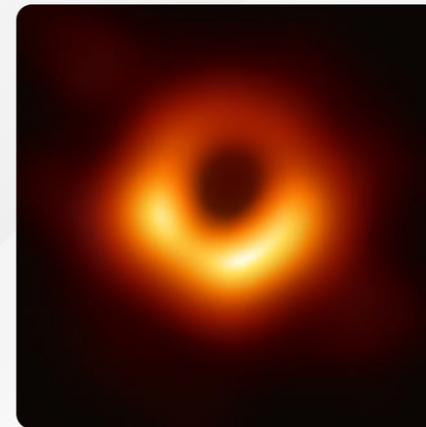
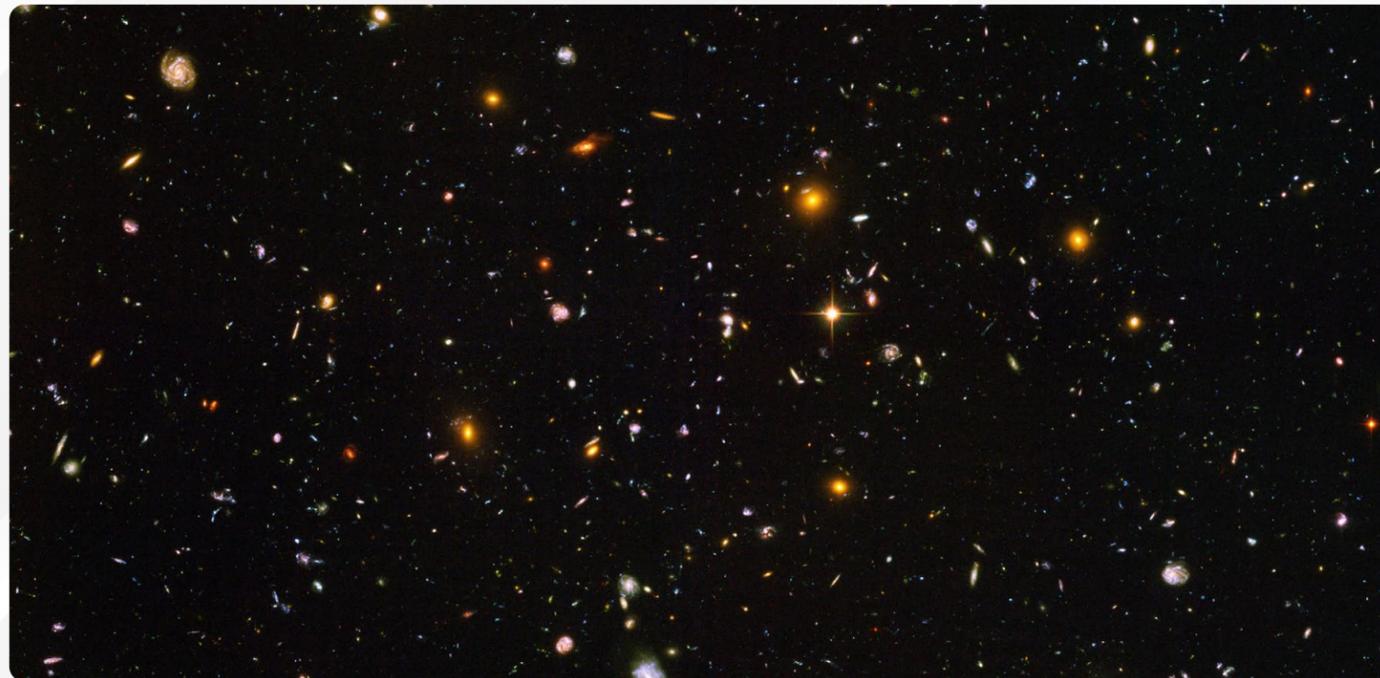
What is the nature of the mysterious dark matter?

85% of the matter in the Universe is invisible and its composition is unknown. The Giant Magellan Telescope and TMT observations will distinguish between competing models of dark matter physics by resolving substructure within galaxy halos on the finest scales.



Is there new dark energy physics beyond the standard model?

The Universe's expansion is accelerating, driven by an unknown dark energy. Recent subtle, but seemingly significant, disagreements between cosmic expansion rates measured in the nearby and distant Universe may imply that the simplest theories of dark energy are wrong. The Giant Magellan Telescope and TMT will provide unique new measurements of cosmic expansion that will constrain the true nature of dark energy.



How did galaxies form and grow in the early Universe?

The Giant Magellan Telescope and TMT will resolve the detailed inner structure of galaxies in the young Universe and measure the “baryon cycle” of gas flowing in and out that connects galaxies to the cosmic web of intergalactic matter.

How does gravity work near supermassive black holes?

The 2020 Nobel Prize was awarded for observations of the supermassive black hole in the center of our Milky Way galaxy. The Giant Magellan Telescope and TMT will determine whether general relativity is an accurate description of gravity in such an extreme environment by tracking the orbits of stars close to the Milky Way's central monster.

Unexpected discoveries anywhere in the sky:

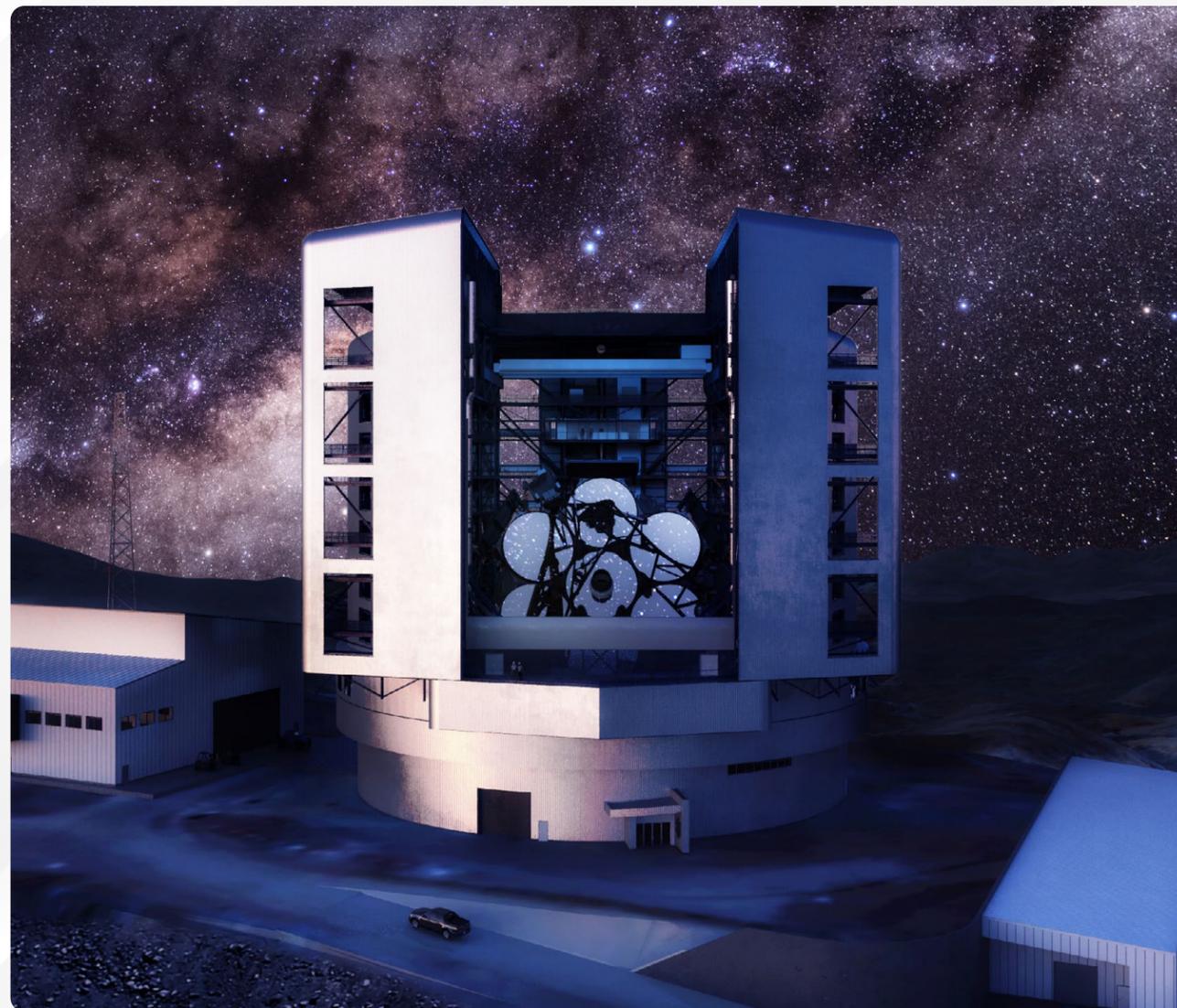
The Universe never fails to yield new surprises! Rare and unique new discoveries will be made in both the northern and southern skies. The all-sky US-ELT Program will allow US astronomers to study them with the Giant Magellan Telescope and TMT wherever they are found.

What is the **GIANT MAGELLAN TELESCOPE?**

The **Giant Magellan Telescope** is the largest Gregorian optical-infrared telescope ever engineered. Its unique design is the most optically efficient of all 30-meter-class telescopes, providing the widest field of view of the Universe with seven of the world's largest mirrors. The telescope is under construction on Las Campanas Peak at the southern edge of Chile's Atacama Desert, one of the best locations on Earth to explore the heavens. Commissioning is scheduled to begin in the late 2020s.

Scientists will use the Giant Magellan Telescope to study nearly all aspects of astrophysics — from searching for signs of life on distant exoplanets to investigating the cosmic origins of chemical elements. With a resolving power 10 times greater than the famed Hubble Space Telescope, it will obtain new clues to the fundamental nature and evolution of the Universe.

The Giant Magellan Telescope is the work of an international consortium of thirteen universities and research institutions from the United States, South Korea, Israel, Brazil, and Australia. Founders include Arizona State University, Astronomy Australia Ltd., Australian National University, Carnegie Institution for Science, Fundação de Amparo à Pesquisa do Estado de São Paulo — FAPESP, Harvard University, Korea Astronomy and Space Science Institute, Smithsonian Institution, Texas A&M University, The University of Texas at Austin, University of Arizona, University of Chicago, and the Weizmann Institute of Science. The telescope is being designed, built, and operated by the GMTO Corporation, a nonprofit organization headquartered in Pasadena, California.



FAST FACTS

Total collecting area of 368 square meters will deliver images sharp enough to resolve the torch engraved on a dime from nearly 160 kilometers away.

24.5-meter primary mirror array consists of seven of the world's largest mirrors, each 8.4 meters in diameter and weighing 18 metric tons.

Seven adaptive secondary mirrors can reshape their 2-millimeter-thick surface 2000 times per second to correct for the optical blurring effect of Earth's atmosphere over the widest field of view of any telescope.

Light path only takes 2 or 3 reflections (depending on observation mode) before entering scientific instruments, the most efficient photon usage of all ELTs.

Gregorian design can accommodate up to ten scientific instruments, more than any other telescope.

Telescope is 22 stories tall, 6300 metric tons, and can complete a full rotation in nearly 3 minutes while tracking celestial objects across the night sky.

Median seeing at Las Campanas Peak in Chile is 0.63 arcseconds at 5000 Å, with the best quartile below 0.50 arcseconds — some of the best optical seeing on Earth.



What is the **THIRTY METER TELESCOPE?**

The **Thirty Meter Telescope (TMT)** will be the largest optical-infrared telescope in the northern hemisphere. It will be sited on Maunakea in Hawai'i, the TMT's preferred location, or on Roque de los Muchachos in La Palma Spain, its alternative site. The telescope will initially be equipped with three powerful science instruments and a laser guide star adaptive optics system that will provide unparalleled imaging and spectroscopic capabilities to scientists worldwide. The TMT will use a segmented primary mirror, as successfully pioneered on the W.M. Keck Observatory twin telescopes. Its extremely large aperture will have nine times the light-gathering power of today's best ground-based telescopes, and more than 150 times the collecting area and 12 times the image resolution of the Hubble Space Telescope. The TMT will transform our understanding of the Universe.

The TMT project is a non-profit collaboration between the University of California, the California Institute of Technology, the National Astronomical Observatories of the Chinese Academy of Sciences, the National Institutes of Natural Sciences of Japan, the National Research Council of Canada and the Department of Science and Technology of India. Significant funding has been provided by the Gordon and Betty Moore Foundation.



FAST FACTS

TMT will carry out scientific investigations across many areas of astronomy, planetary science, and physics, such as dark matter and dark energy, supermassive black holes, the formation of the first stars and galaxies in our Universe and signs of life on planets outside our Solar System.

TMT's primary mirror is 30 meters in diameter, and is composed of 492 hexagonal segments, each 1.44 meters across.

TMT will observe at many wavelengths, from the ultraviolet (0.4 μ m) to the mid-infrared (20 μ m), a range that includes light invisible to the human eye.

TMT's first-light adaptive optics system will correct image degradation induced by Earth's atmosphere, enabling TMT to collect images 12 times sharper than the Hubble Space Telescope.

TMT will integrate the latest innovations in precision control to acquire a new science target anywhere on the sky within five minutes.

TMT's international consortium represents nearly half of the world's population.

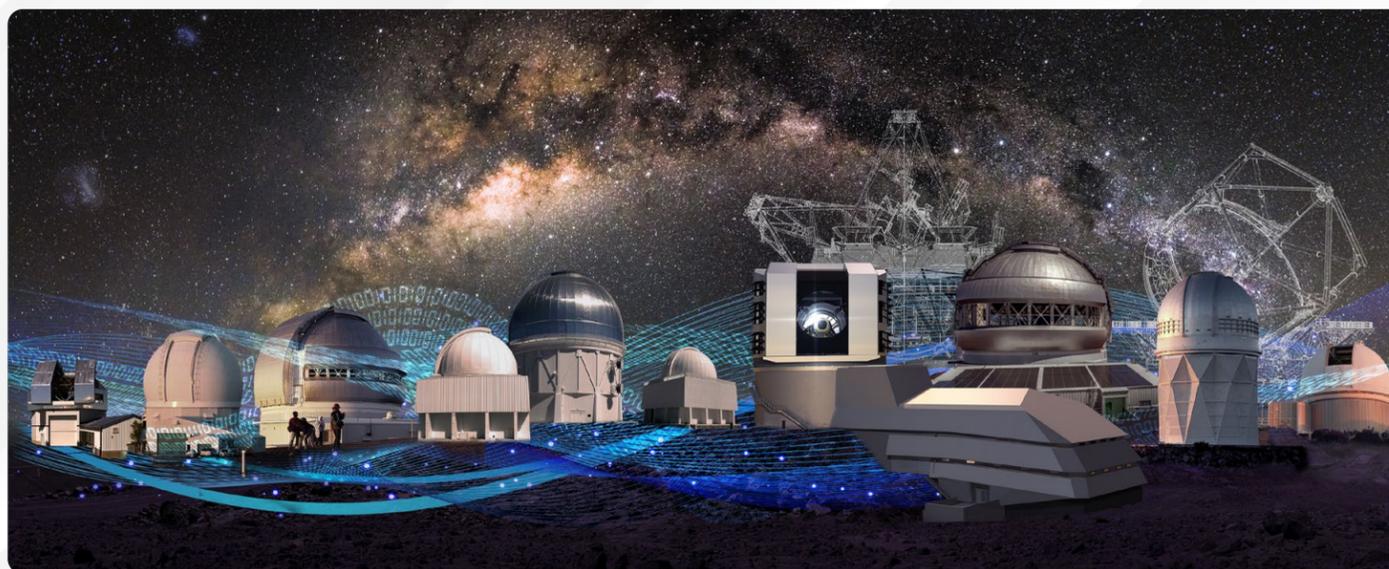
What is NOIRLab?

NSF's **NOIRLab** is the US national center for ground-based, nighttime optical astronomy. NOIRLab's mission is to enable breakthrough discoveries in astrophysics by developing and operating state-of-the-art ground-based observatories and providing data products and services for a diverse and inclusive community.

NOIRLab will be the US portal to the forthcoming US ELTs and will provide an extensive suite of user services, documentation, and training to support the entire research lifecycle from submission of proposals to observations to data analysis.

NOIRLab creates a powerful capability for discovery, technology development, STEM workforce growth and education. NOIRLab empowers astronomers to tackle the most pressing questions in astrophysics today and opens up new discovery space for the future, including dark energy and dark matter, galaxies and quasars, the Milky Way, exoplanets, and objects in our own Solar System.

NOIRLab is managed by the Association of Universities for Research in Astronomy (AURA) under a cooperative agreement with the National Science Foundation (NSF).



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FAST FACTS

For the first time, all of the nighttime optical observatories funded by the National Science Foundation are unified into a single organization — NOIRLab.

NOIRLab's Programs are the US-ELTP, international Gemini Observatory, Vera C. Rubin Observatory, Kitt Peak National Observatory, Cerro Tololo Inter-American Observatory, and the Community Science and Data Center.

NOIRLab hosts more than 70 of the most diverse and innovative ground-based telescopes in the world at three unique observing sites in Chile, Hawai'i, and Arizona, and is headquartered in Tucson, Arizona, USA.

NOIRLab opens up new frontiers through data science, powerful observatories that operate in harmony with their environments, and a diverse and talented staff that plays a leadership role in the astronomy of tomorrow.

We are privileged to conduct research on I'oligam Du'ag (Kitt Peak) in Arizona, on Maunakea in Hawai'i, and on Cerro Tololo and Cerro Pachón in Chile, and acknowledge the Tohono O'odham Nation, the Native Hawaiian communities, and the Indigenous communities in Chile, respectively, as original stewards of these lands.

MEDIA CONTACTS

For media inquiries, please contact the appropriate US-ELTP partner media representative.



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