National Aeronautics and Space Administration

Goddard View

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Month 2012

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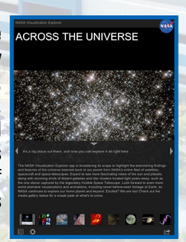
GoddardView

THE WEEKLY

See the Moon's evolution and take a tour
In honor of 1,000 days in orbit. The *Lunar Reconnaissance Orbiter* (LRO) team at Goddard has released two new videos. One video takes viewers through the Moon's evolutionary history. Another video gives viewers a guided tour of prominent locations on the Moon's surface.

NASA Viz App Will Take Users Across the Universe
The NASA Visualization Explorer is now delivering new opportunities to explore NASA's research of the Sun, planetary bodies, Earth and the universe to your iPad. The NASA Visualization Explorer app has broadened its scope to include more awe-inspiring discoveries beamed back to Earth from the agency's entire fleet of satellites, spacecraft, and space telescopes



Goddard Astrophysicist Amber Straughn on JWST
Straughn spoke on March 21 at the Library of Congress. The illustrated lecture, the second in a series of programs in 2012, is presented through a collaboration between the Library's Science, Technology, and Business Division and NASA Goddard. The lecture series is in its sixth year.

NASA's STEREO Mission Wins Public Accolades for 2011 Triumph
NASA asked the world to vote on their biggest accomplishment of 2011... and the results are in. With 492 votes, the winner is "Twin Solar Spacecraft Take First Complete Image of Far Side of Sun" referring to an image captured by NASA's two *Solar Terrestrial Relations Observatory* (STEREO) spacecraft. The STEREO satellites are currently in orbit around the Sun and separated such that each has a view of the opposite sides of our closest star. Together, the two observatories captured the first simultaneous images of the entire Sun in June of 2011.

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Cover caption: Goddard Deputy Director Christyl Johnson stands with Nichelle Nichols.

Photo Credit: NASA/Goddard/Bill Hrybyk

GoddardView **Info**

Goddard View is an official publication of NASA's Goddard Space Flight Center. *Goddard View* showcases people and achievements in the Goddard community that support Goddard's mission to explore, discover, and understand our dynamic universe. *Goddard View* is published weekly by the Office of Communications. Archived issues are available at:
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News items for publication in *Goddard View* must be received by noon Wednesday of each week. You may submit contributions to the editor via e-mail at john.m.putman@nasa.gov. Ideas for new stories are welcome but will be published as space allows. All submissions are subject to editing.

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NICHELLE NICHOLS TREKS TO GODDARD

By: Robert Garner

Nichelle Nichols, best known for her role as *Star Trek*'s Lt. Uhura, keynoted Goddard's 2012 Martin Luther King, Jr., and African-American History Month commemorative presentation on February 29.

As part of the U.S.S. Enterprise's racially- and culturally-diverse crew in the 23rd century, Lt. Uhura explored the galaxy and famously went where no one had gone before.

Back in the 20th century, when *Star Trek* first aired in the 1960s, there were no multiracial spaceship crews: "Nichelle Nichols was living out future equality a generation before the first African-American astronauts," said Dr. Christyl Johnson, Goddard's Deputy Director for Science and Technology.

Johnson introduced Nichols to a packed auditorium. The crowd erupted in applause as Nichols entered singing the opening melody of the original *Star Trek* title theme. (Nichols' performing career began singing with renowned jazz musician Duke Ellington.)

Nichols played the Enterprise's communications officer over a 25-year span, beginning with the original TV series run in 1966, and culminating with *Star Trek*'s sixth feature film in 1991.

It was a portrayal that nearly ended just as it began. "I grew up planning to be a great star in theater," Nichols said. As the show's first season wrapped up, she went to *Star Trek* creator Gene Roddenberry to tell him she planned to quit "to pursue my first love."

Roddenberry pleaded with her to stay and to take the weekend to think it over. That Saturday, Nichols attended an NAACP fundraiser. One of the event promoters asked her if she would meet with a fan.

"I stood up and turned around, and looked into the beautiful face of Dr. Martin Luther King—my leader!" Nichols said. They discussed the cultural significance of Nichols's role and her intent to depart television for the stage. She reflected on King's response: "You cannot leave; you cannot abdicate," he told her. "You don't know what you mean to us. Every night that you're on, we can look on and see what we're fighting for."

On Monday, Nichols shared the experience with Roddenberry and said she would stay with *Star Trek*. "He said, 'God bless Dr. Martin Luther King. Somebody knows what I'm trying to achieve,'" Nichols said. "Bless Dr. King for bringing me to my senses."

"I stayed and never looked back," she said. "I'm glad I did." Her continued role on *Star Trek* eventually served to help bring the diversity of the Enterprise to the diversity of NASA's astronaut corps.

"I'd always been proud of our feats in space," Nichols said. "But something always bothered me: Where are the women? Where are the people of color?" She began discussing her concerns at *Star Trek* conventions.

A speech Nichols gave on the subject caught the ear of NASA officials, who enlisted her help to recruit the first women and minority astronauts for the Space Shuttle Program in the late 1970s.

Nichols's role as one of television's first black characters to be more than just a stereotype and one of the first women in a position of authority inspired thousands of applications tions from women and minorities.

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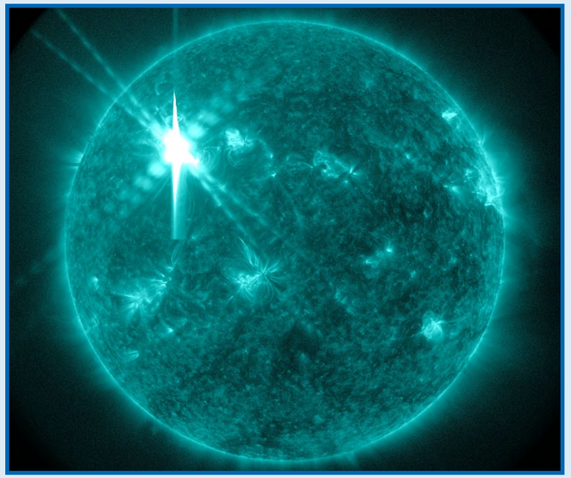
"It triggered a temporary radio blackout of the sunlit side of Earth..."



SECOND BIGGEST FLARE OF THE SOLAR CYCLE

By: Karen C. Fox

The Sun erupted with one of the largest solar flares of this solar cycle on March 6, 2012. This flare was categorized as an X5.4, making it the second largest flare—after an X6.9 on August 9, 2011—since the Sun's activity segued into a period of relatively low activity called solar minimum in early 2007. The current increase in the number of X-class flares is part of the Sun's normal 11-year solar cycle, during which activity on the Sun ramps up to solar maximum, which is expected to peak in late 2013.

About an hour later on March 6, the same region let loose an X1.3 class flare. An X1 is 5 times smaller than an X5 flare.

These X-class flares erupted from an active region named AR 1429 that rotated into view on March 2. Prior to this, the region had already produced numerous M-class and one X-class flare. The region continues to rotate across the front of the Sun, so the March 6 flare was more Earthward facing than the previous ones. It triggered a temporary radio blackout on the sunlit side of Earth that interfered with radio navigation and short wave radio.

In association with these flares, the Sun also expelled two significant coronal mass ejections (CMEs), which are travelling faster than 600 miles a second and may arrive at Earth in the next few days. In the meantime, the CME associated with the X-class flare from March 4 has dumped solar particles and magnetic fields into Earth's atmosphere and distorted Earth's magnetic fields, causing a moderate geomagnetic storm, rated a G2 on a scale from G1 to G5.

Such storms happen when the magnetic fields around Earth rapidly change strength and shape. A moderate storm usually causes aurora and may interfere with high frequency radio transmission near the poles. This storm is already dwindling, but the Earth may experience another enhancement if the most recent CMEs are directed toward and impact Earth.

In addition, last night's flares have sent solar particles into Earth's atmosphere, producing a moderate solar energetic particle event, also called a solar radiation storm. These particles have been detected by NASA's *Solar and Heliospheric Observatory* (SOHO) and *Solar TErrestrial RElations Observatory* (STEREO) spacecraft, and NOAA's *Geostationary Operational Environmental Satellite* (GOES) spacecraft. At the time of writing, this storm is rated an S3 on a scale that goes up to S5. Such storms can interfere with high frequency radio communication.

Besides the August 2011 X-class flare, the last time the Sun sent out flares of this magnitude was in 2006. There was an X6.5 on December 6, 2006 and an X9.0 on December 5, 2006. Like the most recent events, those two flares erupted from the same region on the Sun, which is a common occurrence. ■

Above: The March 6 flare is shown in the 131 Angstrom wavelength, a wavelength that is particularly good for watching flares. Credit: NASA/SDO/AIA

Opposite page: The March 6, 2012 X5.4 flare was captured by the *Solar Dynamics Observatory* (SDO) in the 171 Angstrom wavelength, which is typically colored in gold. Credit: NASA/SDO/AIA

RATTLING JET STREAM ON JUPITER

By: Elizabeth Zubritsky

New movies of Jupiter are the first to catch an invisible wave shaking up one of the giant planet's jet streams, an interaction that also takes place in Earth's atmosphere and influences the weather. The movies, made from images taken by NASA's *Cassini* spacecraft when it flew by Jupiter in 2000, are part of an in-depth study conducted by a team of scientists and amateur astronomers led by Amy Simon-Miller at Goddard and published in the April 2012 issue of *Icarus*.

"This is the first time anyone has actually seen direct wave motion in one of Jupiter's jet streams," says Simon-Miller, the paper's lead author. "And by comparing this type of interaction in Earth's atmosphere to what happens on a planet as radically different as Jupiter, we can learn a lot about both planets."

Like Earth, Jupiter has several fast-moving jet streams that circle the globe. Earth's strongest and best known jet streams are those near the north and south poles; as these winds blow west to east, they take the scenic route, wandering north and south. What sets these jet streams on their meandering paths—and sometimes makes them blast Florida and other warm places with frigid air—are their encounters with slow-moving waves in Earth's atmosphere, called Rossby waves.

In contrast, Jupiter's jet streams "have always appeared to be straight and narrow," says co-author John Rogers, who is the Jupiter Section Director of the British Astronomical Association, London, U.K., and one of the amateur astronomers involved in this study.

Rossby waves were identified on Jupiter about 20 years ago, in the northern hemisphere. Even so, the expected meandering winds could not be traced directly, and no evidence of them had been found in the southern hemisphere, which puzzled planetary scientists.

To get a more complete view, the team analyzed images taken by NASA's *Voyager* spacecraft, NASA's *Hubble Space Telescope*, and *Cassini*, as well as a decade's worth of observations made by amateur astronomers and compiled by the JUPOS project.

The movies zoom in on a single jet stream in Jupiter's southern hemisphere. A line of small, dark, V-shaped chevrons has formed along one edge of the jet stream and zips along west to east with the wind. Later, the well-ordered line starts to ripple, with each chevron moving up and down (north and south) in turn. And for the first time, it's clear that Jupiter's jet streams, like Earth's, wander off course.

"That's the signature of the Rossby wave," says David Choi, the postdoctoral fellow at Goddard who strung together about a hundred *Cassini* images to make each time-lapse movie. "The chevrons in the fast-moving jet stream interact with the slower-moving Rossby wave, and that's when we see the chevrons oscillate."

The team's analysis also reveals that the chevrons are tied to a different type of wave in Jupiter's atmosphere, called a gravity inertia wave. Earth also has gravity inertia waves, and under proper conditions, these can be seen in repeating cloud patterns.

"A planet's atmosphere is a lot like the string of an instrument," says co-author Michael D. Allison of the Goddard Institute for Space Studies in New York. "If you pluck the string, it can resonate at different frequencies, which we hear as different notes. In the same way, an atmosphere can resonate with different modes, which is why we find different kinds of waves."

> "...the first time anyone has seen direct wave motion in one of Jupiter's jet streams"

Characterizing these waves should offer important clues to the layering of the deep atmosphere of Jupiter, which has so far been inaccessible to remote sensing, Allison adds.

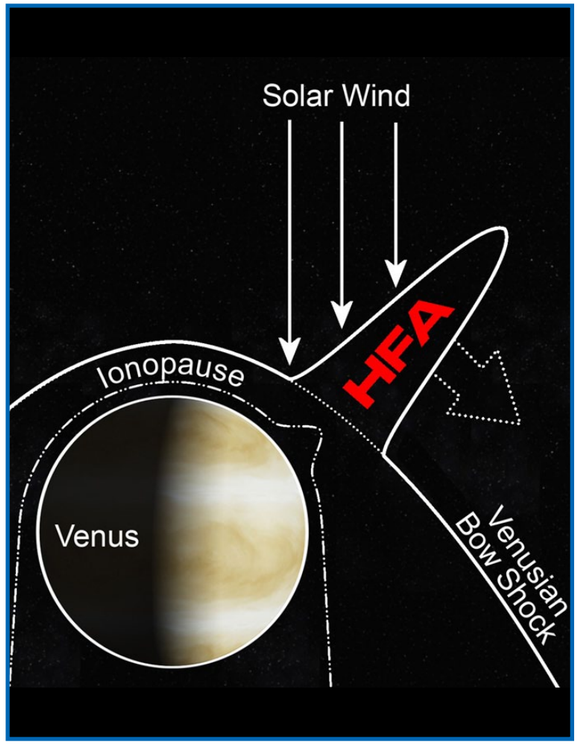
Crucial to the study was the complementary information that the team was able to retrieve from the detailed spacecraft images and the more complete visual record provided by amateur astronomers. For example, the high resolution of the spacecraft images made it possible to establish the top speed of the jet stream's wind, and then the amateur astronomers involved in the study looked through the ground-based images to find variations in the wind speed.

The team also relied on images that amateur astronomers had been gathering of a large, transient storm called the South Equatorial Disturbance. This visual record dates back to 1999, when members of the community spotted the most recent recurrence of the storm just south of Jupiter's equator. Analysis of these images revealed the dynamics of this storm and its impact on the chevrons. The team now thinks this storm, together with the Great Red Spot, accounts for many of the differences noted between the jet streams and Rossby waves on the two sides of Jupiter's equator.

"We are just starting to investigate the long-term behavior of this alien atmosphere," says co-author Gianluigi Adamoli, an amateur astronomer in Italy. "Understanding the emerging analogies between Earth and Jupiter, as well as the obviously profound differences, helps us learn fundamentally what an atmosphere is and how it can behave."

The *Cassini-Huygens* mission is a cooperative project of NASA, the European Space Agency, and the Italian Space Agency. NASA's Jet Propulsion Laboratory, Pasadena, Calif., manages the mission for NASA's Science Mission Directorate, Washington, D.C. ■

Above: Following the path of one of Jupiter's jet streams, a line of V-shaped chevrons travels west to east just above Jupiter's Great Red Spot. Most of the planet is unfolded here in a single, flat map made on December 11 and 12, 2000, when NASA's *Cassini* spacecraft flew past Jupiter. NASA/JPL/Space Science Institute



In the grand scheme of the solar system, Venus and Earth are almost the same distance from the Sun. Yet the planets differ dramatically: Venus is some 100 times hotter than Earth and its days more than 200 times longer. The atmosphere on Venus is so thick that the longest any spacecraft has survived on its surface before being crushed is a little over two hours. There's another difference, too. Earth has a magnetic field and Venus does not—a crucial distinction when assessing the effects of the Sun on each planet.

As the solar wind rushes outward from the Sun at nearly a million miles per hour, it is stopped about 44,000 miles away from Earth when it collides with the giant magnetic envelope called the magnetosphere that surrounds the planet. Most of the solar wind flows around the magnetosphere, but in certain circumstances it can enter the magnetosphere to create a variety of dynamic space weather effects on Earth. Venus has no such protective shield, but it is still an immovable rock surrounded by an atmosphere that disrupts and interacts with the solar wind, causing interesting space weather effects.

A recent study, appearing online in the *Journal of Geophysical Research* on February 29, 2012, has found clear evidence on Venus for a type of space weather outburst quite common at Earth, called a hot flow anomaly or HFA.

"They are an amazing phenomenon," says David Sibeck, a scientist at Goddard who studies HFAs at Earth and is a co-author on the paper. "Hot flow anomalies release so much energy that the solar wind is deflected and can even move back toward the Sun. That's a lot of energy when you consider that the solar wind is supersonic—traveling faster than the speed of sound—and the HFA is strong enough to make it turn around."

Observing an HFA on Venus will help scientists tease out how space weather is similar and different at this planet so foreign to our own. With no magnetic field to interact with, space weather at Venus is milder than that at Earth, but occurs much closer to the surface.

"At Venus, since there's no protective magnetic field, the explosion happens right above the surface of the planet," says Goddard scientist Glyn Collinson who is the first author on the new paper.

For evidence of an HFA on Venus, Collinson turned to a European Space Agency spacecraft called *Venus Express*. He looked for a pattern of magnetic change that would indicate the spacecraft traveled through one of these gigantic explosions. He searched for this signature through a few days worth of data.

"That may not sound like much," he says. "But a day on Venus is 243 Earth days."

His work paid off. He found evidence that a Venusian hot flow anomaly did indeed take place on March 22, 2008.

Understanding what the HFAs do in the non-magnetized Venusian environment, of course, would require direct observations that the current data sets from *Venus Express* do not provide. However, Collinson and his colleagues have made some educated guesses, by taking the *Venus Express* data and comparing it to the known physics at Earth.

The bow shock on Venus serves as the boundary between the incoming solar wind, and the planet's own ionosphere—a layer of atmosphere filled with charged particles. This boundary changes in height easily in response to the environment, and so the scientists believe it would also respond strongly in the presence of an HFA. Since the HFA causes material to flow sunward, away from the planet, it may operate almost like a vacuum cleaner, pulling that bow shock further away from Venus. The size of the ionosphere would swell in concert.

That HFAs can occur on a planet without a magnetic field suggests that they may well happen on planets throughout the solar system, and indeed in other solar systems as well. ■

Image: When discontinuities in the solar wind remain in contact with a planet's bow shock, they can collect a pool of hot particles that becomes a hot flow anomaly. Credit: NASA/Goddard/Collinson

EXPLOSIONS ON VENUS

By: Karen C. Fox

NICHELLE NICHOLS

Continued from Page 3.

Among them: Ronald McNair, Frederick Gregory, Judith Resnick, Sally Ride, and NASA Administrator Charlie Bolden.

Former NASA astronaut Mae Jemison often cited her *Star Trek* fandom, and Nichols's performance in the program, as having inspired her interest in space. As a mission specialist on the STS-47 flight of space shuttle *Endeavour* in 1992, Jemison became the first African-American woman in space. Coincidentally, Jemison appeared in an episode of *Star Trek: The Next Generation* in 1993.

"Now more than ever, we're exploring space beyond the 'beyond,'" Nichols said. "I wish I could live forever so I could live to see it, because we're on our way to the 23rd century that Gene Roddenberry gave us. All our posterity will benefit from the growth of NASA."

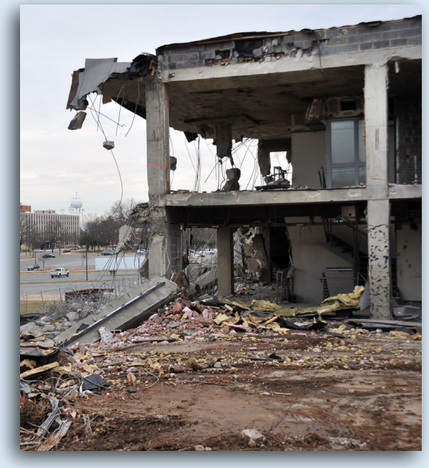
The commemoration also featured Eleanor Roosevelt High School's color guard, and musical performances from Suitland High School and the Children of the Gospel Choir. Other event speakers included Crystal Moten, Deputy Chief of the Center's Equal Opportunity Programs Office, and Kristen Soper from the office of Sen. Barbara Mikulski.

The 2012 event was sponsored by the Equal Opportunity Programs Office in partnership with the African-American Advisory Committee, and the Center-wide Planning Committee. ■

Pictures by Bill Hrybyk. Pat Izzo, and Debora McCallum

BUILDING 2 DECONSTRUCTION CONTINUES

By: Rob Gutro



By March 1, Building 2 was no longer standing on Goddard's Greenbelt campus. One of Goddard's oldest buildings had been deconstructed and all that remained was cement rubble. Rubble removal has been going on since mid-February to clear the land for the next step.

Instead of being demolished, Building 2 was brought down in a more environmentally friendly manner—it was "deconstructed." Tim McCain, Branch Head of Engineering in the Goddard Facilities Management Division (Code 224), said, "Deconstruction is a process of more systematically dismantling a structure, separating the materials, then recycling as much as possible as opposed to sending everything to landfills."

By February 16, the Building 2 structure was down and the contractor was breaking up ground level concrete and foundations and continuing the process of separating materials for recycling. The contractor will be continuing the activities and continue hauling materials from the site.

After the removal of materials, the area will then be filled, graded, and will topped off with soil and seeding. "The plan is to have grass growing on the finished site by around the end of April," McCain said. ■

Photos by Debora McCallum

OUTSIDE GODDARD

Mindy Thomas

By: Elizabeth M. Jarrell

Goddard Web applications developer Mindy Thomas is also a Women's National Duckpin Bowling Congress (NDBC) National Champion. Duckpin bowling differs from tenpin bowling in that the balls are smaller, three balls are used instead of two, and the pins are shorter. The game was developed in Baltimore, Md.

At the age of eight, Thomas and her brother began duckpin bowling at the local Boys & Girls Club. Says Thomas, "The league itself was not competitive, although I still wanted to beat everyone." In her early teens, she started entering state tournaments for kids divided by age division. "When I was thirteen, my brother won the Boys' State Invitational Tournament and I won the Girls' State Invitational Tournament. It felt awesome to win against all the other older girls. My mother was ecstatic." They each won a two-foot trophy. She later won $500 scholarship for college in a national youth team tournament. "I won a few other state invitationals, but the first one was the best one for me since I was so young."

Thomas moved into the adult leagues early because she wanted more competition. Today she is in two leagues so she bowls two nights a week, which she uses for practice. In 2004, she joined the Pro Tour of the Women's National Duckpin Association (WNDA) and became the 2004 Rookie of the Year.

Thomas' first major win in a women's national tournament, the Ladies' All-Star Classic, was in March 2008. Participants are invited based on their averages. The first day, they bowl eight games as qualifiers. Only the top 24 bowlers advance to the next day and are put into one of four Divisions. Explains Thomas, "Six people are in each of four Divisions. You bowl five games on Sunday and bowl each person in your Division once. Then the top person in each Division gets put on the ladder which is called 'making the ladder.' Your position on the ladder is determined by your win-loss record for those five games. If there is a tie, the total pin fall determines the winner."

Thomas was first on the ladder in her Division so she had to beat one more person to win. After winning, says Thomas, "I honestly couldn't believe it! My mother had had a nervous headache all day. She gets nervous headaches when I make the ladder. She was so relieved and so proud that her headache went away." She won $2,000 and an 18k gold star pin designed by the jeweler who reset the Hope Diamond for the Smithsonian Museum of National History.

Two months later, in May 2008, she won her first Pro Tour. Explains Thomas, "For every Pro Tour you win, you get a star that you put on your shirt. So I got my first star; a plaque; and $3,000."

Thomas was ranked "Number One Woman Nationally" for the 2008- 2009 season by the National Duckpin Bowling Congress. "I was surprised that I won," says Thomas, who received a "big trophy."

Thomas acknowledges that "duckpins is a head game. There are just so many variables. If I'm doing well, I try to do the same silly little superstitious things between frames such as where I sit. Sometimes I'll sing a song in my head, probably the last song I heard on the radio. A lot of people say, 'Don't think, just throw the ball.'" As for her long term goal, Thomas says, "I'd like to end up in the WNDA Hall of Fame." ■