The Prairie Astronomer

March 2016 Volume 57, Issue #3

March Program:

Mark Ellis: "Space Law"

Brett Boller's Milky Way

See page 4

Night Sky Network

The Newsletter of the Prairie Astronomy Club

The Prairie Astronomer

NEXT PAC MEETING: March 29, 7:30pm
at Hyde Observatory

PROGRAM

March: Space Law Part I - Mark Ellis

The Martian portrayed a positive future for the US Space Program. NASA, with help from China, was able to rescue Mark Watney after being marooned on Mars.

To do this, we saw them use great technology that exists today. But what are the legal implications of interplanetary travel? Attorney Mark Ells, a recent graduate of UNL's Space Law Program, will explore that topic at the March PAC meeting.

FUTURE PROGRAMS

April: Space Law Part II - Elsbeth Magilton & Prof Frans Von der Dunk

June: Solar Star Party

August: NSP Review

Buy the book! The Prairie Astronomy Club: Fifty Years of Amateur Astronomy.
Order online from Amazon or lulu.com.

CONTENTS

4 Meeting Minutes
5 2017 Eclipse Planning Meeting
6 Astrophotography
7 Black Hole Rotation Rate
9 Mercury's Crust
11 Observatory Update: IC 239
13 DSLR Astrophotography
17 From the Archives
18 April Observing
19 Focus on Constellations
20 Gravitational Wave Astronomy
22 Ceres Bright Spots (Again)
24 Club Information

EVENTS

PAC Meeting

PAC Meeting
Tuesday March 29th, 2016, 7:30pm
Hyde Observatory

Astronomy Day, Sunday, April 17 at Morrill Hall

PAC Meeting
Tuesday April 26th, 2016, 7:30pm
Hyde Observatory

PAC Meeting
Tuesday May 31st, 2016, 7:30pm
Hyde Observatory

Newsletter submission deadline April 16

2016 STAR PARTY DATES

Photo by Brian Sivill

	Star Party Date	Star Party Date	Lunar Party Date
January	Jan 1st	**Jan 8th**	
February	Jan 29th	**Feb 5th**	
March	Mar 4th	**Mar 11th**	
April	Apr 1st	**Apr 8th**	Apr 15th
May	Apr 29th	**May 6th**	May 13th
June	May 27th	**Jun 3rd**	
July	**Jul 1st**	Jul 8th	
NSP	**July 31st - Aug 5th**		
August	Jul 29th	**Aug 5th**	Aug 12th
August	Aug 26th	**Sep 2nd**	Sep 9th
September	Sep 23rd	**Sep 30th**	
October	Oct 21st	**Oct 28th**	
November	Nov 25th	**Dec 2nd**	
December	Dec 23rd	**Dec 30th**	

PAC E-MAIL:

info@prairieastronomyclub.org

PAC-LIST:

Subscribe through GoogleGroups.
To post messages to the list, send to the address:

pac-list@googlegroups.com

ADDRESS

The Prairie Astronomer
c/o The Prairie Astronomy Club, Inc.
P.O. Box 5585
Lincoln, NE 68505-0585

WEBSITES

www.prairieastronomyclub.org
https://nightsky.jpl.nasa.gov
www.hydeobservatory.info
www.nebraskastarparty.org
www.OmahaAstro.com
Panhandleastronomyclub.com
www.universetoday.com/
www.planetary.org/home/
http://www.darksky.org/

Night Sky Network

PAC Meeting Minutes

Prairie Astronomy Club

Minutes for the meeting of February 23, 2016

President Jim Kvasnicka called the meeting to order. 11 members, 2 guests.

Jim welcomed members and guests to the meeting.

Jim Reviewed upcoming events and star parties for the month.

We reviewed the benefits and requirements of club membership.

Jim presented his observing report for March. The club star parties are March 4th and 11th at the Farm.

Club Business:

Astronomy Day is coming up on April 17 from 1:30-4:30. We need telescopes for display in Morrill Hall. If anyone would like to provide a telescope, please contact Zach by March 1.

John Reinert provided the treasurer's report. The audit was completed on February 6th by John, Mike Kearns, Rick Brown and Lee Taylor. John summarized the audit for the club. John is working on an easier way for the membership to access the roster.

Adjourn to the program on the Astronomical League's observing programs.

Respectfully submitted by

Lee Taylor

The new mural has been installed at Hyde Observatory. This photo is a composite of the Milky Way taken by Brett Boller and Dave Knisely at the Nebraska Star Party in July, 2015.

2017 Solar Eclipse Planning Committee Meeting Minutes

March 3, 2016
5:30 pm, Hyde Memorial Observatory

Present: Lee Thomas, Dan Delzell, Jamie Kelley, Dave Churilla, Guest - Michael Sibbernsen

The group invited Michael Sibbernsen to share info about other solar eclipse events going on throughout Nebraska on August 21, 2017.

- The Nebraska Eclipse Consortium this group is made up of individuals/agency's involved in planning solar eclipse events throughout the state.
    - Lee Thomas will be notified via Sibbernsen of the next meeting
    - There will be a website, it is not active right now.
        - Listing of activity locations
        - Public can go to for information
    - NASA NE Space Grant
        - Statewide ambassadors
    - Distribution of up to 50,000 solar eclipse glasses
- In addition to the Eclipse Consortium, Sibbernsen will be involved, on the day of the eclipse, with the release of a constellation of weather balloons documenting the eclipse.

Updates on activities from Hyde/PAC:

- Hyde has ordered 2000 solar glasses. 1000 were ordered in 2014.
- The committee has discussed possibly train the trainer workshops for LPS science teachers and others leading up to the eclipse.
    - The training could be done also via video conference or pre-recorded training
    - Sibbersnsen mentioned that these trainings could also be done by the NASA Ambassadors to reach more individuals
- The need for a brochure with eclipse and safe viewing info was discussed.
    - Sibbersnsen thinks this is a good idea
    - It would be ideal for the Consortium to work together on this so that information being distributed is consistent
    - Brochure should be ready by January 1, 2017
- Other media coverage will be needed
    - Where and how to view
    - Resources available
    - Contacts – Hyde/Web
- Promotion of the eclipse can begin
    - 5 min presentation as part of Saturday night program.
- Hyde will be open for the eclipse
    - There will need to be a capacity set
    - Traffic control will be needed
    - At least 10 volunteers will be needed
    - Exclusive use permits with Parks and Rec will need to be completed
- Other happenings in 2017
    - Hyde's 40th Anniversary
    - Nebraska's 150th
- A chair for the committee is needed

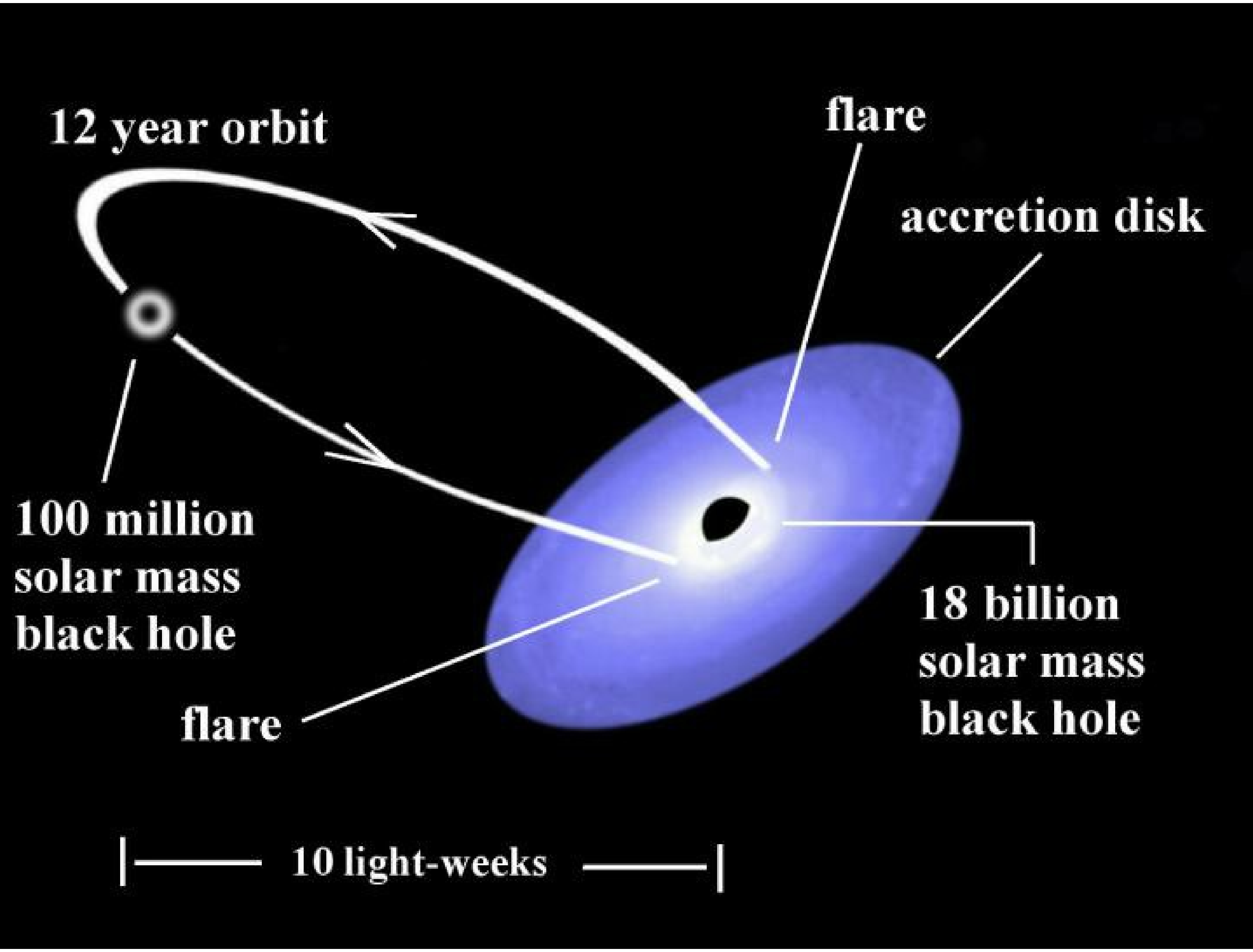
Astrophotography by Club Members

Beth Jenckes

Clocking the Rotation Rate of a Supermassive Black Hole

A recent observational campaign involving more than two dozen optical telescopes and NASA's space based SWIFT X-ray telescope allowed a team of astronomers to measure very accurately the rotational rate of one of the most massive black holes in the universe. The rotational rate of this massive black hole is one third of the maximum spin rate allowed in General Relativity. This 18 billion solar mass heavy black hole powers a quasar called OJ287 which lies about 3.5 billion light years away from Earth. Quasi-stellar radio sources or `quasars' for short, are the very bright centers of distant galaxies which emit huge amounts of electro-magnetic radiation due to the infall of matter into their massive black holes.

This quasar lies very close to the apparent path of the Sun's motion on the celestial sphere as seen from Earth, where most searches for asteroids and comets are conducted.



An illustration of the binary black hole system in OJ287. The predictions of the model are verified by observations.

Therefore, its optical photometric measurements already cover more than 100 years. A careful analysis of these observations show that OJ 287 has produced quasi-periodic optical outbursts at intervals of approximately 12 years dating back to around 1891. Additionally, a close inspection of newer data sets reveals the presence of double-peaks in these outbursts.

These deductions prompted Prof. Mauri Valtonen of University of Turku, Finland and his collaborators to develop a model that requires the quasar OJ287 to harbour two unequal mass black holes. Their model involves a massive black hole with an accretion disk (a disk of interstellar material formed by matter falling into objects like black holes) while the comparatively smaller black hole revolves around it. The quasar OJ287 is visible due to the slow accretion of matter, present in the accretion disk, onto the largest black hole. Additionally, the small black hole passes through the accretion disk during its orbit which causes the disk material to heat up to very high temperatures. This heated material flows out from both sides of the accretion disk and radiates strongly for weeks. This causes peaks in the brightness, and the double peaks arise due to the ellipticity of the orbit, as shown in the figure.

The binary black hole model for OJ287 implies that the smaller black hole's orbit should rotate, and this changes where and when the smaller hole impacts the accretion disk. This effect arises from Einstein's General Theory of Relativity and its precessional rate depends mainly on the two black hole masses and the rotation rate of the more massive black hole. In 2010, Valtonen and collaborators used eight well timed bright outbursts of OJ287 to accurately measure the precession rate of the smaller hole's orbit. This analysis revealed for the first time the rotation rate of the massive black hole along with accurate estimates for the masses of the two black holes. This was possible since the smaller black hole's orbit precess at an incredible 39 degrees per individual orbit. The General Relativistic model for OJ287 also predicted that the next outburst could occur around the time of GR Centenary, 25 November 2015, which marks the 100th anniversary of Einstein's General Theory of Relativity.

An observational campaign was therefore launched to catch this predicted outburst. The predicted optical flare began around November 18, 2015 and reached its maximum brightness on December 4, 2015. It is the timing of this bright outburst that allowed Valtonen and his co-workers to directly measure the rotation rate of the more massive black hole to be one third of the maximum spin rate allowed in General Relativity. In other words, its Kerr parameter is accurately measured to be 0.31 and its maximum allowed value in General Relativity is one. In comparison, the Kerr parameter of the final black hole associated with the first ever direct detection of gravitational waves is only estimated to be below 0.7.

The observations leading to accurate spin measurement have been made due to the collaboration of a number of optical telescopes in Japan, South Korea, India, Turkey, Greece, Finland, Poland, Germany, UK, Spain, USA and Mexico. The effort, led by Staszek Zola of Poland, involved close to 100 astronomers from these countries. Interestingly, a number of key participants were amateur astronomers who operate their own telescopes. Valtonen's team that developed and contributed to the spinning binary black hole model include theoretical astrophysicist A. Gopakumar from TIFR, India, and Italian X-Ray astronomer Stefano Ciprini who obtained and analyzed the X-ray data.

The occurrence of the predicted optical outburst of OJ287 also allowed the team to confirm the loss of orbital energy to gravitational waves within two percent of General Relativity's prediction. This provides the first indirect evidence for the existence of a massive spinning black hole binary emitting gravitational waves. This is encouraging news for the Pulsar Timing Array efforts that will directly detect gravitational waves from such systems in the near future. Therefore, the present optical outburst of OJ287 makes a fitting contribution to the centenary celebrations of General Relativity and adds to the excitement of the first direct observation of a transient gravitational wave signal by LIGO.

Expanded-color image of Mercury's 52-km Degas crater, showing an abundance of low-reflectance material (LRM).

Dark Stains on Mercury Reveal Its Ancient Crust

Jason Major, Universe Today

Ever since the MESSENGER spacecraft entered orbit around Mercury in 2011, and indeed even since Mariner 10's flyby in 1974, peculiar "dark spots" observed on the planet's surface have intrigued scientists as to their composition and origin. Now, thanks to high-resolution spectral data acquired by MESSENGER during the last few months of its mission, researchers have confirmed that Mercury's dark spots contain a form of carbon called graphite, excavated from the planet's original, ancient crust.

Commonly found within and around impact craters and volcanic vents, the dark spots on Mercury—also referred to as "low-reflectance material," or LRM—were originally suspected to contain carbon delivered to the planet by comets.

Data from MESSENGER's Gamma-Ray and Neutron Spectrometer (GRNS) and X-ray instruments confirmed the LRM to contain high amounts of graphitic carbon, but likely originating from within Mercury itself. It's thought that Mercury was once covered by a crust composed of graphite, when much of the planet was still molten.

"Experiments and modeling show that as this magma ocean cooled and minerals began to crystallize, minerals that solidified would all sink with the exception of graphite, which would have been buoyant and would have accumulated as the original crust of Mercury," said Rachel Klima, co-author of a recent study on LRM and a planetary geologist at the Johns Hopkins University Applied Physics Laboratory. "We think that LRM may contain remnants of this primordial crust. If so, we may be observing the remains of Mercury's original, 4.6-billion-year-old surface."

Although similar in visible coloration and covered in craters, cracks, and mountains, any similarities between Mercury and other smaller worlds in our Solar System—including our Moon—end there. Mercury has a formation history all it own and is compositionally unique among the planets.

These data revealing such a relatively high concentration of graphite in Mercury's crust only adds to those differences, and also tell us about the various elements that were present around the Sun when the planets were forming.

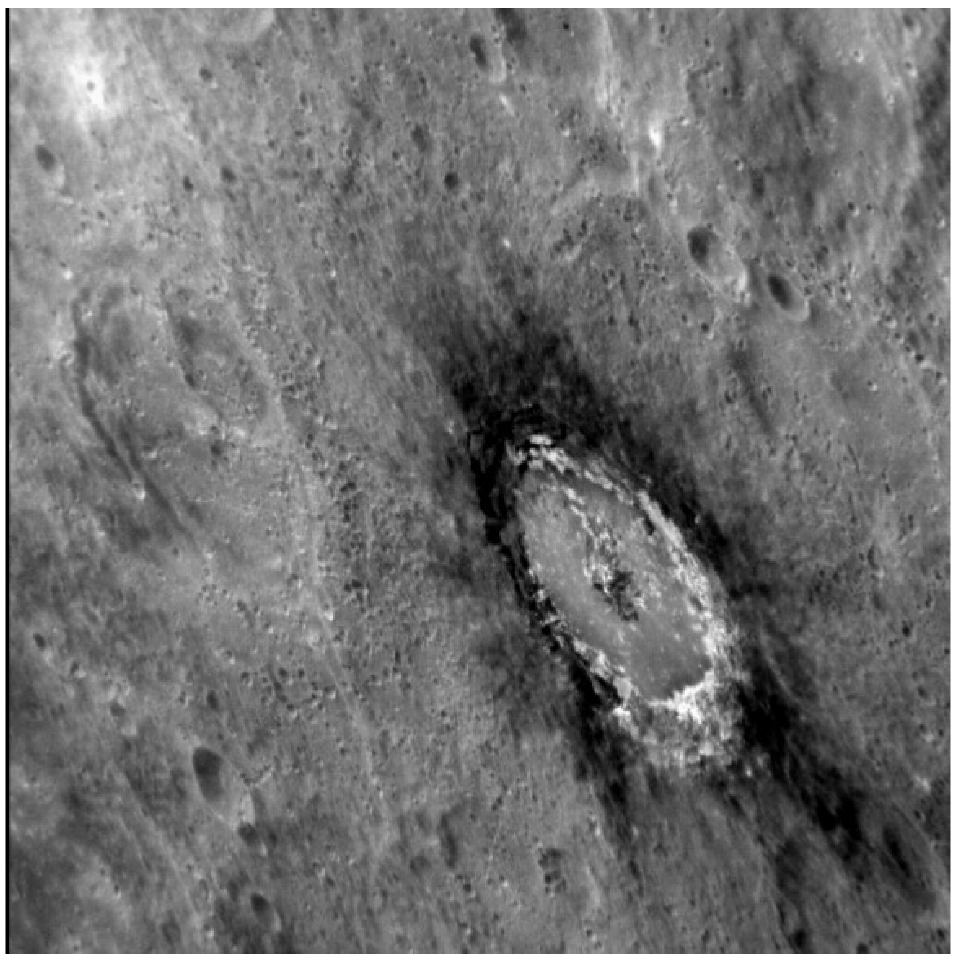
"The finding of abundant carbon on the surface suggests that we may be seeing remnants of Mercury's original ancient crust mixed into the volcanic rocks and impact ejecta that form the surface we see today," said Larry Nittler, research paper co-author and Deputy Principal Investigator of the MESSENGER mission. "This result is a testament to the phenomenal success of the MESSENGER mission and adds to a long list of ways the innermost planet differs from its planetary neighbors and provides additional clues to the origin and early evolution of the inner Solar System."

On Earth graphite is used in industry to make bricks that line refractory furnaces and increase the carbon content of steel. It's also widely used in fire retardants, batteries, and lubricants, and is mixed with clay in various amounts to create the "lead" in pencils (which, by the way, contain no actual lead.)

These findings have been published in the March 7, 2016 Advanced Online Publication of Nature Geoscience.

MESSENGER (MErcury Surface, Space ENvironment, GEochemistry, and Ranging) was a NASA-sponsored scientific investigation of the planet Mercury and the first space mission designed to orbit the planet closest to the Sun. The MESSENGER spacecraft launched on August 3, 2004, and entered orbit about Mercury on March 17, 2011 (March 18, 2011 UTC). On April 30, 2015, after four years in orbit MESSENGER's mission and operational life came to an end when it impacted the surface of Mercury in its northern polar region.

Source: Carnegie Science and JHUAPL

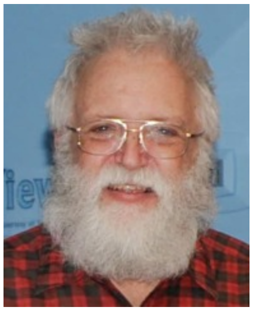


Low-reflectance material surrounding an 80-km crater called Basho, imaged in May 2012

Observatory Update: IC 239

Rick Johnson

IC 239 is a low surface brightness spiral that is considered part of the NGC 1023 group. NGC 1023 is Arp 135 and is located about 45 minutes of arc east of IC 239. It is located in far eastern Andromeda while NGC 1023 is in Perseus. The distance to both is highly controversial. As a member of the 1023 group it should be at approximately the same distance. When I took Arp 135 back in October of 2008 I put it at 20 million light-years. That isn't likely correct. While current distance estimates for Arp 135 seem to collect around 32 to 34 million light-years values down to the 20 million light-years I used and up to 64 million light-years are found in the reasonably current literature. I'll go with 32 million light-years simply because that is also the redshift value for IC 239. Using that distance the separation of IC 239 from Arp 135 is only 430,000 light-years so it is possible that IC 239 is feeling the tidal forces of the far more massive Arp 135. Indeed it shows faint extended arms or plumes to the north and south.



Attempts to get a Tully-Fisher distance estimate are bugged by not being able to determine exactly how face on we are seeing it. Two different methods of determining this give two very different answers. With so many uncertainties it is possible, but unlikely the two aren't related. My post about NGC 1023/Arp 135 with its likely too close

distance estimate can be seen here.

NED classifies IC 239 as SAB(rs)cd LINER2. This indicates something may have shaken up the core black hole to a rather active state. That may be Arp 135. Assume the 32 million light-year distance I get a size of about 42,000 light-years and that includes the plumes. Ignoring them it is 30,000 light-years in size. So not only is it a small spiral it's low surface brightness indicates few stars filling what little volume it takes up. As such it shouldn't be hard

for a larger companion to distort it as appears to have happened. Though if it has a ton of dark matter we can't see all this is moot.

It was discovered photographically by Isaac Roberts in 1893 using the 20" reflector at his observatory "Starfield", Crowborough Hill, Sussex, UK. He put it in Perseus though at that time the constellation borders were not well defined and it may well have been in that constellation by the boundaries is use at the time. Today it is only in Andromeda by 28 arc minutes.

There is only one other obvious galaxy in my image, PGC 2802360 to the east. Another very low surface brightness galaxy. No distance information is available at NED. It may be a dwarf member of the group. In fact it's other catalog name is NGC 1023 GROUP:[TT2009] 18. That, I've found, doesn't count for much as galaxies labeled as members of other groups often have redshifts that put them billions of light-years from the cluster whose name they carry. With nothing worth annotating but for IC 239 I didn't prepare an annotated image.

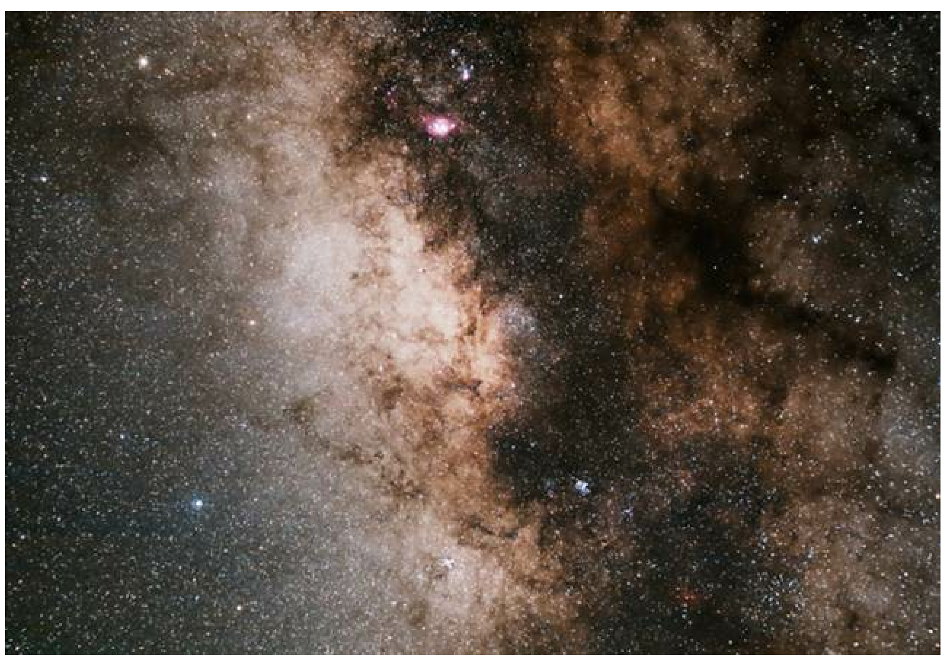
DSLR Astrophotography Untracked

Karoline Mrazek and Erwin Matys, Project Nightflight

With DSLRs and standard camera lenses astrophotography is on the verge of a new epoch, where tracking is no longer absolutely mandatory. When we heard about the technique described in this article, we immediately wanted to give it a try. It allows any stargazer using a modern DSLR to capture colorful, noise-free images of deep-sky objects, without an equatorial mount or tracking device needed.

How it Works

The technique described here was originally brought to our attention by our fellow observer Wolfgang Vollmann, who has been using it for some time to capture comets. His initial results were promising and we decided to give it a closer look and develop it further where possible. After a series of experiments we are now able to present a tried and tested workflow that guarantees great images of star fields. The basic idea of the method is actually quite simple: Shoot a lot of similar exposures at very high ISO ratings and keep the single exposures so short that no tracking is needed. The individual frames can then be digitally combined in a stacking program to create a final picture that shows faint details and is free of the noise that comes with the high ISO setting. As the sample images show, the results are quite astounding. For example, with a 135mm lens we captured detailed images of star clusters and nebulae, reaching a limiting magnitude of 14mag. Images shot with a 50mm lens easily captured star clouds and



The Great Sagittarius Star Cloud, imaged with a 50mm lens without tracking. All images were captured under the pristine skies of La Palma island. See text for exposure details.

Typical setup for untracked astrophotography; instrument requirements are minimal. All you need is a DSLR, a tripod and a remote release timer. You may want to add a lens hood and a right-angle viewfinder.

nebulae in the Milky Way with great detail.

What You Need

The imaging method is very simple and therefore instrument requirements are minimal. First of all, you will need one of the later DSLR models that allow ISO settings of 6400 or higher. As a lens, any wide angle, standard or tele lens will do, even the typical kit zoom lenses will work. A small but sturdy tripod is required for mounting and pointing the camera. For field work at remote sites we recommend the new, lightweight models (<0.5kg) with a ball head that are available from several manufacturers. The last mandatory item is a remote release timer that allows you to program a series of exposures. As an alternative, many of the newer DSLR models can be remote controlled via a smartphone app. Additionally, you might want to use a right-angle viewfinder and a lens hood. As the shopping list shows, any astrophotographer or nature-interested terrestrial photographer will probably already own most of these items. For this reason the method is ideal for casual astrophotography to capture a comet, a nova or simply to take some pictures of your favorite deep-sky objects during a vacation at a dark site.

How to Shoot

First of all, shoot at the darkest location and under the best skies you have access to. This will guarantee that the individual exposures already show the best contrast possible. After setting up your equipment, set the DSLR's picture mode to RAW, white balance to daylight and sensitivity to ISO 6400 or higher. Turn off any presets for noise reduction, sharpening or color enhancement. Switch your lens to manual focus and use magnified live mode to focus your lens on a brighter star. Finally, step down your lens at least one f-stop from wide open. This will reduce lens aberrations noticeably, especially when using a zoom lens. The next step is to program your remote release timer for a greater number of exposures, 100 is a good value to start with. When you set the exposure time for the individual frames, be aware that it is limited by the focal length of your lens. With a 50mm lens, 3-second exposures are fine, with a 135mm lens exposure time should be around 1 second. To determine the maximum exposure time for your specific DSLR and lens more precisely, use the formula given in the workflow tutorial that is available for free download (see link at the end of the article). If you keep your exposure times within the specified limits, the stars on your pictures will be nice and round without any signs of trailing. As soon as you have completed these steps, your camera is ready and it is time to frame your target. Point your DSLR at the star field, nebula or comet you want to image. Place the object slightly off center in the camera's viewfinder, so it will drift over the center during your exposure series. Start your timer and let your camera record the target. Once the exposure series is finished, cover your lens and shoot at least 10 dark frames with the same exposure settings. To give you an idea which settings work well, the images accompanying this article were shot at rural sites on La Palma Island with a Canon 1100D body set at ISO 6400 with series of 100 exposures each. We used a 50mm lens @f/2.8 and a 135mm lens @f/4 with 3 and 1 second exposures, respectively. Except that our Canon 1100D is modified for optimum H-alpha sensitivity, it is an ordinary, off-the-shelf APS-C sized camera body. Although an unmodified DSLR will record less red nebulosity it will still work very well for the method described.

Omega Centauri Cluster, imaged with a 135mm lens without tracking. Limiting magnitude is 14mag, see text for exposure details.

Processing the Images

Once you return from your imaging trip, star party, vacation or camping hike, it is time to develop the final images. As we mentioned above, the magic unfolds with the stacking of the individual exposures. This procedure cancels out the noise of the high ISO setting and enhances faint details as well as small stars. For the task of stacking the images there are many different programs available. We recommend the widely used freeware Deep Sky Stacker to start with, but any other stacking software will do the job as well (For tips on the parameter settings in Deep Sky Stacker follow the link to the tutorial at the end of the text). With the stacking software of your choice, simply import your exposure series as well as the dark frames and let the program register and digitally combine the individual frames. The result is a calibrated stack of your images that is practically noise-free. To get the maximum out of your resulting image you will then have to enhance it using an image processing software such as Photoshop.

Some Final Thoughts

As our experiments show, tracking is no longer an absolute requirement for stunning star field images. But

Deneb and the North America Nebula, imaged with a 50mm lens without tracking. See text for exposure details.

don't get us wrong: A stack of short untracked shots is no substitute for a stack of tracked long exposures, which will have a better signal-to-noise ratio in any case. Nevertheless, we find it very interesting how far a modern DSLR can go without any tracking. And with DSLR cameras getting more and more sensitive, this is only the beginning. As far as we can tell, even today there are a lot of possible applications for this method of untracked DSLR astrophotography. To name only a few:

- The technique is so simple that even beginners to astrophotography will easily master it. Therefore, it is no longer mandatory to buy an equatorial mount or sky tracker to get started with astrophotography.

- Instrument requirements of untracked DSLR astrophotography are minimal. Photographers who want to travel light to dark locations will have less weight to carry with them.

- The method is ideal in all situations when the photographer doesn't want to hassle with the complexity that comes with the use of an equatorial mount or tracking device.

The authors Karoline Mrazek and Erwin Matys are founding members of the astrophotography group project nightflight. Check out their images, tests and tools at www.project-nightflight.net

Orion Nebula M42, imaged with a 135mm lens. The colorful and noise-free picture is the result of a stack of 100 single exposures.

Download the Tutorial

A compact tutorial of the workflow described can be downloaded from the tests & tools section on our website. We prepared the tutorial for all fellow photographers, because this method provides an easy way to capture star fields, nebulae, star clusters, Milky Way regions and even binocular comets with minimal equipment. The full article, including the workflow tutorial can be downloaded here.

Scutum Star Cloud, imaged with a 50mm lens without tracking. Short focus lenses work especially well for capturing Milky Way vistas like this one. See text for exposure details.

From the Archives: March, 1976

Comet West – Brilliant, Unexpected Maverick – Now is it Comets West?

Aside from its unanticipated brilliance (consistently one to two magnitudes brighter than initial predictions), Comet West has managed to command the attention of professionals and amateurs with some interesting antics in the morning sky.

Its prominent tail has, on close observation, been seen to include a broad dust tail composed of a number of “synchronic bands‘, according to Z. Sekanina of the Center for astrophysics. “The bands showed a systematic translational motion of about 1.60 per day and rotated at about 13° per day relative to the faint plasma tail, one of them essentially coinciding with its southern border." On a print obtained March 5, Sekanina noted as many as 20 "synchronic bands‘, the most distant of which reached as far as 19 degrees from the nucleus,with "the dust tail extending to some 25 degrees. Sekanina explained that the dust tail was composed of postperihelion particle emissions, while a faint section northeast of the nucleus was made up of somewhat heavier particles emitted during the week before perihelion.

Brian G. Marsden of the Smithsonian Astrophysical Observatory speculated during the week of March 15 that Comet West might have broken up into a main cometary nucleus and as many as three smaller nuclei. Visual observations beginning March 5 indicated secondary nuclei at p.a. 50 degrees, separation 3", magnitude difference 0.5; another at 120 degrees, magnitude 0, no separation data; and one at 350 degrees, separated by about 4", magnitude difference 0.5. Reliable estimates on Comet West indicated a magnitude of -3.65 shortly after perihelion on February 26, viewed during daylight. The comet declined to magnitude 0 by March 3, approximately magnitude 1 on March 6, and was still at magnitude 1.8 late on March 5. Original predictions were that West should have been down to magnitude 3.2 on the 8th--so, given its rapid advance into dark skies, providing contrast, and its retained brilliance, Comet West was turning out to be everything Kohoutek wasn't.

Comet West was discovered in photographs by Richard West on August 10, 1975. It reached peak brightness in March 1976. During its peak brightness, observers reported that it was bright enough to study during full daylight. Despite its spectacular appearance, it did't cause much expectation among the popular media. The comet has an estimated orbital period of 558,000 years. Photo credit: J. Linder/ESO. [Source: Wikipedia]

April Observing: What to View

Jim Kvasnicka

This is a partial list of objects visible for the upcoming month.

Planets

Mercury: Low in the WNW shining as bright as -1.5 in early April.
Jupiter: Shines at magnitude -2.3 with a disk 41" wide.
Mars and Saturn: The two form a pair just above Antares. Mars rises around midnight with Saturn 40 minutes later. Mars increases in magnitude from -0.6 to -1.4. This is the largest Mars will appear in the last 10 years with a disk 16" wide.
Venus: Rises just a half hour before the Sun and after April 9th is not visible.
Uranus and Neptune: Both are not visible in April.

Meteor Showers

Lyrids: Peaks at 2:00 am the morning of April 22nd. This weak shower will be impacted by the full Moon.

Messier List

M40: Multiple star in Ursa Major.
M65/M66: Galaxies in the Leo Triplet Group.
M95/M96: Galaxies in Leo that fit in the same FOV.
M105: Galaxy in Leo.
M106: Galaxy in Canes Venatici
M108: Galaxy in Ursa Major.
M109: Galaxy in Ursa Major.
Last Month: M41, M44. M46, M47, M48, M50, M67, M81, M82, M93
Next Month: M49, M51, M61, M63, M64, M85, M94, M101, M102, M104

NGC and other Deep Sky Objects

NGC 2841: Galaxy in Ursa Major.
NGC 2903: Galaxy in Leo.
NGC 3184: Galaxy in Ursa Major.
NGC 3242: The Ghost of Jupiter in Hydra.
NGC 3384/NGC 3389: Galaxies in the same FOV with M105 in Leo.
NGC 3521: Galaxy in Leo.

Double Star Program List

Alpha Leonis: Regulus, white primary with a pale yellow secondary.
Gamma Leonis: Algieba, pair of yellow stars.
54 Leonis: Yellow primary with a greenish colored secondary.
Alpha Canum Venaticorum: Cor Caroli, blue-white and greenish yellow pair.
Zeta Ursa Majoris: Mizar, white pair.
Gamma Virginis: Porrima, close pair of yellow stars.
24 Comae Berenices: Yellow primary with a pale blue secondary.
Delta Corvi: White and rose colored pair.

Challenge Object

NGC 3995 Group: The brightest member in a trio of galaxies in Ursa Major. Other galaxies include NGC 3991 and NGC 3994.

Focus on Constellations: Leo

Jim Kvasnicka

Leo

Leo, the Lion is one of the most distinctive constellation patterns in the sky. The head and forequarters of the Lion are marked by the asterism called the sickle. Leo, as is typical of constellations off the Milky Way, contains many galaxies. A number of them are large and bright. Leo contains five galaxies with Messier numbers: M65, M66, M95, M96, and M105. The constellation contains several interesting double stars. One of them Algieba, Gamma Leonis, is one of the finest double stars in the sky. Leo contains the radiant of the Leonid meteor shower which peaks every year around November 17th. The constellation Leo is best seen in April.

Mythology

In Greek mythology the celestial Lion was associated with the Nemean Lion slain by Hercules as the first of his Twelve Labors. The Greeks inherited the Lion from the Babylonians before them. A common theme in Babylonian art is a battle between a Lion and a Bull with the Lion always defeating the Bull.

Number of Objects Magnitude 12.0 and Brighter

Galaxies: 58

Showpiece Objects

Galaxies: M65, M66, M95, M96, M105, NGC 2903, NGC 3521, NGC 3628
Multiple Stars: Alpha Leonis (Regulus), Gamma Leonis (Algieba), 54 Leonis, 88 Leonis

Photo: Till Credner - Own work: AlltheSky.com

Gravitational Wave Astronomy Will Be The Next Great Scientific Frontier

Ethan Siegel

This article is provided by NASA Space Place.
With articles, activities, crafts, games, and lesson plans, NASA Space Place encourages everyone to get excited about science and technology. Visit spaceplace.nasa.gov to explore space and Earth science!

Imagine a world very different from our own: permanently shrouded in clouds, where the sky was never seen. Never had anyone see the Sun, the Moon, the stars or planets, until one night, a single bright object shone through. Imagine that you saw not only a bright point of light against a dark backdrop of sky, but that you could see a banded structure, a ringed system around it and perhaps even a bright satellite: a moon. That's the magnitude of what LIGO (the Laser Interferometer Gravitational-wave Observatory) saw, when it directly detected gravitational waves for the first time.

An unavoidable prediction of Einstein's General Relativity, gravitational waves emerge whenever a mass gets accelerated. For most systems -- like Earth orbiting the Sun -- the waves are so weak that it would take many times the age of the Universe to notice. But when very massive objects orbit at very short distances, the orbits decay noticeably and rapidly, producing potentially observable gravitational waves. Systems such as the binary pulsar PSR B1913+16 [the subtlety here is that binary pulsars may contain a single neutron star, so it's best to be specific], where two neutron stars orbit one another at very short distances, had previously shown this phenomenon of orbital decay, but gravitational waves had never been directly detected until now.

When a gravitational wave passes through an objects, it simultaneously stretches and compresses space along mutually perpendicular directions: first horizontally, then vertically, in an oscillating fashion. The LIGO detectors work by splitting a laser beam into perpendicular "arms," letting the beams reflect back and forth in each arm hundreds of times (for an effective path lengths of hundreds of km), and then recombining them at a photodetector. The interference pattern seen there will shift, predictably, if gravitational waves pass through and change the effective path lengths of the arms. Over a span of 20 milliseconds on September 14, 2015, both LIGO detectors (in Louisiana and Washington) saw identical stretching-and-compressing patterns. From that tiny amount of data, scientists were able to conclude that two black holes, of 36 and 29 solar masses apiece, merged together, emitting 5% of their total mass into gravitational wave energy, via Einstein's $E = mc^2$.

During that event, more energy was emitted in gravitational waves than by all the stars in the observable Universe combined. The entire Earth was compressed by less than the width of a proton during this event, yet thanks to LIGO's incredible precision, we were able to detect it. At least a handful of these events are expected every year. In the future, different observatories, such as NANOGrav (which uses radiotelescopes to the delay caused by gravitational waves on pulsar radiation) and the space mission LISA will detect gravitational waves from supermassive black holes and many other sources. We've just seen our first event using a new type of astronomy, and can now test black holes and gravity like never before.

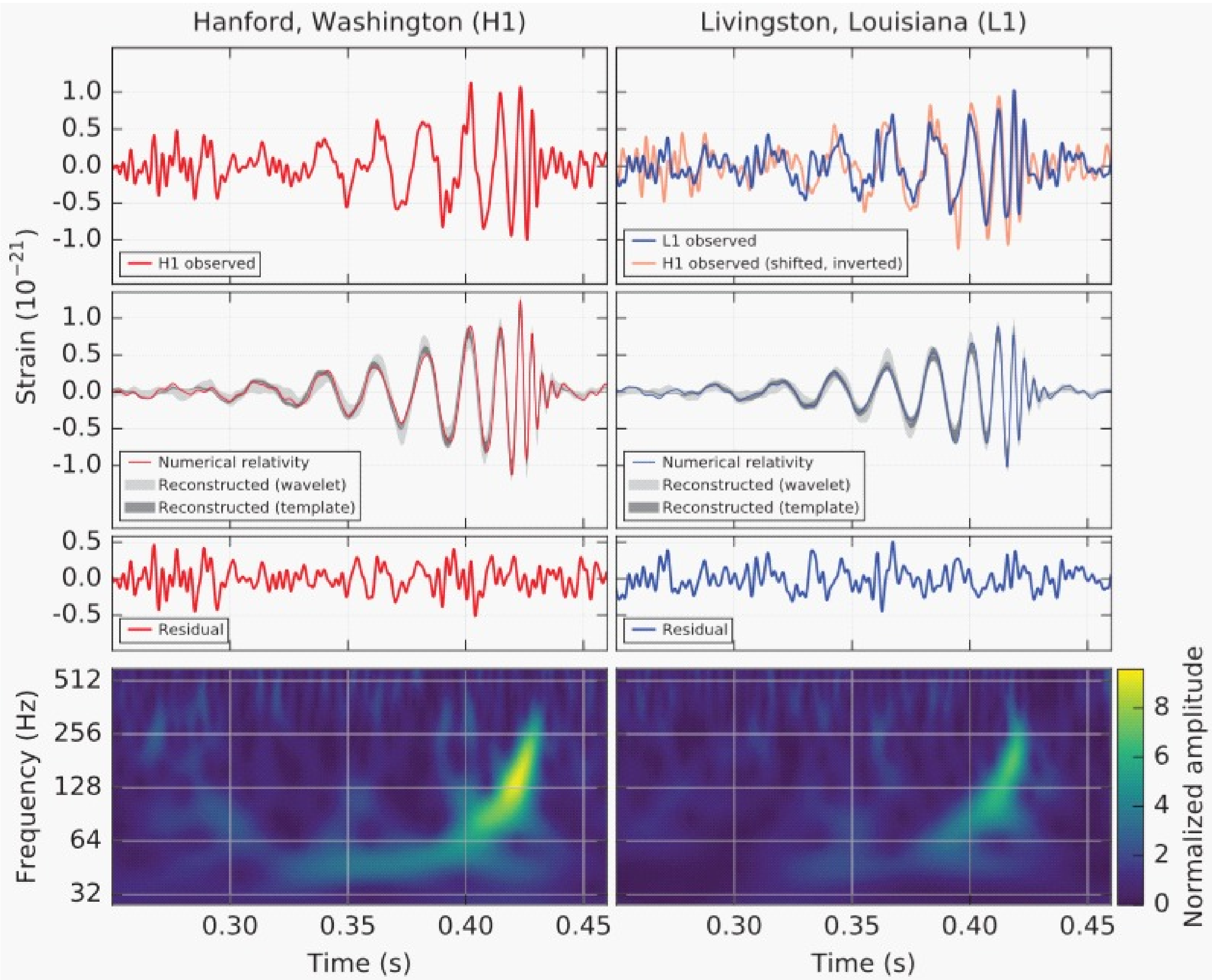


Image credit: Observation of Gravitational Waves from a Binary Black Hole Merger B. P. Abbott et al., (LIGO Scientific Collaboration and Virgo Collaboration), Physical Review Letters 116, 061102 (2016). This figure shows the data (top panels) at the Washington and Louisiana LIGO stations, the predicted signal from Einstein's theory (middle panels), and the inferred signals (bottom panels). The signals matched perfectly in both detectors.

The Bright Spots on Ceres Are Blinking

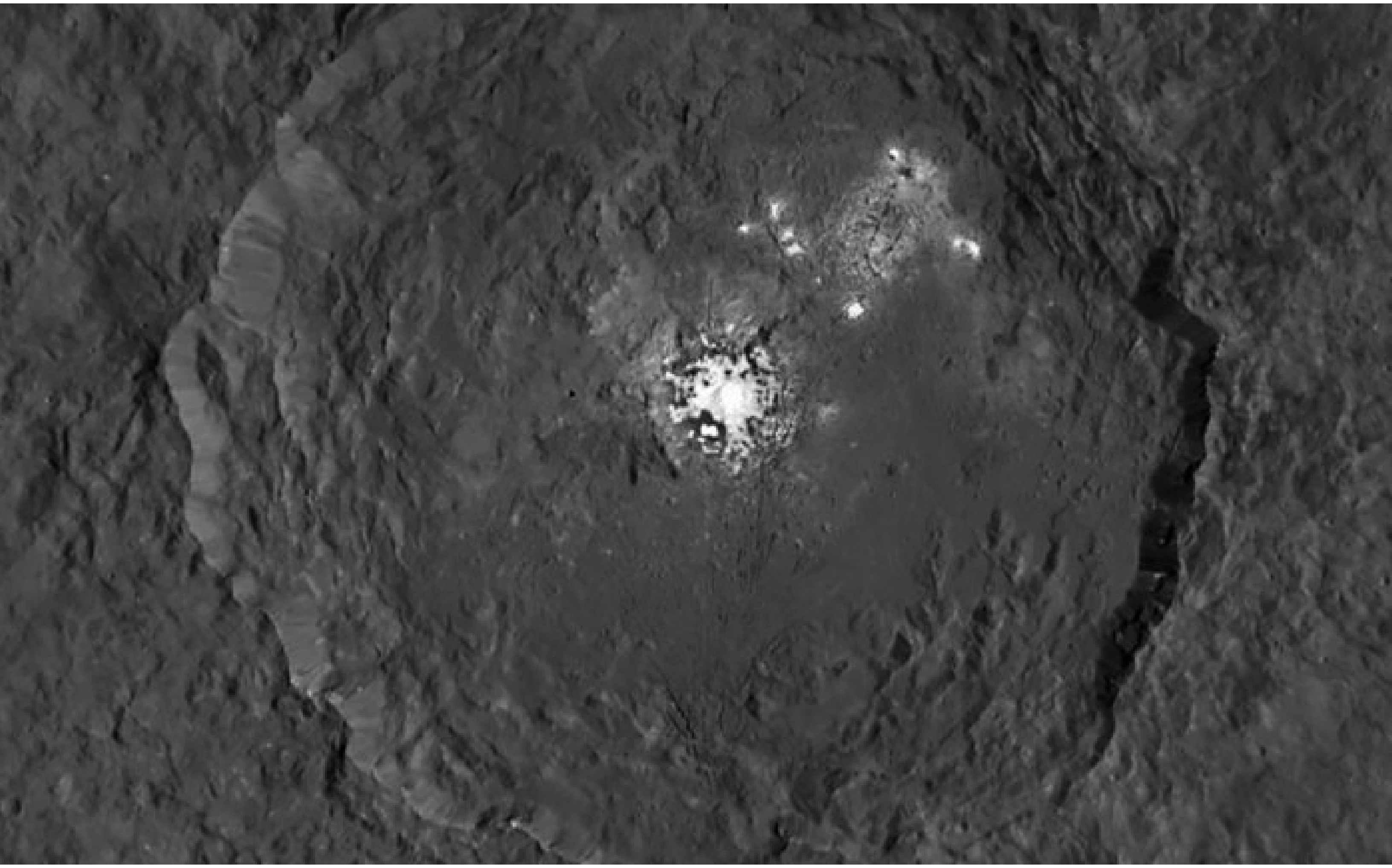
Jason Major, Universe Today

All right, maybe not blinking like a flashlight (or a beacon on the tippity-top of a communication tower—don't even start that speculation up) but the now-famous "bright spots" on the dwarf planet Ceres have been observed to detectably increase and decrease in brightness, if ever-so-slightly.

And what's particularly interesting is that these observations were made not by NASA's Dawn spacecraft, currently in orbit around Ceres, but from a telescope right here on Earth.

Researchers using the High Accuracy Radial velocity Planet Searcher (HARPS) instrument on ESO's 3.6-meter telescope at La Silla detected "unexpected" changes in the brightness of Ceres during observations in July and August of 2015. Variations in line with Ceres' 9-hour rotational period—specifically a Doppler effect in spectral wavelength created by the motion of the bright spots toward or away from Earth—were expected, but other fluctuations in brightness were also detected.

"The result was a surprise,"said Antonino Lanza from the INAF–Catania Astrophysical Observatory, co-author of the study. "We did find the expected changes to the spectrum from the rotation of Ceres, but with considerable other variations from night to night."



Bright reflective material in Ceres' Occator crater, imaged by NASA's Dawn spacecraft in Sept .2015. Credit: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA.

Watch a video below illustrating the rotation of Ceres and how reflected light from the bright spots within Occator crater are alternately blue- and red-shifted according to the motion relative to Earth.

First observed with Hubble in December 2003, Ceres' curious bright spots were resolved by Dawn's cameras to be a cluster of separate regions clustered inside the 60-mile (90-km) -wide Occator crater. Based on Dawn data they are composed of some type of highly-reflective materials like salt and ice, although the exact composition or method of formation isn't yet known.

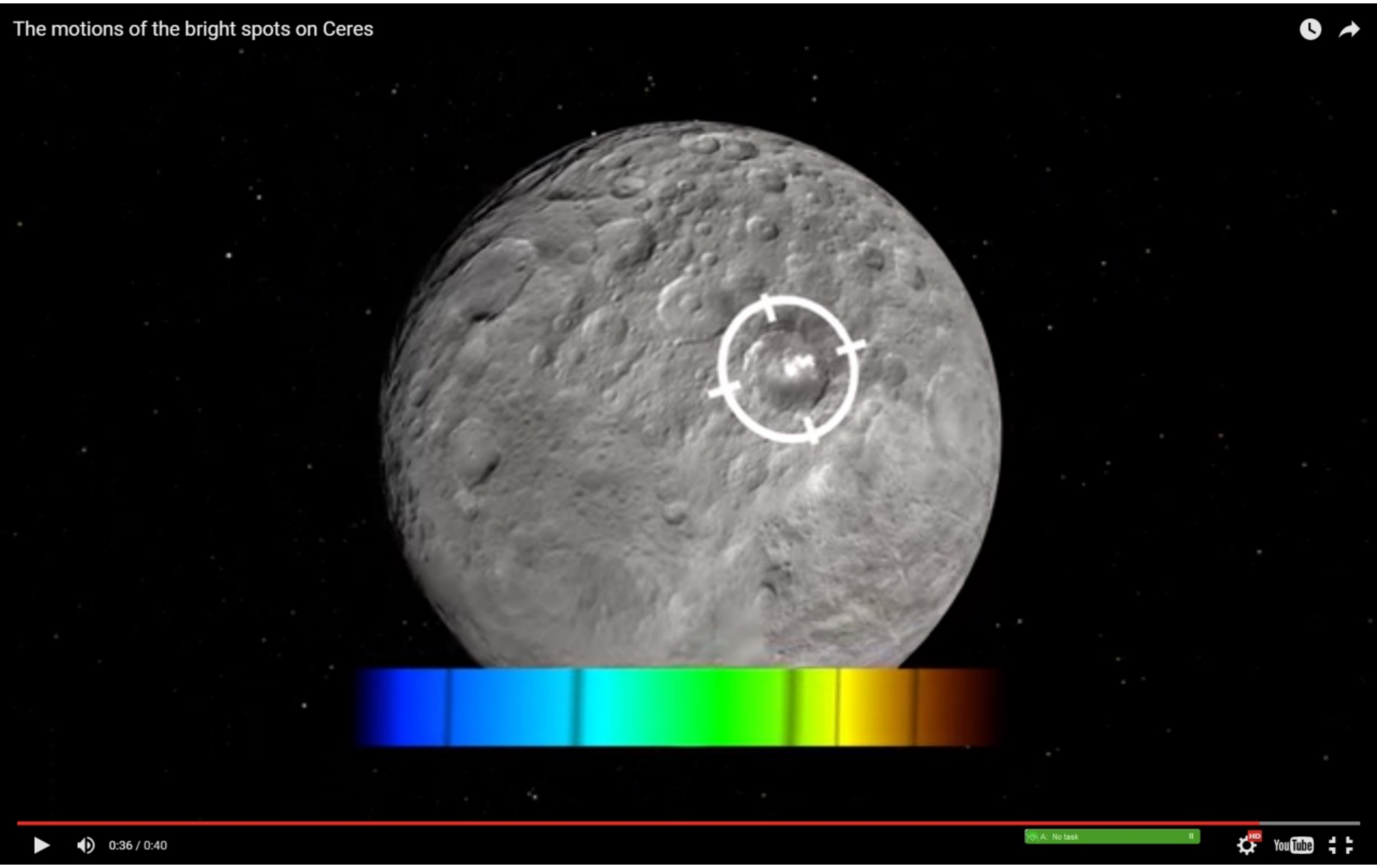
Since they are made of such volatile materials though, interaction with solar radiation is likely the cause of the observed daily brightening. As the deposits heat up during the course of the 4.5-hour Ceres daytime they may create hazes and plumes of reflective particles.

"It has been noted that the spots appear bright at dawn on Ceres while they seem to fade by dusk," noted study lead author Paolo Molaro in the team's paper. "That could mean that sunlight plays an important role, for instance by heating up ice just beneath the surface and causing it to blast off some kind of plume or other feature."

Once day turns to night these hazes will re-freeze, depositing the particles back down to the surface—although never in exactly the same way. These slight differences in evaporation and condensation could explain the random variation in daily brightening observed with HARPS.

These findings have been published the journal Monthly Notices of the Royal Astronomical Society (full text on arXiv here.)

Source: ESO



Youtube link: https://www.youtube.com/watch?v=AN9MxTDyqww

CLUB MEMBERSHIP INFO

REGULAR MEMBER - $30.00 per year. Includes club newsletter, and 1 vote at club meetings, plus all other standard club privileges.

FAMILY MEMBER - $35.00 per year. Same as regular member except gets 2 votes at club meetings.

STUDENT MEMBER - $10.00 per year with volunteer requirement.

If you renew your membership prior to your annual renewal date, you will receive a 10% discount.

Club members are also eligible for special subscription discounts on Sky & Telescope Magazine.

CLUB TELESCOPES

To check out one of the club telescopes, please contact a club officer. Scopes can be checked out at a regular club meeting and kept for one month. Checkout can be extended for another month if there are no other requests for the telescope, but you must notify a club officer in advance.

100mm Orion refractor: Available
10 inch Meade Dobsonian: Checked out to Lee Taylor
13 inch Truss Dobsonian: Available

CLUB APPAREL

Order club apparel from cafepress.com:

Shop through Amazon Smile to automatically donate to PAC:

CLUB OFFICERS

President	Jim Kvasnicka (402) 423-7390 jim.kvasnicka@yahoo.com
Vice President	Brett Boller proboller86@yahoo.com
2nd VP (Program Chair)	Beth Jenckes beth.jenckes@yahoo.com
Secretary	Lee Taylor otaylor88@gmail.com
Treasurer	John Reinert jr6@aol.com
Club Observing Chair	Jim Kvasnicka jim.kvasnicka@yahoo.com
Outreach Coordinator	Dan Delzell dan@delzell.net
Website and Newsletter Editor	Mark Dahmke mark@dahmke.com

The Prairie Astronomer is published monthly by the Prairie Astronomy Club, Inc. Membership expiration date is listed on the mailing label. Membership dues are: **Regular $30/yr, Family $35/yr**. Address all new memberships and renewals to: **The Prairie Astronomy Club, Inc., PO Box 5585, Lincoln, NE 68505-0585**. For other club information, please contact one of the club officers listed to the right. Newsletter comments and articles should be submitted to: **Mark Dahmke, P. O. Box 5585, Lincoln, NE 68505 or** mark@dahmke.com**,** no less than ten days prior to the club meeting. The Prairie Astronomy Club meets the last Tuesday of each month at Hyde Memorial Observatory in Lincoln, NE.