NASA team lays plans to observe new worlds

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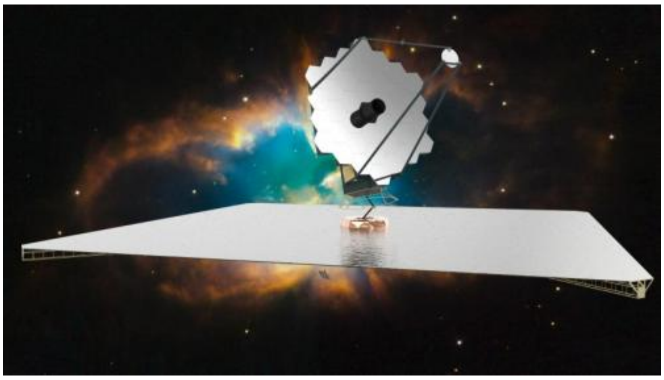


This artist's rendition shows a possible design of a potential successor to the Hubble Space Telescope. A NASA-led team of experts in now investigating the viability of this conceptual mission, called the Advanced Telescope Large-Aperture Space Telescope. Credit: NASA

It can take decades to mature an astrophysics flagship mission from concept to launch pad.

For example, the iconic Hubble Space Telescope—arguably the greatest telescope in history and certainly the most recognized—was proposed in the 1940s. Its development began in the 1970s and it launched in 1990. Similarly, the James Webb Space Telescope will launch in 2018, 23 years after work began on the concept. And if approved for development, the Wide-Field Infrared Space Telescope-Astrophysics Focused Telescope Assets (WFIRST-AFTA), currently in a study phase, could launch by the mid-2020s. Early versions of this mission were first proposed in the early 2000s.

Given the long lead times, it's time to lay plans for a future flagship mission, NASA scientists and engineers agree.

A team led by scientists and engineers at NASA's Goddard Space Flight Center in Greenbelt, Maryland, is now studying the scientific and technical requirements and costs associated with building a successor to Hubble and the Webb telescope. Dubbed the Advanced Technology Large-Aperture Space Telescope (ATLAST), this mission concept builds upon key technologies developed for Hubble and Webb.

"Conceptually, ATLAST would leverage the technological advances pioneered by the Webb telescope, such as deployable, large segmented-mirror arrays," said Mark Clampin, ATLAST study scientist and Webb's project scientist.

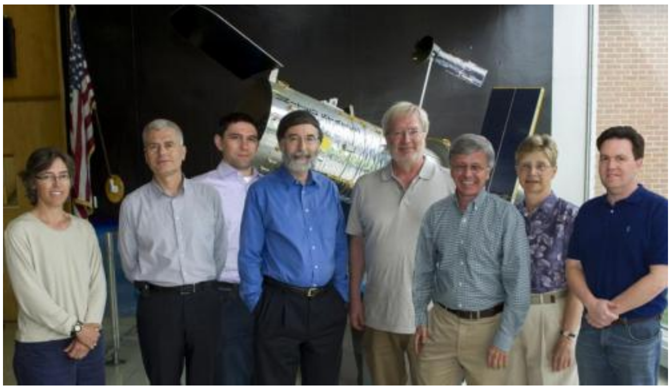
The study team also includes world-renowned experts in science and technology from the Space Telescope Science Institute in Baltimore, Maryland, the Jet Propulsion Laboratory in Pasadena, California, and the Marshall Space Flight Center in Huntsville, Alabama.

NASA already has identified an ATLAST-type mission in its recent 30-year vision for astrophysics, "Enduring Quests, Daring Visions." "While people expect Hubble and Webb to operate for many years, we are looking ahead to the telescope and instrument requirements needed to answer the questions posed in NASA's 30-year vision," said Harley Thronson, the Goddard senior scientist for Advanced Concepts in Astrophysics and ATLAST study scientist.

This investigation ultimately would guide design studies, science justifications, and technology plans that the National Research Council (NRC) then could use when developing its 2020 Decadal Survey for Astrophysics, which recommends priority research areas, observations, and priority missions for the subsequent decade. These surveys take advantage of significant input from the astronomical community and represent a consensus opinion of priorities NASA should pursue.

Different Science Objectives

The Webb telescope is often referred to as Hubble's scientific successor, though its science mission is different. Equipped with a 21-foot (6.5-meter) segmented primary mirror, this cold observatory will peer into the cosmos from its orbital outpost nearly 1-million miles (1.5-million kilometers) from Earth to study the birth and evolution of galaxies and the formation of stars and planets. Its suite of four instruments operates from long-wavelength visible to mid-infrared wavelength bands ideal for studying very distant objects in the universe or peering into dusty regions of our own galaxy where visible light is blocked.



A NASA team is studying conceptual successors to Hubble and the James Webb Space Telescope. Some of the team at NASA's Goddard Space Flight Center in Greenbelt, Maryland (from left): Julie Crooke, Mark Clampin, Avi Mandell, Norman Rioux, Harley Thronson, Carl Stahle, Kathy Hartman, Lee Feinberg. Credit: NASA's Goddard Space Flight Center/Bill Hrybyk

WFIRST-AFTA, which as currently envisioned would carry a nearly 8-foot (2.4-meter) mirror, will be equipped with an imager and a slitless spectrometer to study dark energy, the mysterious form of energy that permeates all of space and accelerates the expansion of the universe. It also could carry a coronagraph, which would allow it to image giant exoplanets and debris disks in other solar systems.

"One of the killer apps currently planned for ATLAST is the ability to detect signatures of life in the atmospheres of Earth-like planets in the solar neighborhood," Clampin said. While other observatories will image larger exoplanets, they would not have ATLAST's advanced ability to identify chemicals that may indicate the presence of life in these far-flung, Earth-size worlds.

ATLAST's large primary mirror would enable other scientific investigations, too. In addition to studying star and galaxy formation in detail, ATLAST would be able to resolve stars in galaxies more than 10 million light-years away and star-formation regions of sizes greater than 100 parsecs anywhere in the universe.

General-Purpose, Serviceable Telescope

To carry out these scientific investigations, ATLAST—envisioned as a long-lived space observatory, like Hubble—would study celestial objects in the ultraviolet, visible, and near-infrared wavelength bands.

"One of the pertinent attributes about ATLAST is that it's being designed to be modular and serviceable, following the Hubble Space Telescope model," observed Julie Crooke, one of the Goddard study leads. Mission planners would design the observatory so that it could be serviced to upgrade instrumentation—a potential capability that depends on available budget and science requirements. "Serviceability has been one of the great paradigms in mission architecture that separates the Hubble Space Telescope from all of the other space missions to date," Crooke said.

To achieve these ambitious goals, the observatory needs to be thermally and mechanically very stable, which can be achieved by operating in the Sun-Earth L2 orbit—the same orbit chosen for the Webb telescope—and be equipped with a coronagraph and/or occulting star shade to mask the parent star's light, which otherwise would swamp the faint light emitted by an Earth-like planet. But perhaps more important, it would have to carry a significantly larger primary mirror—one even larger than Webb's, which will be the largest segmented mirror ever flown by NASA.

For now, however, the team is studying the viability of a 33-foot (10-meter) glass or carbon-fiber segmented mirror, which would give the telescope a larger light-gathering surface, but still fit inside the fairing of an existing launch vehicle. Currently, the team is baselining the Delta-IV Heavy launch vehicle because it offers the largest mass-to-orbit capability.

"This gives seventeen times greater light-gathering capability than Hubble's mirror," added Carl Stahle, a Goddard engineer who is leading the team evaluating the technologies needed to pull off the ATLAST mission. The resulting technology plans would show the NRC that NASA has identified technology requirements and risks, which the agency is maturing now.

In addition to building a larger segmented primary mirror, which, like the Webb telescope's mirror, would fold up for launch and then deploy in space, mission planners would have to fine-tune techniques to align the mirror segments and assure stability. One of the big technical challenges for exoplanet imaging and spectroscopy is building a very stable observatory, Stahle said. ATLAST would require the wavefront error to be stable to 10 picometers for 10 minutes, a factor of 1,000 better than the Webb telescope's stability requirements.

Leveraging Technologies

"We will be leveraging a lot of heritage from the Webb telescope and then developing new technologies over the next few years for the primary-mirror assembly, wavefront sensing and control, and ultra-stable structures to achieve this wavefront error stability," Clampin said.

Stahle also said that while NASA has invested heavily in near-infrared detectors and mirror coatings, technologists must devote more resources to improve the sensitivity of ultraviolet (UV) detectors and the reflectivity of UV mirror coatings that would extend into the visible and near infrared.

The 2010 Astrophysics Decadal Survey recommended that NASA invest in UV technologies for a future large mission, and indeed, NASA's Cosmic Origins Office is making these investments, Clampin said. "With a sustained effort, ATLAST would have vastly more efficient UV instruments than prior observatories, giving it a high-definition view of the UV and visible universe."

"ATLAST would achieve critically important science goals not possible with ground-based observatories or with any other planned space missions," added Thronson. "Now is the time to plan for the future."

Provided by NASA's Goddard Space Flight Center

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