Southwest Florida Astronomical Society
SWFAS

The Eyepiece
March 2015

Contents:

A MESSAGE FROM THE PRESIDENT

Times, they are a changing… Don't forget Daylight Savings Time starts on the 8th.

We have had several very good events in February. Doug reported that the Shell Point Star Party was a great success. The Rotary Park Star Party was a great success too. The next day we had a good time at the Edison Day of Discovery/STEMtastic. Harn's Marsh was cold but clear. The next night with Kelly at the Astronomy for Amatuers was also a beautiful (and warmer) night. On the 28th, the Burrowing Owl Festival looked like it was going to be cloudy, but we had a number of hours of good seeing.

I want to thank all who came out and helped at these events. Those who I know were at events include Don Palmer, Tony Heiner, Dick Gala, Carol Stewart, Doug Heatherly, Carol Morin, John MacLean, Chuck Pavlick, Ron Madl, Brian Shultis, Tom Segur and Gary McFall. Tony Heiner and Tom Segur have also been doing a lot of events in Charlotte County as well.

I have been asked by members if we have any eyepieces for sale. Well, Tony has obtained some surplus eyepieces and many of these will be on sale at the meeting. I will send more details out on these before the meeting. Many are Meade/Orion Plossls, Celestron Erfles, Orthos and Kellners, Edmund Orthos and RKE and a few other misc eyepieces and accessories.

The March program is on Planetary Nebulae by Heather Preston. Last month's program by Prof. Derek Buzasi was great. We have another program from Jack Berninger on the Search for ETs scheduled for the April meeting.

Don't forget, it is annual dues times. Please pay Tony at the meeting or mail it to our PO Box:
Southwest Florida Astronomical Society, Inc. P.O. Box 100127 Cape Coral, FL 33910
Dues are $20.00 (If you paid in the last quarter of 2014, you have paid for 2015)

Brian

In the Sky this Month

Moon: March – Full, 5th; Last Quarter, 13th; New, 20th; 1st Quarter, 27th.

The Planets:

Venus will dominate the western sky during dusk at -4.0 magnitude. The sunlit portion of its disc will reduce from 86 to 78 % during the month as its orbit closes with the earth.

Mars glimmers dimly at 1.4 magnitude. It starts the month about 4° below Venus, but they're 17° apart by month's end.

Uranus is found within a degree of Venus on the 4th, and within a degree of Mars on the 11th. Finder charts for Uranus are located at **skypub.com/urnep**.

Jupiter will be featured all month long high in the east until midnight at magnitude -2.4.

Saturn will be rising around midnight at magnitude 0.4. It will linger all month near the head of the Scorpion.

Comet Lovejoy – The comet continues to surprise by being bright enough for binocular viewing early in March. See article below for finder chart.

International Space Station: Only opportunities for viewing this month are in the morning. Best is March 8 after 7 am. Check website for accurate times.
http://www.heavens-above.com/

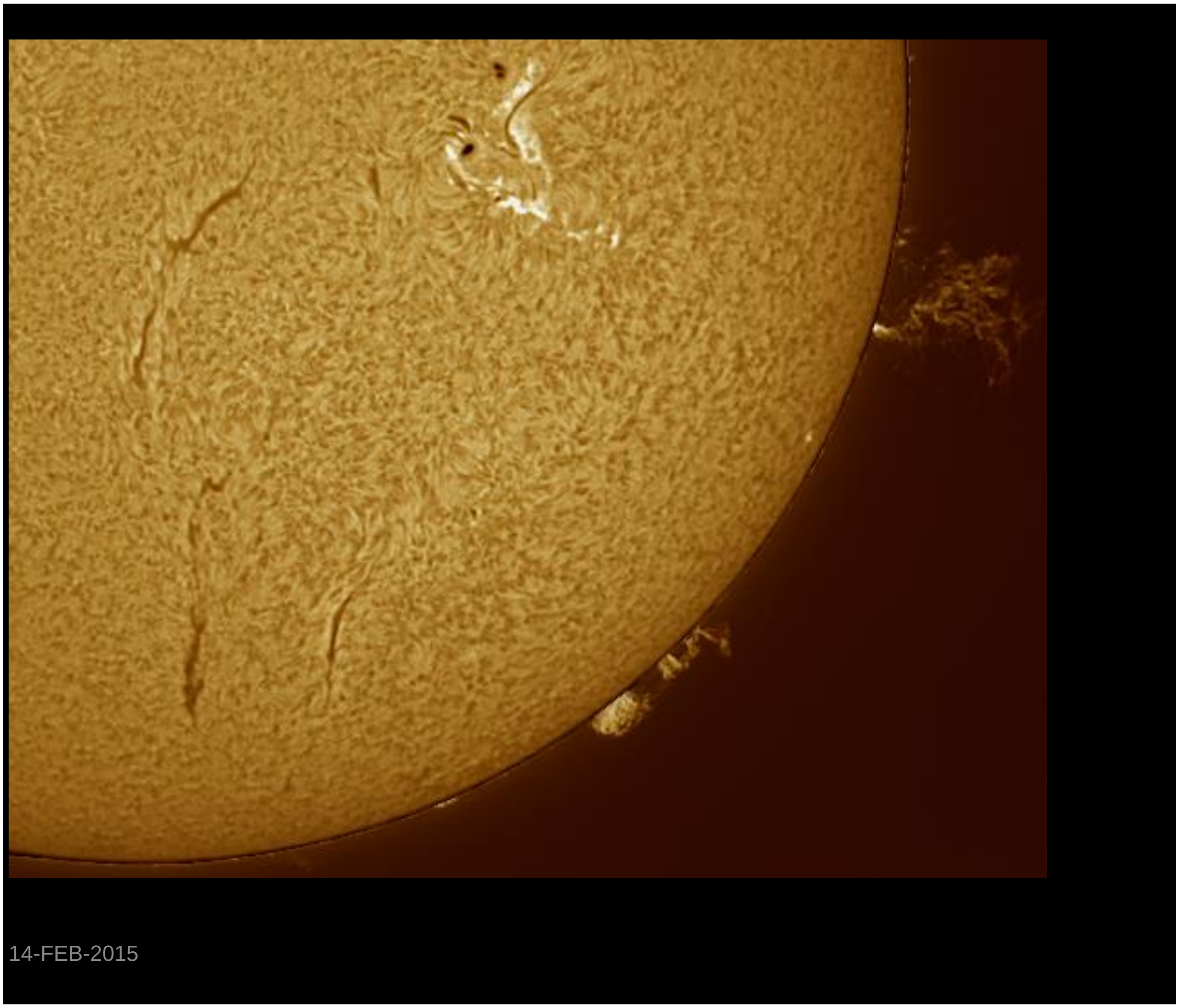
Photos by Chuck Pavlick

Jupiter 02-23-15

Red spot, Ganymede with shadow
Telescope: Celestron edge 9.25
Camera: DMK 21AU618 with Orion RGB filters
2x Televue Barlow

Leo Triplet

Telescope: William Optics FLT 110 F/7 w/Field Flattener
Mount: AP Mach 1 - Orion Mini guider
Camera: SBIG 8300 c
Subs: 7 @ 600sec.
Taken at the Fakahatchee Strand



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Future Events

Star Party and Event Schedule

Date	Event	Location	Time	Info/Contact
Thursday, March 5th	Monthly Meeting	Calusa Nature Center & Planetarium	7:30 pm	Brian Risley
Saturday March 21st	Star Party	CRP	Dusk	Bruce Dissette
Thursday April 2nd	Monthly Meeting – Program: Jack Berninger	Calusa Nature Center & Planetarium	7:30program followed by business meeting	Brian Risley
April 18th	Star Party		Dusk	Bruce Dissette
Thursday May 7th	Monthly Meeting – Program: TBD	Calusa Nature Center & Planetarium	7:30 pm	Brian Risley
May 16th	Star Party		Dusk	Bruce Dissette
Thursday June 4th	Monthly Meeting – Program: TBD	Calusa Nature Center & Planetarium	7:30 pm	Brian Risley
June 13th	Star Party		Dusk	Bruce Dissette
Thursday July 2nd	Monthly Meeting – Program: TBD	Calusa Nature Center & Planetarium	7:30 pm	Brian Risley
July 18th	Star Party		Dusk	Bruce Dissette
Thursday August 6th	Monthly Meeting – Program: TBD	Calusa Nature Center & Planetarium	7:30 pm	Brian Risley
August 15th	Star Party		Dusk	Bruce Dissette
Sept. 12th	Star Party		Dusk	Bruce Dissette
October 10th	Star Party		Dusk	Bruce Dissette
November 14th	Star Party		Dusk	Bruce Dissette
December 12th	Star Party		Dusk	Bruce Dissette

Minutes of December SWFAS Meeting – February 5th, 2015

The regular monthly meeting of the Southwest Florida Astronomical Society was called to order at 7:32 pm by president Brian Risley in the Calusa Nature Center Planetarium.
There were 40 people present, including 9 new members / visitors.
Members should see Tony Heiner or mail in annual dues for 2015.
The annual audit by Chuck Pavlick reported that all financial matters are in good order. Brian Shultis moved and Bruce Dissette seconded that the report be accepted. The motion carried on a voice vote.
Past events listed on the printed agenda were reviewed. All were successful in spite of varied skies at some.
Upcoming events listed in the printed agenda were discussed.
The March program will be a presentation on Planetary Nebulae by Heather Preston.
April will be the Search for ETs by Jack Berninger.
It was pointed out that the February newsletter contained several astrophotos from members. Members' contributions are welcomed.
Brian Shultis made a motion, seconded by Carlos Perosio, to approve the December 4, 2014 minutes as e-mailed. The motion carried on a voice vote.
Treasurer Tony Heiner reported a December 2014 balance of $2116.09. Brian Shultis made a motion, seconded by Bruce Dissette, to accept the report. The motion carried on a voice vote. Tony reported a January 2015 balance of $2133.87. Brian Shultis made a motion, seconded by Dick Gala, to accept the report. The motion carried on a voice vote.
Chuck Pavlick reported good dark skies at Fakahatchee. Bruce Dissette reported that the January star party at Caloosahatchee Regional Park was good.
Equipment Coordinator Brian Risley reminded us that telescopes are available for checkout.
Website coordinator Bill Francis is continuing to work on the website. Becky Brooks suggested that a presence on various social media would be a good outreach method and way to disseminate current information. There was consensus that this would be a good idea.
Astronomical League Coordinator Carol Stewart reported that membership info has been updated through December 2014, and also that the League has an observation sketching program.
The business meeting was adjourned at 8:04.
FGCU Professor Derek Buzasi presented a program on the search for extrasolar planets, including methods of finding them, characterizing them, a current census overview, and what we have learned about how solar systems form and evolve.

submitted by Don Palmer, secretary

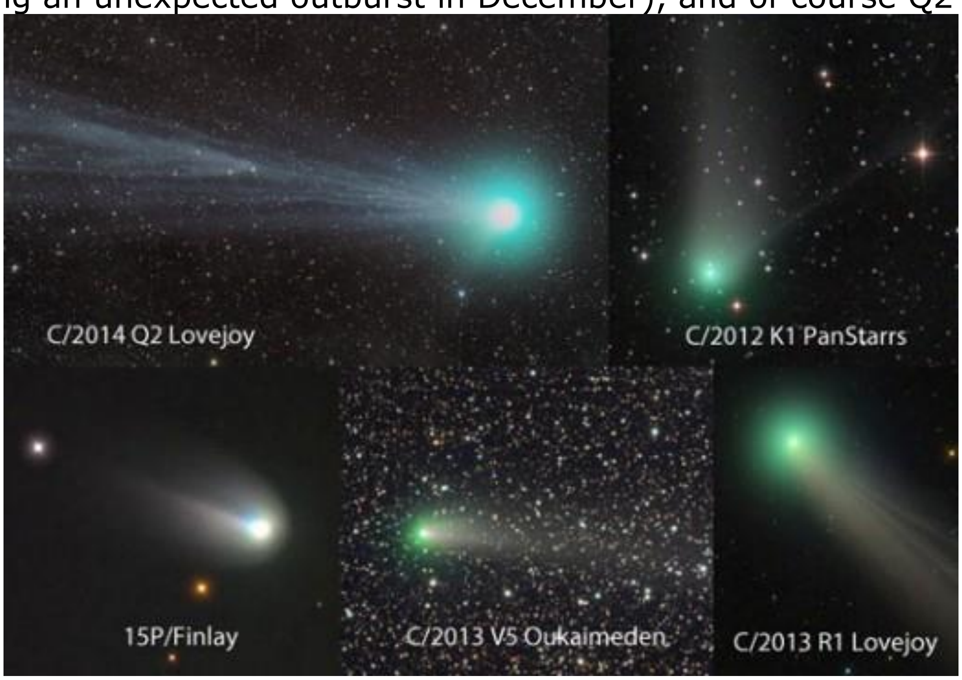
Has Comet Q2 Lovejoy stoked you to see more of these celestial travelers?
We look into the crystal ball to see what's coming in 2015.

A new year means new comets. Several are predicted, but will they live up to expectations?

How fortunate we are to begin 2015 with a naked eye comet. Many of you have undoubtedly seen Terry Lovejoy's most recent discovery, C/2014 Q2 Lovejoy, either in the flesh or in photos across the Web. Topping out around magnitude +3.8 earlier this month, this icy blue gem still hovers around +4.5 as January draws to a close. Who knows — Q2 may turn out to be the best comet of the year.

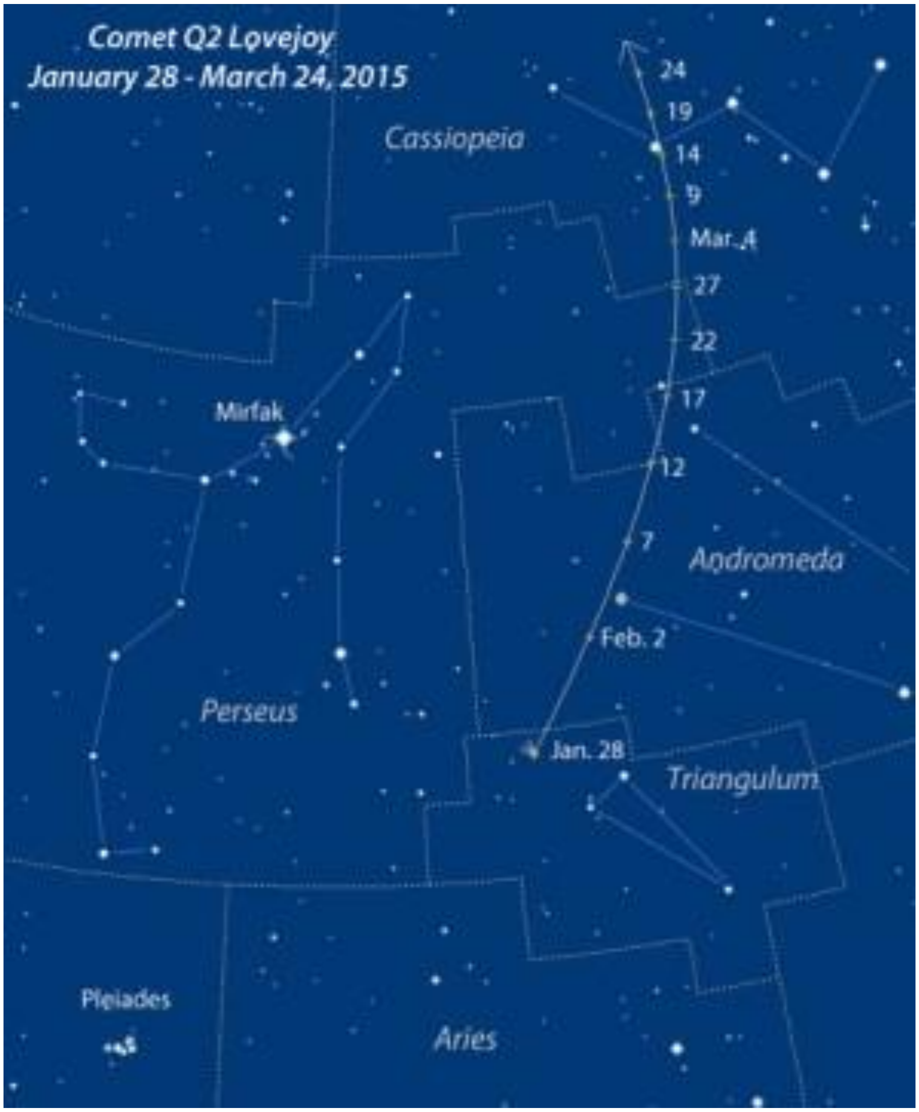
Looking back, 2014 was a generous one for bright comets. Bright could mean "visible with the naked eye," but since naked-eye comets are so scarce, we'll choose a slightly different definition which (I hope) comet aficionados will find acceptable. How about anything visible in an ordinary pair of 7 x 50 binoculars from a reasonably dark sky? That would set our limiting magnitude at about +8.

Using this criterion, 2014 presented skywatchers with six bright comets — C/2013 R1 Lovejoy (6th magnitude in January); C/2014 E2 Jacques (7 in August); C/2013 V5 Oukaimeden (+6.5 in September), C/2012 K1 PanSTARRS (+7.5 in October), 15P/Finlay (briefly at +8.7 during an unexpected outburst in December), and of course Q2 Lovejoy (+5.0 in December).



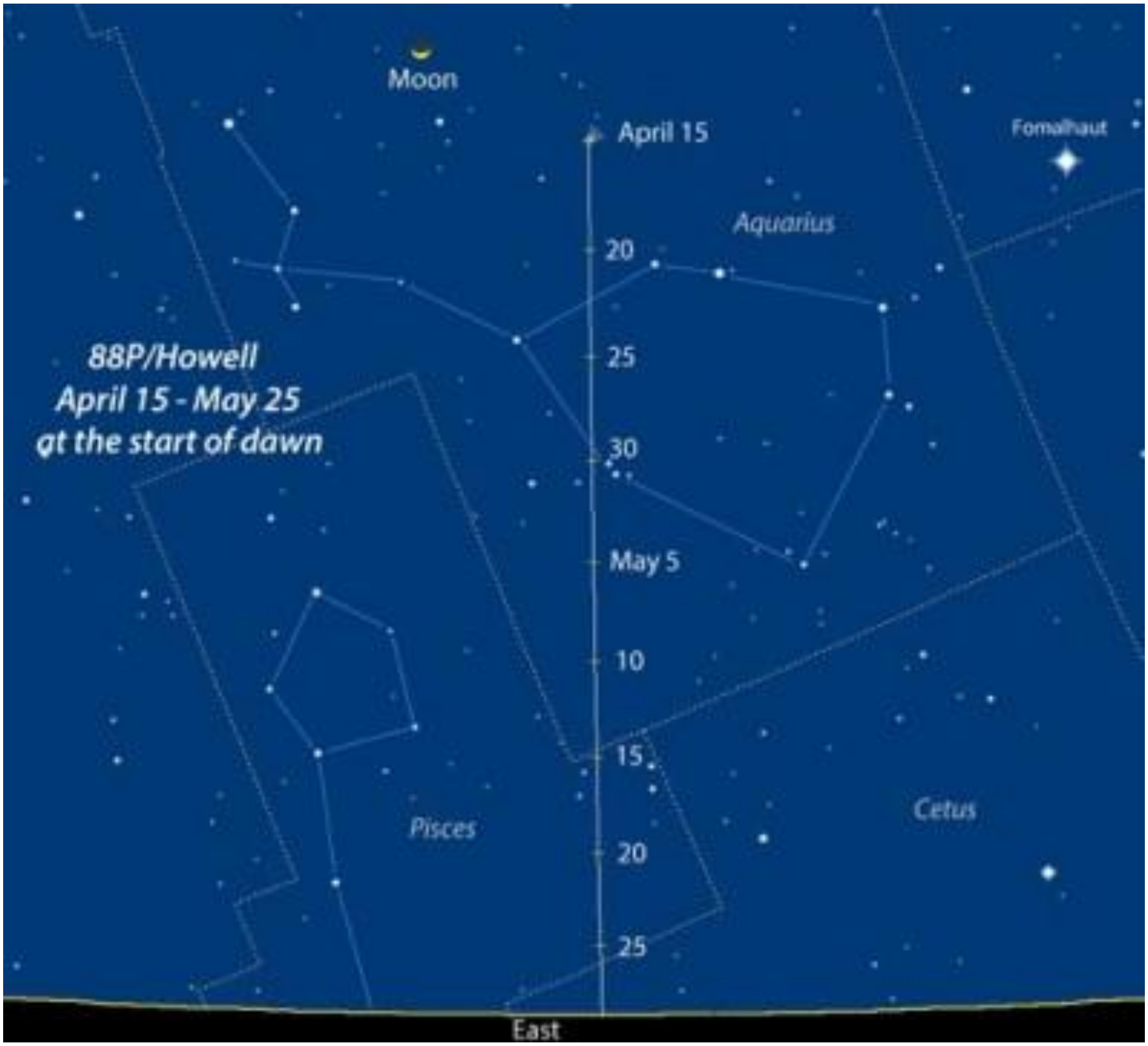
Five of the six comets that reached magnitude +8 or brighter in 2014: C/2014 Q2 Lovejoy (Rolando Ligustri), C/2012 K1 PanStarrs (Damian Peach), 15P/FInlay (Efrain Morales Rivera), C/2013 V5 Oukaimeden (Damian Peach), and C/2013 R1 Lovejoy (Damian Peach)

2015 began with a bang with Lovejoy and a second surge from from 15P/Finlay to magnitude +7.5 in mid-January, but we'll soon enter the doldrums as Q2 Lovejoy fades below 6th magnitude sometime next month.



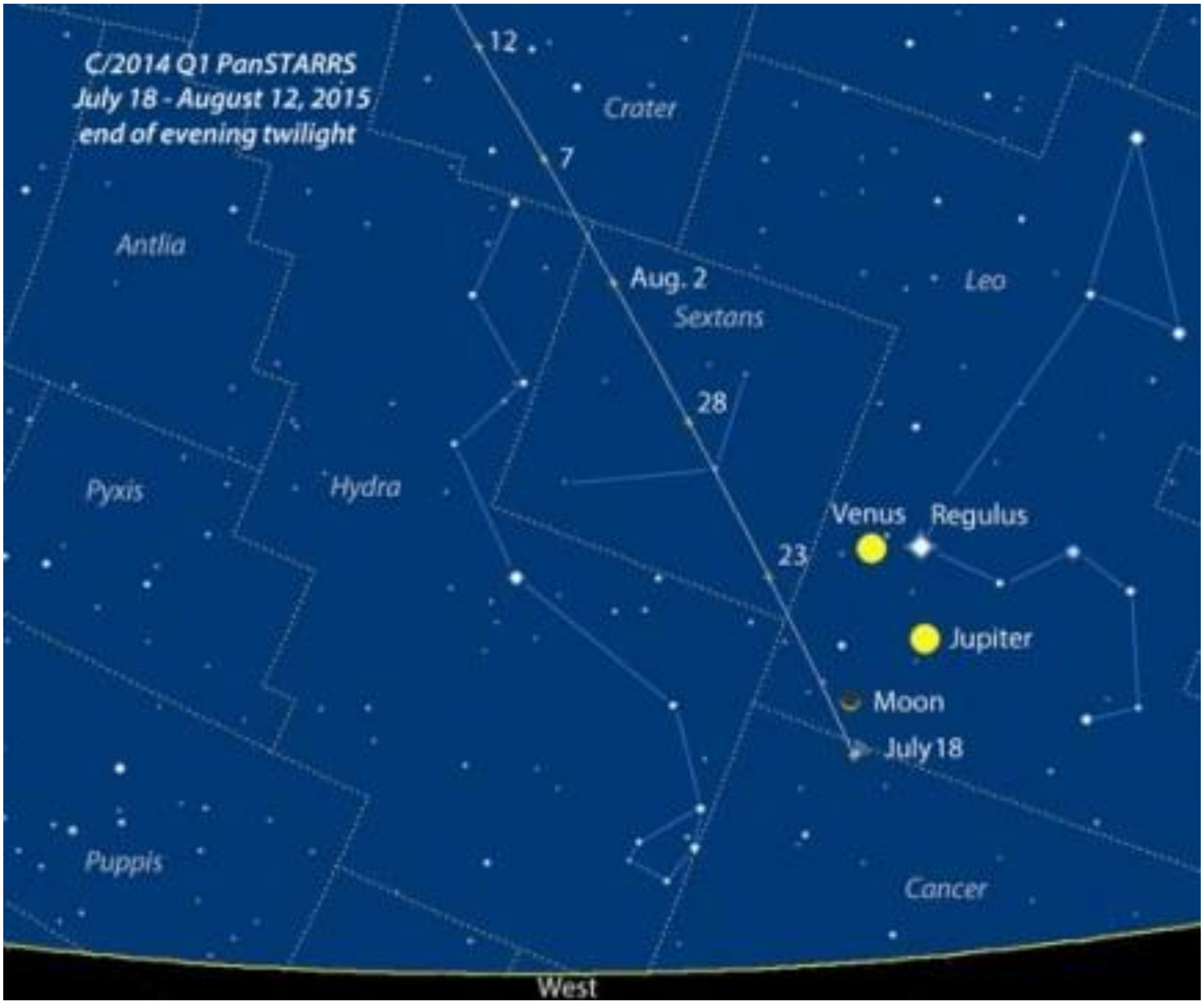
Comet Q2 Lovejoy's position plotted every five days, January 28 through March 24, 2015 at 8 p.m. (CST). The comet is currently still bright at magnitude +4.5 and high in the western sky at nightfall. Click to enlarge.
Source: Chris Marriott's SkyMap software

Barring the discovery of a bright newcomer, the new year offers up three bright entries: 88P/Howell, C/2014 Q1 PanSTARRS, and C/2013 US10 Catalina. Let's look at each in turn.



Comet 88P/Howell puts on a nice show around the start of morning twilight in the eastern sky as seen from the southern hemisphere (Alice Springs, Australia here). Although the comet tracks east, the Sun does likewise, so the comet maintains a steady altitude of 30°-35°. Moon shown for April 15th. Click to enlarge.
Source: Chris Marriott's SkyMap software

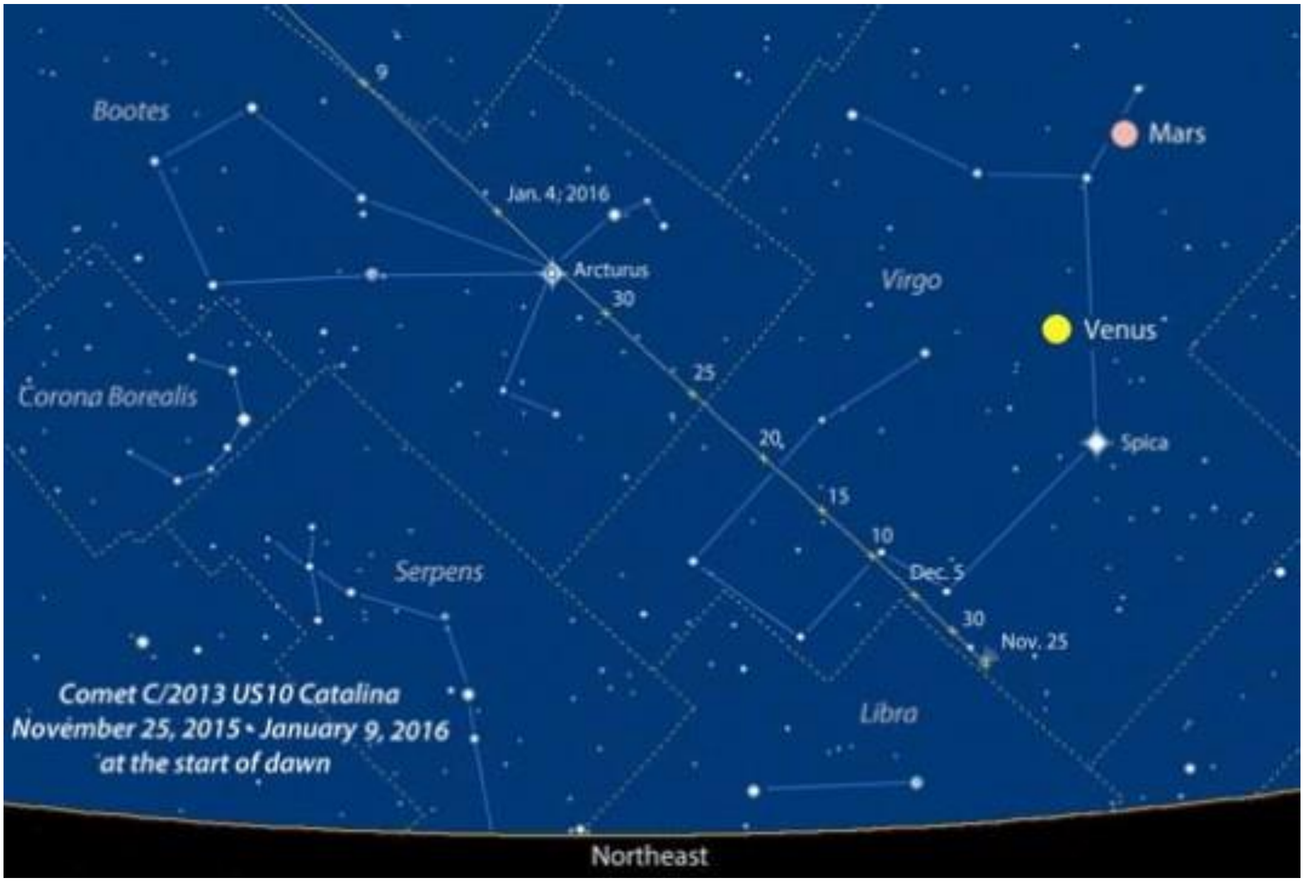
* ***88P/Howell*** — Discovered with the 0.46-m Schmidt telescope at Palomar Observatory on 1981. It reaches perihelion on April 6th, when it could become as bright as 8th magnitude. Northerners need not apply — this comet will be only be visible from the southern hemisphere during the fall season (April, May). **More** on 88P.



Like 88P, Comet Q1 PanSTARRS is best seen from the southern hemisphere (Alice Springs, Australia here) during the winter months July and August. On July 18 (shown here) the comet joins the crescent Moon, Jupiter, and Venus for a spectacular gathering in the west at nightfall. Click to enlarge.
Source: Chris Marriott's SkyMap software

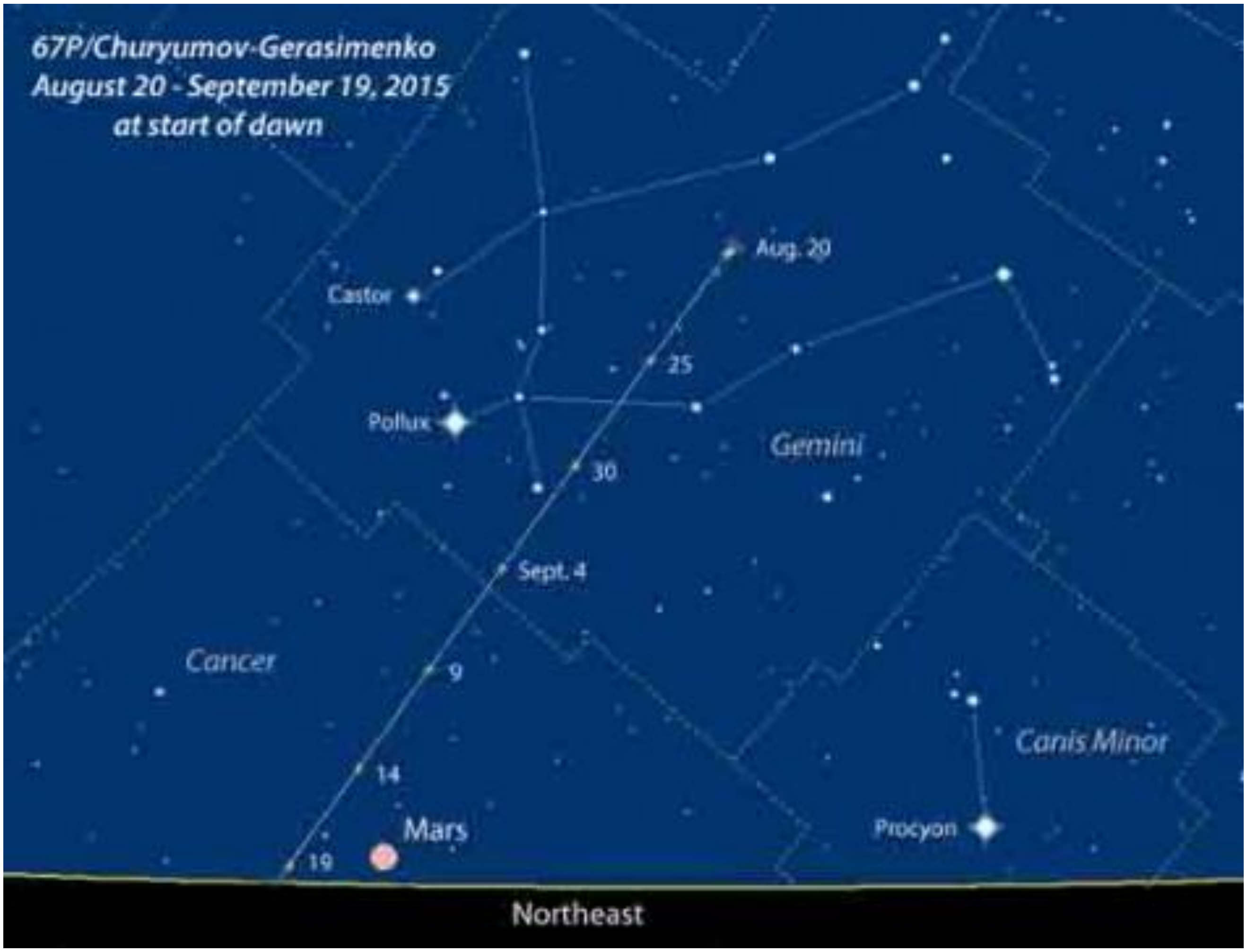
* ***C/2014 Q1 PanSTARRS*** — Not only is Hawaii the surfing capital of the world, but it's lately become a hotbed of comet discovery thanks to the **Panoramic Survey Telescope & Rapid Response System** (PanSTARRS) survey atop Mt. Haleakala, a favorite tourist destination. Created to discover and characterize Earth-approaching asteroids and comets, the automated survey has bagged more than **80 new comets** since full-time science operations began in 2010.

Discovered in August 2014, Q1 PanSTARRS will reach perihelion on July 6, 2015, after passing just 0.3 a.u. from the Sun. Expectations are high for it to grow a long, bright tail and possibly crest to magnitude +3 at nightfall during July and early August in the middle of southern winter.



Comet US10 Catalina should become an easy naked-eye object at around magnitude +3 in the pre-dawn sky from northern latitudes from November 2015 into January 2016. Planet positions shown for Nov. 25th. Map shows the sky facing northeast shortly before dawn from the central U.S. Click to enlarge. *Source: Chris Marriott's SkyMap software*

* ***C/2013 US10 Catalina*** — Finally, northern folk get their due! US10 was discovered by the **Catalina Sky Survey** on Halloween 2013. For much of the year, the comet remains the province of southern hemisphere skywatchers. In late July and early August, it reaches magnitude +7 and becomes a south circumpolar object. By late September the comet achieves naked eye visibility (6th magnitude). After perihelion on November 15th perihelion, it surges into view for northern hemisphere skywatchers and peaks at around magnitude +3. As 2015 gives way to 2016, US10 remains bright as it buzzes Arcturus on New Year's night.



All eyes will be on Comet 67P when it emerges from the dawn in late August and peaks at 10th magnitude (possibly 9th) in late September. Map shows the sky facing northeast at the start of dawn from the central U.S. Although the comet tracks east, the Sun does likewise, so the comet maintains a steady altitude of 20-25°. Click to enlarge.
Source: Chris Marriott's SkyMap software

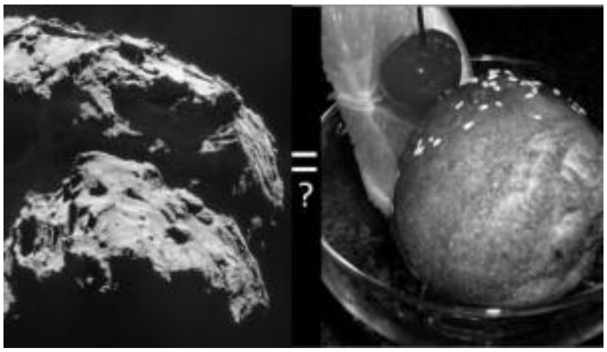
One last comet that *must* be mentioned, even if it's not expected to surpass 10th magnitude, is **67P/Churyumov-Gerasimenko**. Thanks to the **Rosetta mission**, 67P has become the most intensely interesting comet in recent years. After months of close-up photos of the comet's nucleus, amateur astronomers are eager to see "Chury" for themselves. We'll have our chance in late August when it returns to the morning sky in Gemini-Cancer following perihelion on the 13th.

While comets seem sparse this year, there's no telling when a new one will blow out of nowhere and surprise us all. Old, familiar ones sometimes experience bright outbursts as well. Their unpredictability just keeps us coming back for more.

Deep Fried Comet Ice

By: Camille M. Carlisle

Scientists studying ice here on Earth think they've confirmed why comets have hard crusts covered in hydrocarbon gunk. Comets are hodgepodge objects of ice and rock, with relatively "soft" (read: porous) interiors and hard exteriors — so hard, in fact, that the Philae lander from ESA's Rosetta orbiter broke its hammering tool trying to penetrate the surface of Comet 67P/Churyumov-Gerasimenko. Like several comets before it, Comet C-G's nucleus has also proven remarkably dark (basically like charcoal) and seems to be coated with organics.



Lab tests suggest that comet nuclei might be a lot like fried ice cream, with hard crusts created by heating the softer stuff they're made of.
Comet: ESA / Rosetta / NAVCAM; Ice Cream: Diane / Wikimedia Commons

It's hard to get to a comet, so Antti Lignell (Caltech) and Murthy Gudipati (JPL) explored super-cold ice laced with hydrocarbons in the lab. They watched what happened as ice transitioned from an amorphous state — in which ice crystals are stuck together haphazardly — to a harder, crystalline state as they heated it. (Only crystalline ice, with its ordered lattices, exists naturally in Earth conditions.) The scientists report in *Journal of Physical Chemistry A* that, as the ice went from amorphous to crystalline, it coughed up its hydrocarbons as aggregates, making space for the ice to build its stiff lattice.

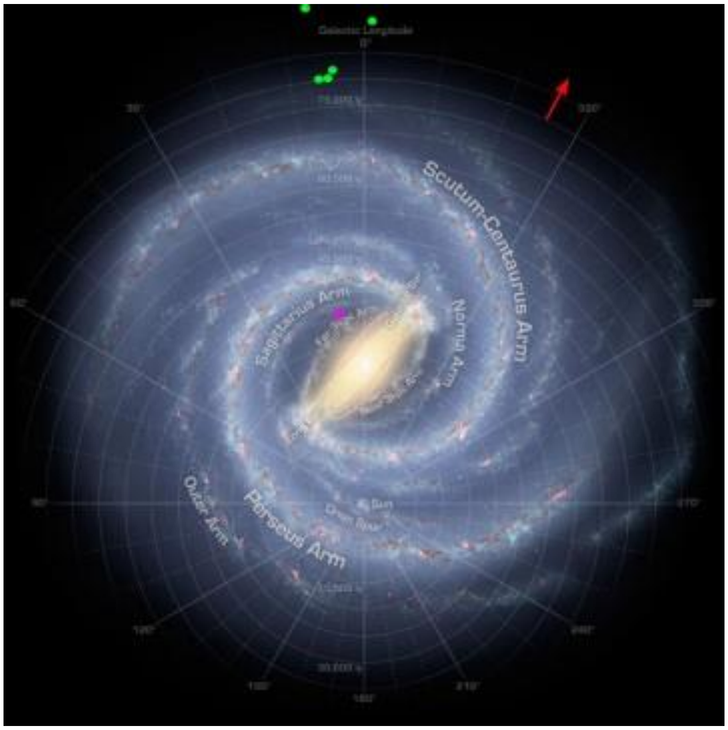
This process is kind of like how brine freezes: the ice doesn't incorporate salt molecules into its lattice, so the residual liquid just gets saltier and saltier.

These results support what many researchers assume: there are deep deposits of fluffy organics on periodic comets' surfaces, explaining their dark coloring. And the surface that Philae tried to drill into was certainly harder than amorphous water ice. But even if in approaching the Sun the comet builds up a crystalline ice crust and hydrocarbon surface layer, it's still unclear what happens when things get too hot for the ice altogether: comets may lose a meter in depth as sunlight sublimates the ice, so whether the comet would shed this crusty stuff and what that would do to the situation isn't known.

Cepheids Map Milky Way – and Beyond

By: Monica Young

Cepheid variable stars are helping astronomers see what our galaxy looks like from within.



This annotated map of the Milky Way galaxy shows the rough location of the Cepheid stars discussed in three independent studies: Dekany et al. (purple), Chakrabarti et al. (red arrow, since they lie far off the galactic disk), and Feast et al. (green). *NASA / JPL-Caltech*

How many spiral arms does the Milky Way have? How far does its disk extend? Even the simplest questions about the galaxy we call home are still up for debate. Now, in what is likely only the beginning of a larger effort, three independent studies are using a famous class of pulsating star to map out hidden reaches of the Milky Way.

Classical Cepheid variables are aging massive stars whose fame derives from their bid to avoid gravitational collapse. Having run out of hydrogen to fuse in their cores, they struggle to burn shells of helium instead, puffing up and deflating at a rate directly tied to their intrinsic luminosity.

That deceptively simple relation, which Henrietta Leavitt discovered in 1908, has led to profound revisions in everything from the shape and extent of our galaxy to the fate of the universe.

Now astronomers are increasingly studying Cepheids in near-infrared light, and they are beginning to pierce the veils of dust and gas that enshroud the Milky Way.

“Our knowledge of galactic structure is rather unsatisfactory . . . no consensus exists,” says Daniel Majaess (Saint Mary’s University and Mount Saint Vincent University, Canada).

That’s what motivates surveys such as VISTA Variables in Vía Láctea (VVV). The VISTA telescope at Paranal Observatory in Chile has already cataloged about a billion point sources. Since 2010, it has returned again and again to look at their variability over time. The VVV survey is expected to turn up hundreds of classical Cepheids — an incredible number when you consider the importance of just two Cepheids on the far side of the Milky Way.

The Twins

Seeing through the Trifid Nebula, Dekany et al. glimpsed two Cepheids on the far side of the galaxy. *ESO / VVV consortium / D. Minniti*

István Dékány (Millenium Institute of Astrophysics, Chile, and Pontificia Universidad Católica de Chile), Majaess, and colleagues announced the discovery of two Cepheids 37,000 light-years from Earth and 11,000 light-years from our galaxy’s center. The pair is remarkably close, separated by only 3 light-years, and both are between 45 million and 51 million years old.

Given their similarities, these Cepheids were most likely born in the same star cluster in the “Far 3 kpc Arm,” a spiral arm thought to circle the far side of the galaxy’s star-packed bulge. But deeper observations will need to confirm this — the intense amount of dust and the sheer number of stars in the bulge prevent the authors from identifying any other members of the alleged cluster. For now, they dub it the “Invisible Cluster.”

The Quadruplets

Just two weeks after Dékány's team published their results, another study (now accepted to Astrophysical Journal Letters) reported an additional four Cepheids in VVV data. But the pulsing stars found by Sukanya Chakrabarti (Rochester Institute of Technology) and colleagues were nowhere near the bulge — they appear to be almost 300,000 light-years from the Sun.

You read that right. These stars lie far beyond the Milky Way's disk, which is about 100,000 light-years across. And this find is all the more interesting because Chakrabarti had predicted the existence of a dwarf galaxy at that exact location six years ago.

Astronomers had previously detected ripples in the outer part of the Milky Way's gas disk, which can't be explained in an isolated spiral galaxy. Instead, such ripples might come from gravitational interactions with smaller, dwarf galaxies. Chakrabarti ran simulations that showed a dwarf one-hundredth the mass of the Milky Way could have passed through our galaxy to create the mysterious ripples. The dwarf would have escaped detection until now because it's dim and lies right behind the Milky Wayplane from our perspective. She even predicted its orbit and structure.

"I had hoped that because the prediction was very specific, observers would try and search for this dwarf galaxy," Chakrabarti adds. "I finally decided to look for it myself."

And she seems to have found exactly what she was looking for. But there's a catch.

The classical Cepheids researchers tend to look for are the more common variable stars: massive, young (even as they near the end of their lives), and pulsating. But a second type of Cepheid variable, called Type II, are actually much less massive stars (half the mass of the Sun or so) and about 100 times older, so their intrinsic luminosity is much fainter.

Trouble is, Type II Cepheid light curves masquerade as classical Cepheids pretty well, with the same general shape of pulsations. And if Chakrabarti's Cepheids are of the Type II variety, then they lie only 160,000 light-years away. They'd still be an interesting (and puzzling) find, but one that wouldn't match the precise prediction for the dwarf galaxy.

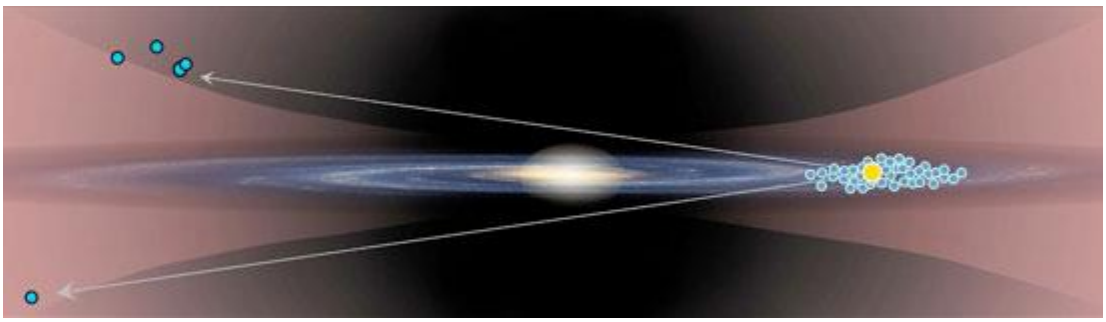
But Chakrabarti's money is on these Cepheids being of the classical variety. For one, Type II Cepheids are less common, and therefore less likely. And Chakrabarti and colleagues also see red clump stars, luminous giant stars that in aggregate serve as another kind of standard candle, at the same location in the sky and at the same distance.

Spectroscopy will cinch the matter, though it will be a challenge for these faint stars. If the team can get radial velocity observations, they can see whether the clump of Cepheids moves together, and if they move in the way predicted for the dwarf's passage through the Milky Way.

Still More Cepheids

All of these results come after a study published last year in the May 15th Nature. Michael Feast (University of Cape Town, South Africa) and colleagues followed up on 32 possible Cepheids discovered in the [Optical Gravitational Lensing Experiment (OGLE)](), using the South African Large Telescope (SALT) and the Infrared Survey Facility. The spectroscopy and near-infrared images allowed the team to more definitely determine the "classical" status of five Cepheids.

These five Cepheids again lie in the outer reaches of the Milky Way's disk, though at distances less extreme than those found in Chakrabarti's study, between 42,000 and 72,000 light-years from the galaxy's center.



The five classical Cepheids discussed in Feast et al. lie above and below our galaxy's plane as pictured here, so the authors suggest they could be part the outer Scutum-Centaurus arm, which flares on the very outer edge of the disk. The Sun is the yellow circle on the right side, surrounded by local Cepheid variables known at the time. *Robin Catchpole (University of Cambridge, UK)*

Since classical Cepheids are massive and young, they are typically associated with spiral arms. It would be odd to see one of these stars sitting out in the galactic halo. So Feast's team suggested that these Cepheids lie in the Outer Scutum-Centaurus arm, which would have to flare to account for the Cepheids' spread above and below the galactic plane.

"Clearly, these Cepheids are just the tip of the iceberg," Feast and colleagues write. The VVV survey and others are well on their way to revealing the rest.

References:

Sukanya Chakrabarti et al. "Clustered Cepheid Variables 90 Kiloparsecs from the Galactic Center." Accepted for publication in *Astrophysical Journal Letters*.

István Dékány et al. "Discovery of a Pair of Classical Cepheids in an Invisible Cluster Beyond the Galactic Bulge." *Astrophysical Journal Letters*, 19 January 2015.

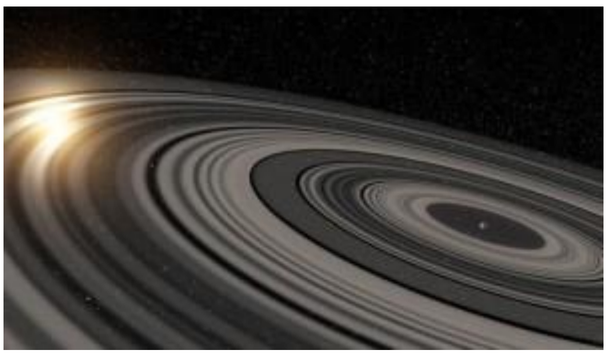
Michael Feast et al. "Cepheid Variable in the Flared Outer Disk of Our Galaxy." *Nature*, 15 May 2014.

Gap Reveals Potential Exomoon

By: John Bochanski

Astronomers have confirmed that the star J1407 seems to have a companion with a gigantic ring system, inside which an "exomoon" might be forming.

In the early 1600s, when Galileo first pointed his telescope at Saturn, he described the planet's sweeping rings as "ears." Since that time, astronomers have closely studied Saturn's ring system, revealing an intricate system composed of a vast number of ice and rock particles, ranging in size from 1 centimeter to 10 meters, or about the size of the tip of your pinky finger to the size of a small house. These particles are not evenly spread out near Saturn, either; instead, there are large gaps in the rings that have been cleared out by the moons of Saturn.



Artist's conception of the ring system circling the young giant planet or brown dwarf J1407b. The rings are shown eclipsing the parent star, J1407, as they would have appeared in early 2007. Detailed analysis of eclipse observations suggests more than 30 individual rings around J1407b. *Credit: Ron Miller*

Ring formation is thought to be fairly common for larger planets, as rings are found around all of the outer solar system planets. (We've even seen them around an asteroid.) Furthermore, astronomers think that the giant planets' major moons formed in souped-up versions of the ring systems we see today, like the planet-forming disks observed around some young stars. But they've only observed one good candidate for such a *circumplanetary disk*, around a companion to a star called 1SWASP J140747.93-394542.6 (hereafter J1407).

The most detailed glimpse of that ring system, or of any ring system outside of our own solar system, was just obtained by Matt Kenworthy (Leiden Observatory, The Netherlands) and Eric Mamajek (University of Rochester).

Kenworthy and Mamajek, in a paper recently accepted by the *Astrophysical Journal*, describe observations of the nearby, 16-million-year-old Sun-like star called J1407. In 2012, Mamajek, Kenworthy, and their colleagues discovered a large planetary companion to the star by identifying an eclipse of the star in its light curve. Yet, as the companion, named J1407b, passed between Earth and its host star, a rich and intricate eclipse pattern occurred, in deep contrast to the typical dips seen for a single companion. (Watch a video of the complicated dips at the bottom of this page, or on the University of Rochester's news cite.) The team attributed this behavior to the presence of a four-ring system around J1407b with at least two gaps.

The pair has performed a new analysis of the data, obtained by the SuperWASP planet search. This analysis shows a rich structure in the rings, with at least 30 separate ring structures. The ring structure itself is gigantic by our own solar system's standards, with a diameter of 1.2 Earth-Sun distances and a mass on the order of 100 Moons, or about the same mass as Earth (Saturn's rings total roughly one-thousandth the Moon's mass). If these rings were around Saturn, they would have a diameter nearly 14 times larger than the full Moon and would appear bright enough to be seen in the daytime sky.

"This planet is much larger than Jupiter or Saturn, and its ring system is roughly 200 times larger than Saturn's rings are today," says coauthor Mamajek. "You could think of it as kind of a super Saturn."

An Exomoon in the Making?

Perhaps even more exciting is Kenworthy and Mamajek's confirmation of one large, clear gap in the ring around J1407b. From our understanding of Saturn's ring structure, we know that moons can carve out gaps between rings. "One obvious explanation is that a satellite formed and carved out this gap," says Kenworthy.

Astronomers can use the size of a gap to infer the mass of the moon responsible; the gap in J1407b's disk implies a satellite mass between that of Earth and Mars, with an orbital period of approximately two years.

This makes the companion to J1407b a very exciting first in the field of exomoons. Despite some tantalizing results, Kepler observations have produced no definitive identification of an exomoon. The search for a direct detection of an exomoon is ongoing, with high-precision observations from the Kepler spacecraft fueling the search.

Astronomers estimate that the orbital period of J1407b is about ten years, but unfortunately they don't exactly when the next eclipse will happen. "It could be tomorrow, next year, a few years, we don't know," says Mamajek. Amateur observations reported to the American Association of Variable Star Observers (AAVSO) have already ruled out some orbital periods for J1407b, and his team encourages amateur astronomers to continue to help them monitor J1407. Such additional observations would help detect the next eclipse by the rings and also constrain the companion's period, size, and mass, as well as the size and mass of the rings. Observations of J1407 can be reported to the American Association of Variable Star Observers (AAVSO).

This glimpse of a ring around a planet in a young solar system gives astronomers a valuable glimpse back in time. They can use these observations to constrain models of planet formation and perhaps better understand how our own solar system evolved with time.

In the meantime, the astronomers are searching other photometric surveys, looking for eclipses by yet-undiscovered ring systems. Kenworthy explains that finding eclipses from more objects like J1407's companion "is the only feasible way we have of observing the early conditions of satellite formation for the near future. J1407's eclipses will allow us to study the physical and chemical properties of satellite-spawning circumplanetary disks."

Reference: M. A. Kenworthy and E. E. Mamajek. "Modeling Giant Extrasolar Ring Systems in Eclipse and the Case of J1407b: Sculpting by Exomoons?" Accepted to *Astrophysical Journal*.

Curtain falls on controversial big bang result

As expected, data like this from ESA's Planck satellite make it clear that researchers have *not* spotted signs of cosmic inflation.

Adrian Cho

As predictably as the heroine's death in an opera, the biggest claim in cosmology in years has finally officially unraveled. Last March, cosmologists working with a specialized telescope at the South Pole called BICEP2 claimed direct evidence that in the first fraction of a second after the big bang, the universe underwent a bizarre exponential growth spurt called inflation. The signs came in their study of the big bang's afterglow, the cosmic microwave background (CMB). But now, in a joint analysis with cosmologists working with the European Space Agency's (ESA's) Planck spacecraft, BICEP researchers take back that claim and report no such signs of inflation, according to a press release issued by ESA.

Like Mimi in Giacomo Puccini's opera *La Bohème*, the BICEP claim seemed doomed from early in the drama. "I would have been surprised if it had turned out otherwise," says Suzanne Staggs, an observational cosmologist at Princeton University. In September, the Planck team released data that suggested the BICEP signal was largely, if not entirely, an artifact of dust in our galaxy, which emits microwaves of its own. The joint analysis sought to resolve the conflicting results. And it rules out the BICEP team's blockbuster claim.

What the BICEP researchers saw were swirls in a patch of the southern sky. The CMB—a kind of electromagnetic backdrop for everything else in the visible universe—is polarized, like light reflected off a lake. According to cosmologists' standard model, the enormous stretching of inflation would have set off ripples in space and time called gravitational waves, which would imprint telltale pinwheel-like patterns—called B modes—in the polarization. And to much fanfare, the BICEP team claimed to see such "primordial B modes."

However, swirls can spiral up from other sources. In particular, radiating dust in our galaxy can produce them, and to see the CMB signal properly, researchers must first strip away this "foreground" contribution. Ordinarily, experimenters do that by taking data at multiple microwave frequencies. However, BICEP2 took data at only one frequency to try to maximize sensitivity and relied on preliminary data from Planck—taken from a slide presented in a talk—to estimate that foreground contamination. The BICEP team believed it was small. But in May, other cosmologists suggested that BICEP researchers may have misinterpreted the Planck data and underestimated the dust contribution. And in September, Planck's final data suggested that BICEP's patch of sky was as dusty as an old pillow.

Now the joint analysis, which also includes data from BICEP2's successor at the South Pole, the Keck Array, yields no definite sign of primordial B modes. If they exist in the data, they can be no more than half the signal BICEP claimed. That limit is in line with what Planck researchers had earlier deduced indirectly by studying tiny variations in the temperature of the CMB across the sky.

In spite of the sad end to this particular tale, Max Tegmark, a cosmologist at the Massachusetts Institute of Technology in Cambridge, says he’s optimistic about the chances of spotting primordial B modes relatively soon. "I'm in the minority," he says, "and I think there is something in there that we can see—if not in this data, then in the next couple of years." However, Princeton's Staggs says the incident underscores that the foreground emissions are likely to be sizable and tricky. If it's there, the big bang signal is more likely to emerge slowly through several experiments than suddenly in one definitive discovery, she says.

"These signals are very faint, and there are lots of things that can go wrong, not just foregrounds," says Charles Bennett, a cosmologist at Johns Hopkins University in Baltimore, Maryland. Nevertheless, multiple teams are striving to detect B modes. "I don't think the BICEP2 experience has slowed anybody down," Bennett says.

Posted in Physics, Space Big Bang Controversy

Club Officers & Positions:

President:
Brian Risley
swfasbrisley@embarqmail.com
(239-464-0366)

Vice President:
Bruce Dissette
bdissette@centurylink.net
(239-936-2212)

Secretary:
Don Palmer
swfas.sec@gmail.com
(239-334-3471)

Treasurer:
Tony Heiner
verahei@aol.com
(941-457-9700)

Program Coordinator:
Vacant

Librarian:
Maria Berni
(239-940-2935)

Viewing Coords./Fakahatchee:
Tony Heiner
verahei@aol.com
(941-629-8849)
Russ Weiland
turtledude@embarqmail.com
(239-281-0456)

Viewing Coord/Caloosahatchee
Bruce Dissette
bdissette@centurylink.net
(239-936-2212)

WebsiteCoordinator
Bill Francis
Bill_Francis@hotmail.com
(239-233-0958)
Gary McFall
tgmcfall2@yahoo.com
(239-458-9222)

Club Historian:
Danny Secary
asecary@gmail.com
(239-470-4764)

Equipment Coordinator:
Brian Risley
swfasbrisley@embarqmail.com
(239-464-0366)

Newsletter Editors:
Ron Madl
rmadlksu@gmail.com
(785-410-2911)
Doug Heatherly
dheatherly72@gmail.com

Astronomical League Coordinator
(ALCOR):
Carol Stewart
cjstewart@mindspring.com
(239-772-1688)

Calusa Nature Center
Planetarium Director:
Heather Preston
heather@calusanature.org
(239-275-3435)

Southwest Florida Astronomical Society, Inc.
P.O. Box 100127
Cape Coral, FL 33910

www.theeyepiece.org