National Aeronautics and Space Administration
NASA
Goddard View
Volume 11 Issue 4
May 2015
HUBBLE SPACE TELESCOPE
NEWSEUM
www.nasa.gov

GoddardView

TRENDING

Washington Nationals Honor Hubble
The Washington Nationals baseball team paid tribute to NASA and the Hubble Space Telescope during their game against the St. Louis Cardinals on April 22. The evening featured a pregame introduction as well as a Hubble-themed mascot race.

Goddard Celebrates Earth Day
Employees from Goddard, NASA Headquarters and other NASA centers celebrated Earth Day with hyperwall presentations, demonstrations and hands-on activities during events at the National Mall and Union Station in Washington, D.C.

New Hubble Displays at Goddard
In celebration of the Hubble Space Telescope's 25th launch anniversary, new Hubble displays are now open for viewing in Buildings 3 and 8. The visitor center has also updated its Hubble display to include tools used during servicing missions.

Goddard Participates in Maryland Day 2015
Goddard presented its work to the public at this year's Maryland Day. Organized by the University of Maryland, College Park, the event invites attendees to learn about the school and its neighbors such as Goddard.

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On the cover: NASA unveils "Celestial Fireworks" as the official image for the Hubble Space Telescope's 25th anniversary during a press conference at the Newseum in Washington, D.C.

Photo credit: NASA/Aubrey Gemignani

NP-2015-5-285-GSFC

GoddardView Info

Goddard View is an official publication of NASA's Goddard Space Flight Center in Greenbelt, Maryland. Goddard View showcases people and achievements in the Goddard community that support the center's mission to explore, discover and understand our dynamic universe. Goddard View is published by the Goddard Office of Communications.

You may submit story ideas to the editor at darrell.d.delarosa@nasa.gov. All contributions are subject to editing and will be published as space allows.

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A QUARTER-CENTURY LATER, HUBBLE CONTINUES TO INSPIRE

After Galileo developed the first skyward-pointing telescope in the early 1600s, subsequent generations of astronomers would be able to see into the cosmos far beyond the limitations of the naked eye. His innovation would forever change our understanding of the universe and mankind's place within it.

In the following centuries, however, Earth's atmosphere proved frustrating for space explorers. Cloudy nights, the refraction of light and the absorption of some of the electromagnetic spectrum of light would limit the ability of telescopes to make detailed observations of celestial objects.

The idea of sending into space a telescope that could transcend the blurring effects of the atmosphere first surfaced in the 1920s. During the 1970s, NASA and its partners set out to build such a telescope that would travel in low Earth orbit and see more clearly than any of its predecessors, thus allowing it to explore the distant universe in more detail than had ever been possible.

In April 1990, the Hubble Space Telescope launched from NASA's Kennedy Space Center in Cape Canaveral, Florida, making the long-awaited dream a reality.

Twenty-five years later, Hubble has provided an array of images of distant stars and galaxies that have captivated and inspired the public. Scientists have used its data to find answers to some of the most compelling mysteries of astronomy.

Thanks to Hubble, we learned the speed at which the universe is expanding, and that this expansion is also accelerating. We have determined the age of the universe with greater accuracy than ever before. Scientists have greater insight into how planets are born. We now know that supermassive black holes likely exist in all galaxies.

Such achievements have made Hubble one of the most iconic symbols of space exploration.

In addition to countless scientific findings, one of Hubble's greatest accomplishments has been its longevity. Just weeks after the telescope's launch, a flawed mirror threatened to derail the entire mission. In 1993, the installation of corrective optics during the first servicing mission would remedy the problem and, within a month, Hubble began producing sharper images.

Four more servicing missions provided vital repairs, as well as upgrades, that gave Hubble new capabilities each mission, enabling it to continue making new observations and generating more breathtaking images. Thanks to successful servicing, Hubble is at its peak of scientific capability even now, and it is expected to continue high levels of scientific return for several years to come.

Today, even after a quarter of a century, teams of engineers continue to operate Hubble and ensure its health, safety and extraordinary scientific productivity.

The longer-than-expected duration of Hubble's mission is also a testament to the hard work, commitment and vision exhibited by the people at NASA's Goddard Space Flight Center. When the idea for Hubble was first conceived, the agency turned to Goddard for the development of scientific instruments and satellite operations. After launch and on-orbit verification, Goddard assumed responsibility for Hubble's ongoing operations and servicing missions as the telescope's lead ground control center.

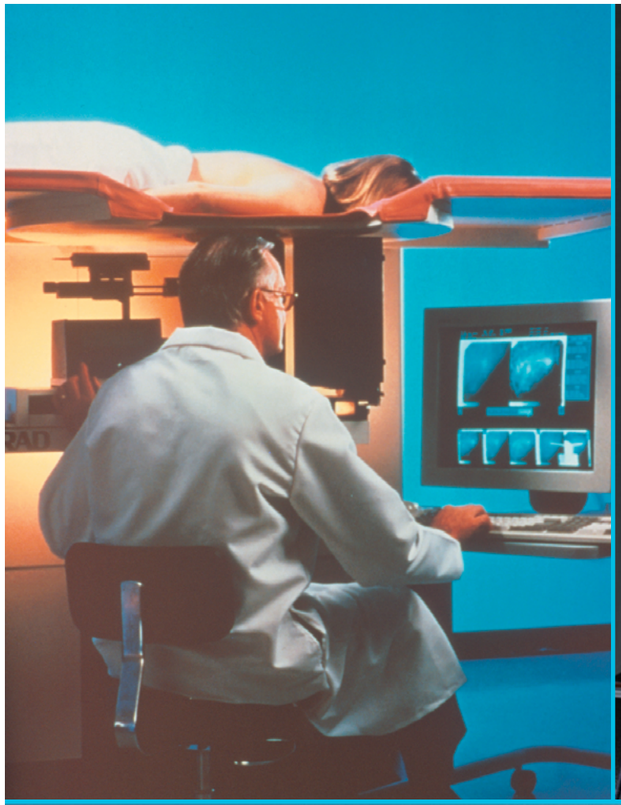
While we anticipate more Hubble discoveries in the coming years, we are also planning further into the future as we apply what we have learned from Hubble to design and build its successor – the James Webb Space Telescope.

The past 25 years are a reflection of Goddard at its best. We have demonstrated to the world not only what Hubble can do, but what the people behind it can achieve when we direct our diverse talents toward a common purpose.

As we look back on the telescope's success and move forward with promising new endeavors, Hubble's legacy to date reminds us of Goddard's continued responsibility to inspire the scientific community and the public around the limitless possibilities that exist in our universe. ■

-- Chris Scolese, Center Director

Photo credit: NASA/Goddard/Tabatha Luskey



HUBBLE TECHNOLOGY NOT JUST FOR THE STARS

By Samson Reiny

The Hubble Space Telescope has shed light on some of astronomy's big-ticket inquiries, from the age of the universe and the proliferation of exoplanets to the substantiation of dark energy. However, the ingenuity brought to bear in developing one of the most powerful telescopes ever has also benefited a wide swath of individuals and industries on Earth.

On-Cue System Makes Hospital Scheduling Easier

To make do with the limited power made available through the telescope's initial solar technology, Hubble needed scheduling software to manage competing tasks, which included switching on instruments and moving them into various positions as well as reorienting the telescope. In addition, certain operations could only be undertaken at specific times in order to avoid direct sunlight or to position the telescope at specific angles. NASA computer scientist Dan Rosenthal helped develop the necessary code and later co-founded Allocade Inc. The company uses the software as part of its On-Cue system, which helps hospitals efficiently schedule appointments and other tasks to save them time and money.

CCD Ideal for Digital Mammography

Goddard engineers developed a charge-coupled device, a silicon chip that converts light into digital images, for installation in Hubble's Space Telescope Imaging Spectrograph. The CCD's ability to deliver high-resolution imagery and capture varying degrees of brightness make it ideal for digital mammography. After developing the specialized chip for NASA, Scientific Imaging Technologies Inc. came up with the LORAD Stereo Guide Breast Biopsy System, ushering in a less invasive and more economical method for viewing and collecting breast tissue for analysis.

Tracking Animals With Modified Algorithm

The Hubble Ultra Deep Field provides a mind-blowing corollary on the immensity of the observable universe. It displays some 10,000 galaxies, each containing billions of stars, within a space that is one thirteen-millionth the universe's total area. In order to map the countless stars Hubble would find, Princeton University Professor of Physics Edward Groth devised an algorithm that compared and matched star configurations. The formula later found use in animal tracking. Australian nonprofit ECOCEAN applied a modified version of the algorithm to track and identify whale sharks by the white spots on their skin. Researchers at the University of Central Florida followed suit by monitoring polar bears, distinguishing each animal through its unique whisker spot pattern.

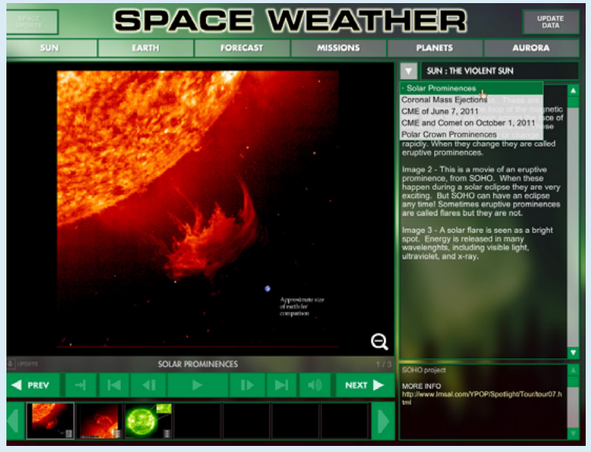
Portable Planetariums Used to Teach Science

By the mid-1990s, Hubble was gathering images that were helping scientists answer intriguing questions about the universe. Such information was largely inaccessible to the public at the time due to an inadequate infrastructure for distributing computer-based data to the masses. Through NASA partnerships and grants dating back to 1994, Rice University and the Houston Museum of Natural Science teamed up to develop the world's first Internet-accessible museum kiosk, followed by educational software such as Space Update, which features the latest Hubble imagery. In 1998, the two institutions created the world's first digital planetarium followed by the world's first portable digital planetarium. Museums Teaching Planet Earth Inc. distributes the domes while continuously expanding the program library. Titles range from a microscopic look inside the human body to a compendium of images of the faintest, farthest galaxies – captured by none other than Hubble. ■

For more information on Hubble and NASA spinoffs, visit spinoff.nasa.gov.

Opposite: A physician studies images produced by the LORAD Stereo Guide Breast Biopsy System (top left). A portable digital planetarium developed by Rice University and the Houston Museum of Natural Science (top right). A marine biologist tracks a whale shark using a device programmed with a modified Hubble algorithm (bottom). Photo credits: NASA/Goddard/Spinoff

Below: A screenshot of Space Weather, one of several software programs used in the world's first Internet-accessible museum kiosk. Photo credit: NASA/Goddard/Spinoff



GODDARD CELEBRATES THE BIRTHDAY OF AN OBSERVATORY

By Tashiana Osborne and Clare Skelly

NASA's Goddard Space Flight Center led the development of the Hubble Space Telescope's scientific instruments and is home to the telescope's operations control center. Ask almost any employee and they can tell you what role they played in the mission since the telescope launched on April 24, 1990.

Here are some ways Goddard celebrated one of NASA's most iconic missions.

Hubble Social

The celebration kicked into high gear with an all-day Hubble-themed NASA Social on April 23. More than 40 social media and media representatives attended the event. The day began at the Newseum in Washington, D.C., and included a tour of Goddard.

Along the way, participants met and spoke to NASA leaders involved in the planning, construction and servicing of Hubble, including scientists, engineers and astronauts who repaired the observatory in orbit.

"All things considered, I think it's fair to say that Hubble is one of the most influential and important scientific instruments and achievements ever devised," NASA Administrator Charles Bolden said at the Newseum press conference. "With two-and-a-half decades of historic trailblazing science already accomplished, we've come to realize and expect that there is still much more out there to discover."

During the event, Bolden and John Grunsfeld, NASA associate administrator for the science mission directorate, unveiled the official Hubble anniversary image. Described as celestial fireworks, the image shows a group of young stars flaring 20,000 light-years from Earth.

"Hubble has shown us where we've come from, told us where we're going, and it's not what we expected," Grunsfeld said. "The universe is expanding. We expected it to be slowing down, but in fact it's speeding up."

After the press conference, guests arrived at Goddard. The afternoon highlighted satellite testing and integration facilities where much of Hubble was built and tested, as well as the ongoing construction of Hubble's scientific successor, the James Webb Space Telescope. Visitors also saw the operations control center where technicians monitor the Hubble's operations from day to day.

Attendees also got to hold and take pictures of various tools used during servicing missions and pose for pictures with Goddard's replica model of Hubble.

The John Bahcall Lecture

Goddard and the Space Telescope Science Institute in Baltimore started the John Bahcall Lectureship series in 2006 to honor the late astrophysicist. Bahcall was a part of the Hubble mission since its inception in 1973 and was the principal investigator for many Hubble projects.

Robert Kirshner, science professor at Harvard University and author of The Extravagant Universe: Exploding Stars, Dark Energy and the Accelerating Cosmos, became the ninth lecturer in the series. He discussed Hubble and the extravagant universe at Goddard on April 24. "The Hubble Space Telescope made a decisive contribution to understanding the expansion of the universe," he said.

Kirshner and his team used Hubble telescope data to observe supernovae exploding billions of years back in time. They showed the universe is accelerating as it expands.

"It is important to do some science for the joy of finding out how the world works," Kirshner added.

Live Shots

To share and celebrate Hubble's anniversary with a broader audience, the Goddard Office of Communications developed a multimedia campaign – or live shot – in concert with network news programs.

Live Shot Producer Michelle Handleman organized satellite interviews with broadcasters and meteorologists from more than 30 television, radio and online news outlets worldwide.

NASA scientists Mark Clampin, Padi Boyd, Jane Rigby, Jennifer Wiseman and Kate Whitaker spoke one-on-one with news anchors and morning show hosts. Susana Deustua also interviewed in Spanish, and Rafael Eufrasio interviewed in Portuguese.

Interviewees emphasized Hubble's accomplishments involving mission operations, astronomy research and societal achievements.

"Hubble has told us that most galaxies have a black hole at the center. With the Hubble Ultra Deep Field we can see back until about 1 billion years before the big bang," said Clampin.

Broadcasters also asked about the future of space telescopes and the prospects of the Webb telescope in particular.

"We are designing and building a new telescope to do what Hubble can't do," said Rigby. "The goal with the Webb telescope is to see the first generation of stars and galaxies that formed after the big bang." ■

Above, left: NASA Social participants exit the Hubble Space Telescope Operations Control Center during their tour of Goddard's facilities. Photo credit: NASA/Goddard/Debora McCallum

Above, right: Robert Kirshner of Harvard University discusses Hubble and the expansion of the universe during this year's John Bahcall Lecture. Photo credit: NASA/Goddard/Tashiana Osborne

THE G-TEAM: BUILDING THE NEXT SPACE TELESCOPE

By Ashley Morrow

If the James Webb Space Telescope leadership team at NASA's Goddard Space Flight Center seems like a bunch of groupies for the Hubble Space Telescope, there's a reason.

The Webb telescope team at Goddard employs more than 300 people, and Optical Telescope Element Manager Lee Feinberg estimates a third of them previously worked on Hubble, including a number of individuals on Webb's leadership team.

Malcolm Niedner, Webb's deputy senior project scientist, technical, who was also a scientist for Hubble, keeps no less than three models of Hubble in his office. "I've gone from one A-team to another A-team, from one great project to another," he said.

It doesn't hurt that a lot of the Hubble team has already joined the new project, and it's not difficult to imagine why. Hubble is the most similar project to Webb that NASA has ever undertaken, according to Feinberg, who worked for 10 years on the optical correction and upgrade instruments for Hubble.

"Hubble engineers have relevant big space telescope experience," Feinberg said. "They've worked on things like this before."

In several ways, however, Hubble and Webb are different types of space telescopes in structure, size and functionality.

Webb, seven times the size of Hubble, must fold up to fit inside the Ariane 5 rocket that will launch it. Once Webb gets into space, it will undergo more than 180 critical steps in the unfolding process, according to Project Manager Bill Ochs. During its mission, Webb will remain perched more than 900,000 miles away from Earth, but it will not orbit the planet. By contrast, Hubble continues to orbit Earth from approximately 340 miles above. Webb will observe objects primarily in the infrared part of the electromagnetic spectrum, while Hubble's core capabilities are in the ultraviolet and visible parts of the spectrum.

Add to all this the need to keep Webb incredibly cold to measure infrared signals, along with the complexities associated with the optics and the instruments, and the challenge begins to take shape.

"This is the most challenging and exciting thing we have ever worked on," Niedner said. "I think if you talked to anyone on James Webb they would tell you that. Webb would not be capable of fulfilling the high scientific expectations held for it if it were an easy thing to do."

That's what drew Paul Geithner, deputy project manager, technical, to the project in 1997, not too long after working on Hubble's second servicing mission. "From wheels down on Servicing Mission 2, I moved on to James Webb," he recalled. "It was really attractive to be able to work on the next space telescope."

It's easy to get caught up in the idea of the Hubble "A-team" singlehandedly taking on Webb, but Integrated Science Instrument Module Systems Lead Ray Lundquist said the project attracted the best and brightest across the center.

"We're not the A-team," Lundquist said. "We're the G-team, for Goddard. Top to bottom, we have a really good team here."

All team members provide their own unique critical perspectives and creativity to solve Webb's ongoing challenges.

"If we were looking to create something just like Hubble, yeah, we might just want Hubble folks, but Webb poses its own new challenges," Feinberg added.

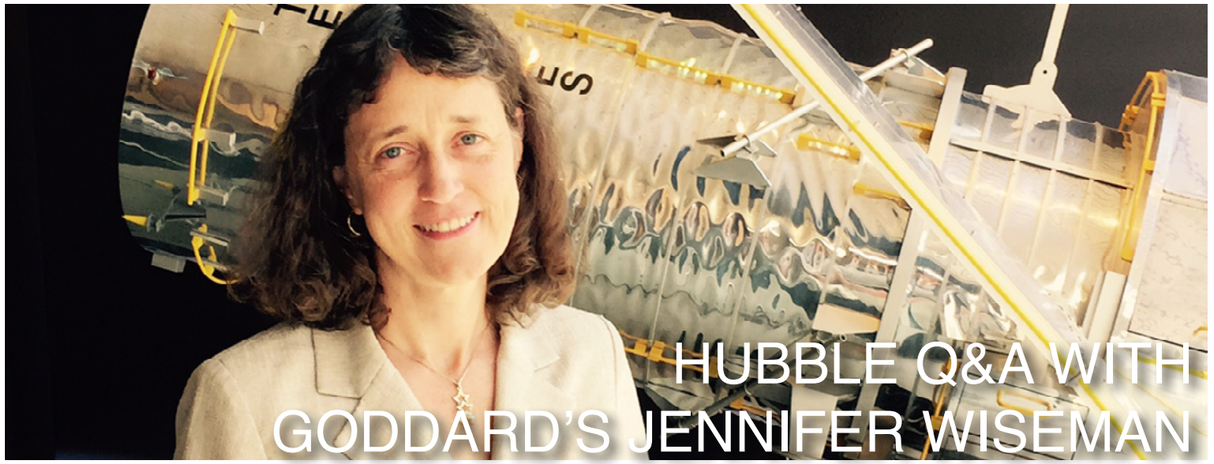
Webb's success relies on an integrated team of NASA, European Space Agency, Canadian Space Agency, industry and academic partners across the world. Members of today's Webb team worked on the Chandra X-ray Observatory, Spitzer Space Telescope, the Cosmic Background Explorer and other missions.

Despite some bumps in the road, the mission is on budget and on schedule for the anticipated launch from French Guiana in late 2018.

Ochs said he can't take credit for such an achievement or any others that will follow. "As nice as it would be for my ego, the progress we see is not because of one person," he said. "What makes this team a success is that we work well together, we communicate well and we solve problems together." ■

Above, left: James Webb Space Telescope team members (from left to right) Paul Geithner, Bill Ochs, Lee Feinberg and Ray Lundquist standing in front of the backplane for the telescope's pathfinder. Photo credit: NASA/Goddard/Chris Gunn

Above, right: Malcolm Niedner (center), deputy senior project scientist, technical, for the James Webb Space Telescope, greets a delegation from the Lake Chad Basin Commission during a tour of the telescope's observation deck. Photo credit: NASA/Goddard/Bill Hrybyk



HUBBLE Q&A WITH GODDARD'S JENNIFER WISEMAN

By Rob Gutro

Jennifer Wiseman is a Goddard astrophysicist and NASA's senior project scientist for the Hubble Space Telescope. She studies star-forming regions of our galaxy using radio, optical and infrared telescopes, with a particular interest in how infant stars develop in dense interstellar clouds. To commemorate Hubble's 25th anniversary, Wiseman answered some questions about the observatory.

Q: How is the Hubble Space Telescope significant after 25 years?

A: Hubble is still on the forefront of scientific discovery and exploration. Thanks to the repeated servicing of the telescope by astronauts over the years, and in particular the last servicing mission in 2009, the observatory is scientifically powerful, making new discoveries and scientific advances in everything from solar system dynamics to the large-scale structure of the universe. This is showing that partnerships between science and astronauts can achieve great advancements for science and human discovery.

Q: What are some of Hubble's biggest discoveries?

A: Some of the biggest Hubble discoveries include:

- the first definitive detection of supermassive black holes at the centers of galaxies,
- measurement of the expansion rate and age of the universe, and even the recent detection, working along with premiere ground-based telescopes, of acceleration in expansion, caused by mysterious "dark energy" that appears to be pushing the universe apart; and
- measurements of the chemical composition of the atmospheres of planets (i.e., exoplanets) circling other stars.

Q: What will history say about Hubble?

A: Hubble will go down in history as having changed the textbooks by totally revolutionizing humanity's view of the universe and our place in it.

Thanks to its orbit in space above Earth's atmosphere, Hubble has been able to get beautifully sharp images and precise scientific data revealing a universe full of activity. It has shown us that galaxies in the universe have changed over the billions of years of cosmic time, producing stars that over time produce heavy elements needed for planets and life. It has also shown us exquisite beauty in the universe, in everything from galaxies to glowing nebulae to planetary atmospheres in our own solar system.

Q: What does the future hold for Hubble?

A: The last servicing mission in 2009 was very successful, thankfully. As a result, Hubble has a suite of several powerful scientific instruments and is more scientifically productive than ever. Hubble is expected to continue to provide valuable data until at least 2020 or years beyond, and NASA scientists are exploring options for the best scientific use of Hubble in its remaining years ahead. Hubble will stay in orbit for a long time. However, in some future decade, NASA will put it out of commission, either boosting it to a storage orbit at a higher altitude or gently guiding it into the ocean safely, but that won't be until at least the 2030s, long after Hubble has finished producing science.

Q: Can Hubble be repaired?

A: Right now, the Hubble is operating beautifully. In the future, we don't have any capability to send astronauts since we don't have the shuttle program in place. So we are using the telescope to the fullest extent and hope that the telescope will operate at least until 2020 and probably many years beyond that. ■

Above: Goddard astrophysicist Jennifer Wiseman poses next to a model of the Hubble Space Telescope. She currently serves as NASA'S senior project scientist for Hubble.

Photo credit: NASA/Goddard/Ed Campion

WASHINGTON AIRPORTS PUT HUBBLE ACCOMPLISHMENTS ON DISPLAY

By Clare Skelly

Crowds surround baggage claim areas and wait for the loud noise that signals the arrival of checked luggage. People stretch and eyes wander. This summer, travelers at Washington, D.C., area airports will also see Hubble Space Telescope displays while their bags hit the carousels or, in the case of one airport, as they wait to board their flights.

Exhibits at Washington Dulles International Airport, Ronald Reagan Washington National Airport and Baltimore Washington International Thurgood Marshall Airport celebrate the telescope's 25 years of cosmic discovery.

The Space Telescope Science Institute in Baltimore, responsible for operating the science program for Hubble, proposed the airport displays as a way to share the science and inspiration of the iconic mission. "As we prepared for Hubble's anniversary, we looked for new venues that would catch a wide swath of the public and engage people who might otherwise never hear about astronomy," said Bonnie Meinke, content specialist in the STScI Office of Public Outreach.

Each airport exhibit is unique.

A large image of dark gas clouds of the Carina Nebula stands atop a baggage claim area at Dulles. The nearby floor exhibit includes images and information about star formation and death. Other displays give information about the critical role of Hubble's five servicing missions in which astronauts visited Hubble to repair instruments and ensure the telescope's functionality.

Reagan National's baggage claim area features 36 panels of Hubble imagery, information and Hubble-inspired student artwork. This June, STScI will install a Hubble exhibit in the airport's Gallery Walk, a section of concourse hallways specifically designed for exhibits. The Gallery Walk will display more Hubble images and cultural items such as the rock band Pearl Jam's "Binaural" album cover, which features Hubble's image of the Hourglass Nebula.

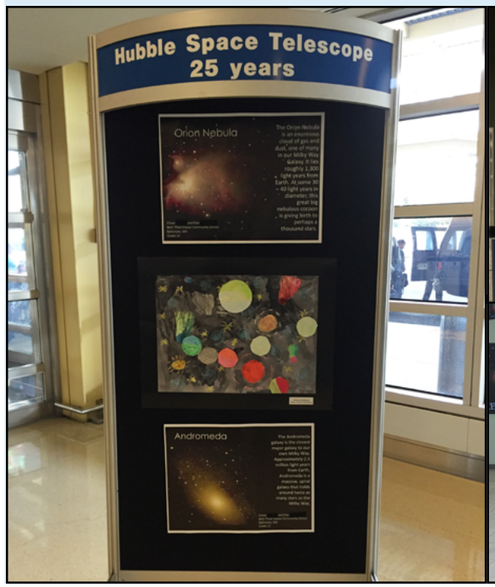
The Baltimore exhibit focuses on Maryland's contributions to astronomy. The wall mural, located in Terminal D, juxtaposes Hubble's 25 years of discovery with the future of space exploration and Hubble's successor – the James Webb Space Telescope.

"Outreach like this is important as more often than not the general public thinks NASA missions are only related to manned spaceflight," said Goddard's Deputy Center Director George Morrow, who encouraged STScI to bring an exhibit to the Baltimore airport. "They are essential to facilitate broad knowledge and increase support for NASA's science and exploration mission."

Each individual exhibit will remain on display until the beginning of July or later. ■

Below: Hubble exhibits on display at (clockwise from left) Ronald Reagan Washington National Airport, Washington Dulles International Airport and Baltimore Washington International Thurgood Marshall Airport.

Photo credits: Space Telescope Science Institute



NASA Goddard Opens Its Doors

National Aeronautics and Space Administration

SAVE THE DATE!

Saturday, Sept. 26, 2015

Goddard welcomes the public for a free open house event for all ages on Saturday, Sept. 26, 2015, from 11 a.m. to 5 p.m. We invite you to visit our center in Greenbelt, Maryland, for a day of activities, tours and hands-on demonstrations that are both fun and educational. Explore@NASAGoddard will engage visitors in Goddard's work in Earth science, heliophysics, planetary science, astrophysics, and engineering and technology.

In celebration of the Hubble Space Telescope's 25th anniversary, this year's theme will be **"Celebrating Hubble and the Spirit of Exploration."**

Bring your family and friends and come learn about the extraordinary work we are doing to better understand our dynamic universe. For more information, please visit www.nasa.gov/explorenasagoddard.

#ExploreGoddard

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