COMING EVENTS
AAL Meeting
Baker Wetlands Discovery Center
SUNDAY, OCT 30, 7:00 PM
10000!
Gary Hug
PUBLIC OBSERVING
8:30 PM
President
Rick Heschmeyer
rcjbm@sbcglobal.net
ALCOR
William Winkler
billwink10@yahoo.com
University Advisor
Dr. Bruce Twarog
btwarog@ku.edu

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What’s the Sunspot Number?
By Bill Pellerinm Houston Astronomical Society

**Object:** The Sun  
**Class:** Star  
**Magnitude:** -26.74

**Size/Spectral:** Diameter = 109 x Earth diameter; G2V

**Distance:** 93 million miles

**Optics needed:** See links below for observing information

You might be surprised to find out that the ‘Sunspot number’ for any given day is not simply a count of the number of visible sunspots. As with many things in science, it’s not that simple. The sunspot number is calculated using the simple equation:

\[ R = (10^G + S)K \]

Where:
- \( R \) = the sunspot number
- \( G \) = the number of sunspot groups observed
- \( S \) = the count of all sunspots in all groups
- \( K \) = a scaling number to compensate for variables (see text).

So, in the end, to calculate the sunspot number you’d count the number of sunspot groups and multiply that number by 10. You then add the result to the number of individual sunspots in all groups, and finally multiply that result by \( K \).
Among the events/activities discussed at the Sept. meeting were:

a) Observing the Supermoon — Nov. 14 on the top floor of the Lawrence Public Library parking lot. LPL will be running an open, online course about the History of Human Spaceflight from Oct. 10th through Nov. 14th. During the course, students will be learning about the topic through writings, documentaries, films, speakers and more. The plan is to finish the class with a viewing party on the 14th, which is also the night of the Supermoon. AAL will set up and staff the telescopes. Since the primary function is to focus on the moon, this will not require extensive experience with using a telescope but should provide a great opportunity to interact with the public. If you can help in any way, please contact Rick.

b) In the past, we annually ran an evening session for scouts. With a change in administration within the local scouting community, that was dropped. It was suggested and approved that the club would reorganize an event aimed at school age children, with specific invitations to Boy Scouts, Girl Scouts and, as suggested by an audience member, 4-H. Given that we normally drew a few hundred people to past sessions, this will take a bit more planning and coordination but, again, it should supply a great opportunity for the Club and the Wetlands Discovery Center.

Any suggestions for improving the club or the newsletter are always welcome.

(Continued from page 1)

This method was suggested by Rudolph Wolf in 1848, and it’s also called the Zurich sunspot number and the International Sunspot Number. The fact that there’s a ‘fudge factor’ (K) associated with the calculation of the sunspot number should cause concern. This factor is meant to normalize the data from various observers using different methods for counting sunspots. As time has gone on new official observers have come and gone, new equipment has been developed, and new techniques have been used to count sunspots. The goal is to make historical data and new data match so long-term trends in the sunspot number can be studied. A newer method came out in the mid 1990’s at meetings of solar scientists. The new method simply counts the sunspot groups observed, and doesn’t attempt to count the individual sunspots. Counting sunspots can be problematic because some of the features on the Sun are hard to classify. A feature called a ‘pore’ usually corresponds to a single, dark, granule of the Sun, but may be indicative of a newly forming sunspot. Some judgement of the observer is involved.

The method that counts groups was developed by Douglas Hoyt and Kenneth Schatten as a way to make old observations (data) match more recent data. This method needed its own ‘fudge’ factor to make the data closely match the results using the Wolf method. This factor turned out to be 12. The results were an excellent match for the Wolf numbers and the observations using this method were less subjective.

You can find information on the sunspot number at www.spaceweather.com. Look at the column at the left edge of the page to see the NOAA sunspot number, which is computed using the Wolf method. NOAA suggests that if you divide the sunspot number by 15 you will get a number that represents the number of sunspots you’d see by projecting the image of the Sun onto a white screen. Today (9/15/16), the sunspot number is 14, so you’d expect to see one via eyepiece projection. Sunspots come and go, and we’re on the down slope of the 11-year sunspot cycle. You can observe sunspots in any one of various ways, but observing the Sun safely is of prime im-
Glass bits, charcoal hint at 56-million-year-old space rock impact

A period of skyrocketing global temperatures started with a bang, new research suggests. Impact debris and evidence of widespread wildfires around eastern North America suggest that a large space rock whacked Earth around 56 million years ago at the beginning of the Paleocene-Eocene Thermal Maximum, also known as the PETM, a period of rapid warming and huge increases in carbon dioxide. The event is one of the closest historic analogs to modern global warming and is used to improve predictions of how Earth’s climate and ecosystems will fare in the coming decades. Too little is known about the newfound impact to guess its origin, size or effect on the global climate, said geochemist Morgan Schaller of Rensselaer Polytechnic Institute in Troy, N.Y. But it fits in with the long-standing and controversial proposal that a comet impact caused the PETM. “The timing is nothing short of remarkable,” said Schaller, who presented the discovery September 27 at the Geological Society of America’s annual meeting. The impact may have contributed to the rapid rise in CO₂ by stirring carbon up into the atmosphere, but it was hardly the sole cause, said Sandra Kirtland Turner, a geochemist at the University of California, Riverside. Her own environmental simulations suggest that the influx of carbon that flooded Earth during the PETM probably took place over at least 2,500 years, far too drawn out to be caused by a single event, she said at the same meeting. During the PETM, a massive influx of carbon flooded the atmosphere and Earth warmed by 5 to 8 degrees Celsius to temperatures much hotter than today. That carbon dump altered the relative abundance of different carbon isotopes in the atmosphere and oceans, leaving a signal in the sedimentary record. While searching for that signal in roughly 56-million-year-old sediments from sites up and down the U.S. East Coast, Schaller spotted microscopic glassy spheres about the size of a dust mite. These specks resemble those blasted from previously identified large impact events. After switching from a black to a white sorting tray to more easily see the black debris, one of Schaller’s Rensselaer colleagues, micropaleontologist Megan Fung, discovered abundant charcoal pieces in the mix. That charcoal formed when wildfires sparked by the impact raged across the landscape, she proposed.

More evidence of the impact will help researchers to better constrain its location, scope and possible relationship to the start of the PETM, Schaller said.
One Incredible Galaxy Cluster Yields Two Types of Gravitational Lenses

By Ethan Siegel

There is this great idea that if you look hard enough and long enough at any region of space, your line of sight will eventually run into a luminous object: a star, a galaxy or a cluster of galaxies. In reality, the universe is finite in age, so this isn't quite the case. There are objects that emit light from the past 13.7 billion years—99 percent of the age of the universe—but none before that. Even in theory, there are no stars or galaxies to see beyond that time, as light is limited by the amount of time it has to travel.

But with the advent of large, powerful space telescopes that can collect data for the equivalent of millions of seconds of observing time, in both visible light and infrared wavelengths, we can see nearly to the edge of all that's accessible to us.

The most massive compact, bound structures in the universe are galaxy clusters that are hundreds or even thousands of times the mass of the Milky Way. One of them, Abell S1063, was the target of a recent set of Hubble Space Telescope observations as part of the Frontier Fields program. While the Advanced Camera for Surveys instrument imaged the cluster, another instrument, the Wide Field Camera 3, used an optical trick to image a parallel field, offset by just a few arc minutes. Then the technique was reversed, giving us an unprecedentedly deep view of two closely aligned fields simultaneously, with wavelengths ranging from 435 to 1600 nanometers.

With a huge, towering galaxy cluster in one field and no comparably massive objects in the other, the effects of both weak and strong gravitational lensing are readily apparent. The galaxy cluster—over 100 trillion times the mass of our sun—warp the fabric of space. This causes background light to bend around it, converging on our eyes another four billion light years away. From behind the cluster, the light from distant galaxies is stretched, magnified, distorted, and bent into arcs and multiple images: a classic example of strong gravitational lensing. But in a subtler fashion, the less optimally aligned galaxies are distorted as well; they are stretched into elliptical shapes along concentric circles surrounding the cluster.

A visual inspection yields more of these tangential alignments than radial ones in the cluster field, while the parallel field exhibits no such shape distortion. This effect, known as weak gravitational lensing, is a very powerful technique for obtaining galaxy cluster masses independent of any other conditions. In this serendipitous image, both types of lensing can be discerned by the naked eye. When the James Webb Space Telescope launches in 2018, gravitational lensing may well empower us to see all the way back to the very first stars and galaxies.

If you're interested in teaching kids about how these large telescopes "see," be sure to see our article on this topic at the NASA Space Place: http://spaceplace.nasa.gov/telescope-mirrors/en/

Galaxy cluster Abell S1063 (left) as imaged with the Hubble Space Telescope as part of the Frontier Fields program. The distorted images of the background galaxies are a consequence of the warped space due to Einstein's general relativity; the parallel field (right) shows no such effects. Image credit: NASA, ESA and Jennifer Lotz (STScI)
Hubble Takes Close-up Look at Disintegrating Comet

NASA's Hubble Space Telescope has captured one of the sharpest, most detailed observations of a comet breaking apart, which occurred 67 million miles from Earth.

In a series of images taken over a three-day span in January 2016, Hubble revealed 25 building-size blocks made of a mixture of ice and dust that are drifting away from the comet at a leisurely pace, about the walking speed of an adult.

The observations suggest that the roughly 4.5-billion-year-old comet, named 332P/Ikeya-Murakami, or Comet 332P, may be spinning so fast that material is ejected from its surface. The resulting debris is now scattered along a 3,000-mile-long trail, larger than the width of the continental U.S.

These observations provide insight into the volatile behavior of comets as they approach the sun and begin to vaporize, unleashing dynamical forces. Comet 332P was 150 million miles from the sun, slightly beyond the orbit of Mars, when Hubble spotted the breakup.

"We know that comets sometimes disintegrate, but we don't know much about why or how they come apart," explained lead researcher David Jewitt of the University of California at Los Angeles. "The trouble is that it happens quickly and without warning, and so we don't have much chance to get useful data. With Hubble's fantastic resolution, not only do we see really tiny, faint bits of the comet, but we can watch them change from day to day. And that has allowed us to make the best measurements ever obtained on such an object."

The three-day observations reveal that the comet shards brighten and dim as icy patches on their surfaces rotate into and out of sunlight. Their shapes change, too, as they break apart. The icy relics comprise about 4 percent of the parent comet and range in size from roughly 65 feet wide to 200 feet wide. They are moving away from each other at a few miles per hour.

The Hubble images show that the parent comet also changes brightness cyclically, completing a rotation every two to four hours. A visitor to the comet would see the sun rise and set in as little as an hour. The comet is also much smaller than astronomers thought, measuring only 1,600 feet across, about the length of five football fields.

Comet 332P was discovered in November 2010, after it surged in brightness and was spotted by two Japanese amateur astronomers, Kaoru Ikeya and Shigeki Murakami.
10000!

Gary Hug
NEO Hunter

North East Kansas Amateur Astronomy League
SUNDAY OCTOBER 30
7:00 PM
BAKER WETLANDS DISCOVERY CENTER
Free and Open to the Public
The Milky Way Project, with over 2 million classification drawings made by 20,000 citizen scientists since 2012, is relaunching its website after upgrading the classification interface.

"We need an additional 2 million classifications to achieve our current science goals," says Povich. "If every one of the 20,000 students at Cal Poly Pomona logged onto our site and made 100 classifications each, we'd be done in no time! The relaunching of the Milky Way Project website will help us acquire a more robust and comprehensive catalog of stellar nurseries and massive runaway stars," adds Cal Poly Pomona physics major Tharindu Jayasinghe, who is analyzing the citizen science data for his senior thesis. "Having everyone joining us in the hunt for amazing astrophysical data makes this project more meaningful."

How does it work? Citizen scientists go to the website http://www.milkywayproject.org. After creating a free Zooniverse user account and following a simple set of instructions, citizen scientists will view infrared images showing different parts of our galaxy and assist professional scientists by making drawings on the images to classify interesting astrophysical phenomena, including interstellar "bubbles" and stellar-wind "bow shocks." These classifications help discover some of the most massive stars in our Milky Way Galaxy.

The Zooniverse is the world's largest and most popular platform for people-powered research. This research is made possible by volunteers—hundreds of thousands of people around the world who come together to assist professional researchers. The goal is to enable research that would not be possible, or practical, otherwise. Zooniverse research results in new discoveries, datasets useful to the wider research community, and many publications.

Based on the Hubble data, the research team suggests that sunlight heated up the comet, causing jets of gas and dust to erupt from its surface. Because the nucleus is so small, these jets act like rocket engines, spinning up the comet's rotation. The faster spin rate loosened chunks of material, which are drifting off into space.

The research team calculated that the comet probably shed material over several months, between October and December 2015. Jewitt suggests that even some of the ejected pieces have themselves fallen to bits in a kind of cascading fragmentation. "Our analysis shows that the smaller fragments are not as abundant as one might expect based on the number of bigger chunks," he said. "This is suggestive that they're being depleted even in the few months since they were launched from the primary body. We think these little guys have a short lifetime."

Hubble's sharp vision also spied a chunk of material close to the comet, which may be the first salvo of another outburst. The remnant from still another flare-up, which may have occurred in 2012, is also visible. The fragment may be as large as Comet 332P, suggesting the comet split in two. But the icy remnant wasn't spotted until Dec. 31, 2015, by the Pan-STARRS (Panoramic Survey Telescope and Rapid Response System) telescope in Hawaii, in work supported by the Near-Earth Object Observations program in NASA's Planetary Defense Coordination Office. That discovery prompted Jewitt and colleagues to request Hubble time to look at the comet in detail. Around the same time, astronomers around the world began to notice a cloudy patch of material near the comet, which Hubble later resolved into the 25 pieces.

"In the past, astronomers thought that comets die when they are warmed by sunlight, causing their ices to simply vaporize away," Jewitt said. "Either nothing would be left over or there would be a dead hulk of material where an active comet used to be. But it's starting to look like fragmentation may be more important. In Comet 332P we may be seeing a comet fragmenting itself into oblivion."

"Hubble's best previous glimpse at a fragmenting comet came during Advanced Camera for Surveys (ACS) observations of 73P/Schwassmann-Wachmann 3 (73P) in April 2006," said collaborator Harold Weaver of the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland. "In those observations, Hubble witnessed a comet with more than 60 named pieces. The Hubble images showed unprecedented detail of 73P's breakup, but the comet wasn't observed long enough to document the evolution of the fragments over time, unlike the case of 332P."

The researchers estimate that Comet 332P contains enough mass to endure another 25 outbursts. "If the comet has an episode every six years, the equivalent of one orbit around the sun, then it will be gone in 150 years," Jewitt said. "It's the blink of an eye, astronomically speaking. The trip to the inner solar system has doomed it."

The icy visitor hails from the Kuiper Belt, a vast swarm of objects at the outskirts of our solar system. These icy relics are the leftover building blocks from our solar system's construction. After nearly 4.5 billion years in this icy deep freeze, chaotic gravitational perturbations from Neptune kicked Comet 332P out of the Kuiper Belt.

As the comet traveled across the solar system, it was deflected by the planets, like a ball bouncing around in a pinball machine, until Jupiter's gravity set its current orbit. Jewitt estimates that a comet from the Kuiper Belt gets tossed into the inner solar system every 40 to 100 years.
Hubble Finds Planet Orbiting Pair of Stars

Two's company, but three might not always be a crowd — at least in space. Astronomers using NASA's Hubble Space Telescope, and a trick of nature, have confirmed the existence of a planet orbiting two stars in the system OGLE-2007-BLG-349, located 8,000 light-years away towards the center of our galaxy.

The planet orbits roughly 300 million miles from the stellar duo, about the distance from the asteroid belt to our sun. It completes an orbit around both stars roughly every seven years. The two red dwarf stars are a mere 7 million miles apart, or 14 times the diameter of the moon's orbit around Earth.

The Hubble observations represent the first time such a three-body system has been confirmed using the gravitational microlensing technique. Gravitational microlensing occurs when the gravity of a foreground star bends and amplifies the light of a background star that momentarily aligns with it. The particular character of the light magnification can reveal clues to the nature of the foreground star and any associated planets.

The three objects were discovered in 2007 by an international collaboration of five different groups: Microlensing Observations in Astrophysics (MOA), the Optical Gravitational Lensing Experiment (OGLE), the Microlensing Follow-up Network (MicroFUN), the Probing Lensing Anomalies Network (PLANET), and the Robonet Collaboration. These ground-based observations uncovered a star and a planet, but a detailed analysis also revealed a third body that astronomers could not definitively identify.

"The ground-based observations suggested two possible scenarios for the three-body system: a Saturn-mass planet orbiting a close binary star pair or a Saturn-mass and an Earth-mass planet orbiting a single star," explained David Bennett of the NASA Goddard Space Flight Center in Greenbelt, Maryland, the paper's first author.

The sharpness of the Hubble images allowed the research team to separate the background source star and the lensing star from their neighbors in the very crowded star field. The Hubble observations revealed that the starlight from the foreground lens system was too faint to be a single star, but it had the brightness expected for two closely orbiting red dwarf stars, which are fainter and less massive than our sun. "So, the model with two stars and one planet is the only one consistent with the Hubble data," Bennett said. Bennett's team conducted the follow-up observations with Hubble's Wide Field Planetary Camera 2. "We were helped in the analysis by the almost perfect alignment of the foreground binary stars with the background star, which greatly magnified the light and allowed us to see the signal of the two stars," Bennett explained. Kepler has discovered 10 other planets orbiting tight binary stars, but these are all much closer to their stars than the one studied by Hubble.

Now that the team has shown that microlensing can successfully detect planets orbiting double-star systems, Hubble could provide an essential role in this new realm in the continued search for exoplanets.

This artist's illustration shows a gas giant planet circling a pair of red dwarf stars. The Saturn-mass planet orbits roughly 300 million miles from the stellar duo. The two red dwarf stars are a mere 7 million miles apart. The illustration is based on Hubble Space Telescope observations that helped astronomers confirm the existence of a planet orbiting two stars in the system OGLE-2007-BLG-349, located 8,000 light-years away.

The system is too far away for Hubble to photograph the planet. Instead, its presence is inferred from gravitational microlensing. This phenomenon occurs when the gravity of a foreground star bends and amplifies the light of a background star that momentarily aligns with it. The particular character of the light magnification can reveal clues to the nature of the foreground star and any associated planets. The Hubble observations represent the first time such a three-body system has been confirmed using the gravitational microlensing technique.

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nature of Pluto that contains a very mild, close-in bowshock, where the solar wind first "meets" Pluto (similar to a shock wave that forms ahead of a supersonic aircraft) and a small wake or tail behind the planet.

The immediate mystery is that Chandra's readings on the brightness of the X-rays are much higher than expected from the solar wind interacting with Pluto's atmosphere.

"Before our observations, scientists thought it was highly unlikely that we'd detect X-rays from Pluto, causing a strong debate as to whether Chandra should observe it at all," said co-author Scott Wolk, of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass. "Prior to Pluto, the most distant solar system body with detected X-ray emission was Saturn's rings and disk."

The Chandra detection is especially surprising since New Horizons discovered Pluto's atmosphere was much more stable than the rapidly escaping, "comet-like" atmosphere that many scientists expected before the spacecraft flew past in July 2015. In fact, New Horizons found that Pluto's interaction with the solar wind is much more like the interaction of the solar wind with Mars, than with a comet. However, although Pluto is releasing enough gas from its atmosphere to make the observed X-rays, in simple models for the intensity of the solar wind at the distance of Pluto, there isn't enough solar wind flowing directly at Pluto to make them.

Lisse and his colleagues – who also include SWAP co-investigators David McComas from Princeton University and Heather Elliott from Southwest Research Institute – suggest several possibilities for the enhanced X-ray emission from Pluto. These include a much wider and longer tail of gases trailing Pluto than New Horizons detected using its SWAP instrument. Other possibilities are that interplanetary magnetic fields are focusing more particles than expected from the solar wind into the region around Pluto, or the low density of the solar wind in the outer solar system at the distance of Pluto could allow for the formation of a doughnut, or torus, of neutral gas centered around Pluto's orbit.

That the Chandra measurements don't quite match up with New Horizons up-close observations is the benefit – and beauty – of an opportunity like the New Horizons flyby. "When you have a chance at a once in a lifetime flyby like New Horizons at Pluto, you want to point every piece of glass – every telescope on and around Earth – at the target," McNutt says. "The measurements come together and give you a much more complete picture you couldn't get at any other time, from anywhere else."

New Horizons has an opportunity to test these findings and shed even more light on this distant region – billions of miles from Earth – as part of its recently approved extended mission to survey the Kuiper Belt and encounter another smaller Kuiper. It is unlikely to be feasible to detect X-rays from MU69, but Chandra might detect X-rays from other larger and closer objects that New Horizons will observe as it flies through the Kuiper Belt towards MU69, Belt object, 2014 MU69, on Jan. 1, 2019.
Scientists using NASA's Chandra X-ray Observatory have made the first detections of X-rays from Pluto. These observations offer new insight into the space environment surrounding the largest and best-known object in the solar system's outermost regions.

While NASA's New Horizons spacecraft was speeding toward and beyond Pluto, Chandra was aimed several times on the dwarf planet and its moons, gathering data on Pluto that the missions could compare after the flyby. Each time Chandra pointed at Pluto – four times in all, from February 2014 through August 2015 – it detected low-energy X-rays from the small planet.

Pluto is the largest object in the Kuiper Belt, a ring or belt containing a vast population of small bodies orbiting the Sun beyond Neptune. The Kuiper belt extends from the orbit of Neptune, at 30 times the distance of Earth from the Sun, to about 50 times the Earth-Sun distance. Pluto's orbit ranges over the same span as the overall Kupier Belt.

"We've just detected, for the first time, X-rays coming from an object in our Kuiper Belt, and learned that Pluto is interacting with the solar wind in an unexpected and energetic fashion," said Carey Lisse, an astrophysicist at the Johns Hopkins University Applied Physics Laboratory (APL) in Laurel, Maryland, who led the Chandra observation team with APL colleague and New Horizons Co-Investigator Ralph McNutt. "We can expect other large Kuiper Belt objects to be doing the same."

The team recently published its findings online in the journal Icarus. The report details what Lisse says was a somewhat surprising detection given that Pluto – being cold, rocky and without a magnetic field – has no natural mechanism for emitting X-rays. But Lisse, having also led the team that made the first X-ray detections from a comet two decades ago, knew the interaction between the gases surrounding such planetary bodies and the solar wind – the constant streams of charged particles from the sun that speed throughout the solar system -- can create X-rays.

New Horizons scientists were particularly interested in learning more about the interaction between the gases in Pluto's atmosphere and the solar wind. The spacecraft itself carries an instrument designed to measure that activity up-close – the aptly named Solar Wind Around Pluto (SWAP) – and scientists are using that data to craft a pic-
Enterprise' Nebulae Seen by Spitzer Space Telescope

Just in time for the 50th anniversary of the TV series "Star Trek," which first aired September 8th, 1966, a new infrared image from NASA's Spitzer Space Telescope may remind fans of the historic show.

Astronomically speaking, the region pictured in the image falls within the disk of our Milky Way galaxy and displays two regions of star formation hidden behind a haze of dust when viewed in visible light. Spitzer's ability to peer deeper into dust clouds has revealed a myriad of stellar birthplaces like these, which are officially known only by their catalog numbers, IRAS 19340+2016 and IRAS19343+2026.

Trekkies, however, may prefer using the more familiar designations NCC-1701 and NCC-1701-D. Fifty years after its inception, Star Trek still inspires fans and astronomers alike to boldly explore where no one has gone before.
NASA’s Hubble Spots Possible Water Plumes Erupting on Jupiter’s Moon Europa

Astronomers using NASA’s Hubble Space Telescope have imaged what may be water vapor plumes erupting off the surface of Jupiter’s moon Europa. This finding bolsters other Hubble observations suggesting the icy moon erupts with high-altitude water vapor plumes. The observation increases the possibility that missions to Europa may be able to sample Europa’s ocean without having to drill through miles of ice.

“Europa’s ocean is considered to be one of the most promising places that could potentially harbor life in the solar system,” said Geoff Yoder, acting associate administrator for NASA’s Science Mission Directorate in Washington, D.C. “These plumes, if they do indeed exist, may provide another way to sample Europa’s subsurface.”

The plumes are estimated to rise about 125 miles (200 kilometers) before, presumably, raining material back down onto Europa’s surface. Europa has a huge global ocean containing twice as much water as Earth’s oceans, but it is protected by a layer of extremely cold and hard ice of unknown thickness. The plumes provide a tantalizing opportunity to gather samples originating from under the surface without having to land or drill through the ice.

The team, led by William Sparks of the Space Telescope Science Institute (STScI) in Baltimore, Maryland, observed these finger-like projections while viewing Europa’s limb as the moon passed in front of Jupiter. The original goal of the team’s observing proposal was to determine whether Europa has a thin, extended atmosphere, or exosphere. Using the same observing method that detects atmospheres around planets orbiting other stars, the team also realized if there was water vapor venting from Europa’s surface, this observation would be an excellent way to see it.

“The atmosphere of an extrasolar planet blocks some of the starlight that is behind it,” Sparks explained. “If there is a thin atmosphere around Europa, it has the potential to block some of the light of Jupiter, and we could see it as a silhouette. And so we were looking for absorption features around the limb of Europa as it transited the smooth face of Jupiter.”

In 10 separate occurrences spanning 15 months, the team observed Europa passing in front of Jupiter. They saw what could be plumes erupting on three of these occasions. This work provides supporting evidence for water plumes on Europa. In 2012, a team led by Lorenz Roth of Southwest Research Institute in San Antonio, Texas, detected evidence for water vapor erupting from the frigid south polar region of Europa and reaching more than 100 miles (160 kilometers) into space. Although both teams used Hubble’s Space Telescope Imaging Spectrograph (STIS) instrument, each used a totally independent method to arrive at the same conclusion.

“When we calculate in a

(Continued on page 11)