April, 2014 Volume 55, Issue #4

The Prairie Astronomer

The Official Newsletter of the Prairie Astronomy Club

IN THIS ISSUE:

April Program

Andy Franknoi's (Astronomical Society of the Pacific) interview with the iconic Frank Drake. Drake is one of the leading authorities on the Search for Extraterrestrial Intelligence (SETI) and the creator of the "Drake Equation" which predicts the probability of finding other intelligent life beyond Earth.

April 15th Lunar Eclipse by Brett Boller

Photo by Rick Johnson: a mix of bright and dark nebula in Cygnus. The field is located less than a degree north northeast of Sh2-120 and Sh2-121 The field is located less than a degree north northeast of Sh2-120 and Sh2-121 and is an area of newly forming stars judging by all the Y*Os in the field (Young Stellar Objects -- that is, stars still coming out of their dust cocoons and moving onto the main sequence where they will spend most of their lives as ordinary stars).

Night Sky Network

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.

Meeting Minutes

PAC Meeting Minutes March 25, 2014

Jack Dunn called meeting to order at 7:35 PM. Welcomed visitors and new members.

Announced program to follow the meeting: "How to Print your Own Telescope" by Mark Dahmke.

Announced that Hyde Observatory is open to the public every Saturday.

Next PAC meeting is April 29, 2014 which will have a program by Jack Dunn.

Detailed benefits of membership and dues (that are available publicly on the website).

Jim Kvasnicka provided Observing Report. March 21 star party was clouded out; none in attendance. March 28 will be a second star party. April 25 and May 2 will be the next star parties, with a Lunar Party May 9.

Treasurer's report was not provided due to treasurer not in attendance.

Announced MSRAL 2014 in St. Louis June 6-8, 2014. Early registration ends May 26, 2014. Keynote speaker is Raymond E. Arvidson.

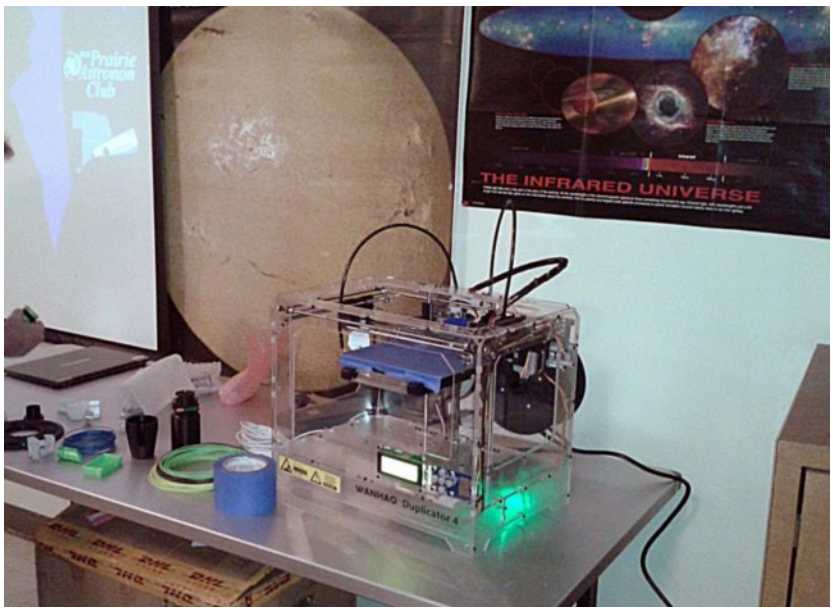
A joint PAC and OAS dinner is being planned for spring at Parker's Restaurant in Ashland, NE. Information will be sent through Night Sky Network and in newsletter (if possible due to timing).

Astronomy Day will be April 26th, 2014 9:30 AM-4:30 PM at UNL State Museum with guest speaker Clay Anderson. Volunteers are needed. Provide provides name(s) and email to Cassie Etmund, PAC Outreach Coordinator if interested in volunteering.

Business meeting adjourned at 7:54 PM.

Members with memberships expiring at the end of April are: Dave Churilla, Jack Dunn, Elizabeth Grady, and Jim Kvasnicka (expire May 1, 2014).

Dale Bazan, Secretary



Mark Dahmke's 3D printer and some printed telescope parts. Taken at the March meeting by Jim Atkins.

ANNUAL MEMBERSHIP

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, contact Cassie Etmund. If you keep a scope for more than a week, please check in once a week, to verify the location of the telescope and how long you plan to use it. The checkout time limit will be two weeks, but can be extended if no one else has requested use of a club scope.

100mm Orion refractor: Available

10 inch Meade Dobsonian: Available

13 inch Truss Dobsonian: Available

PAC Star Party Dates

Dates in bold are closest to the new moon

2014 Star Party Dates
January 24, **31**
February 21, **28**
March 21, **28,** April 25
May 2, 23, **30,** June 20, **27**
July 18, **25**
NSP: July 27-Aug 1
August **22**, 29, Sept 19, **26**
Oct 17, **24,** Nov 14, **21**
Dec 12, **19**

Lunar Party Dates
May 9, June 6, Sept 5, Oct 3
* Lunar party dates are tentative, sites to be determined.

PAC E-Mail:
info@prairieastronomyclub.org

PAC-LIST:
To subscribe send a request to PAC. To post messages to the list, send to the address:

pac-list@prairieastronomyclub.org

Events

Astronomy Day, April 26th @Morrill Hall

PAC Meeting
Tuesday April 29th, 2014
@Hyde Observatory

PAC Meeting
Tuesday May 27th, 2014
@Hyde Observatory

MSRAL 2014
June 6-8, St Lous, MO

PAC Meeting
Tuesday June 24th, 2014
@Hyde Observatory

PAC Meeting
Tuesday July 29th, 2014
@Hyde Observatory

Newsletter submission deadline May 16, 2013

Links

PAC: www.prairieastronomyclub.org
Night Sky Network: https://nightsky.jpl.nasa.gov/
CafePress (club apparel) www.cafepress.com

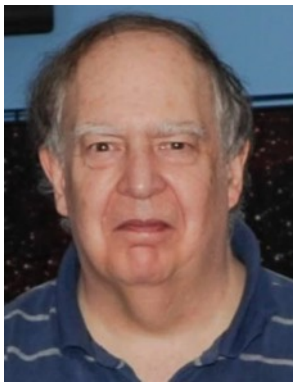
www.hydeobservatory.info
www.nebraskastarparty.org
www.OmahaAstro.com
Panhandleastronomyclub.com
www.universetoday.com/
www.planetary.org/home/
http://www.darksky.org/

NGC4603 Credit: NASA

The Importance of Astronomy Day and Outreach - Jack Dunn, PAC President

By the time we have our April meeting, another Astronomy Day will have passed. But as I write this, we are hip-deep in Astronomy Day planning. Few know what goes into the operation simply because our volunteers show up and everything is ready for them with a table or tables and power at their location. Sure, we really need you to bring telescopes and other pieces of equipment, but getting ready takes weeks (and unfortunately a lot of meetings). The University has now made our lives more complicated with background checks and we have to find someone to do them. It means we have to have people committed to volunteering further in advance of the event. We have to have names and addresses to meet the requirements. Plus, we have to figure out how much space a particular station needs and then put it at a location in the building where there is room (and power if needed). This year, things are complicated by the Tintanoboa exhibit which takes up all of Elephant Hall. That's a huge amount of space we used every year. Don't get me wrong, the giant snake has been a huge draw to the Museum and even helped my planetarium attendance. It just makes logistics more interesting.

This year Clay Anderson is going to be our guest speaker again. Having an astronaut is always a plus and we know Clay is very popular with Nebraska audiences. He is now retired from NASA. That means he's living on his retirement and whatever he makes from speaking engagements. He's donating his services for the event. So when you see him, thank him. If you want to know, his fee now is $5000 plus expenses, so if anyone wants to whip out their wallet he'll gladly take it. But otherwise, that is a big contribution. We know most people aren't aware of speaker fees these days. For astronauts, Clay is very inexpensive. Some of the names you know like Chris Hadfield are getting upwards of $20,000 for a speaking engagement. And don't even ask about an Apollo astronaut. At least with an astronaut you usually get an interesting person. Political figures and some of the former government policy types that show up at big lectures here at the University get more. As I mentioned, if you see Clay at the event, thank him for coming. His book "Just Taking Up Space" is going to be published by University of Nebraska Press later in 2014.



Astronomy Day when it first started with PAC was a small affair, just a few tables and telescopes set up in a mall. Maybe 8 to 10 volunteers throughout a day. We got to see a lot of the public, but they were there to shop and we were a curiosity. Since we've been at Morrill Hall, at least you know those attending are more interested in science – or at least you hope they have some such leanings. I've built relationships with the Air Force Association, and the University's Nanotechnology group among others to give us a wider range of science and technology interests. In particular, having the UNL Microgravity team of engineers is something unique. But every outside group requires contacting and getting them enthused about participating. More meetings.

One important point for this or any year, we know we have an enthusiastic bunch of solar observers. But if it is cloudy, you need to have an alternative station planned inside the building. Doesn't work to just wander in and stand around. Best if you pick one of the other stations and inform us that's where you would be.

It sounds obvious, but never hurts to repeat how much outreach contributes to the club. We know observing is fun, but we always need to attract new members and spread the enjoyment of our hobby. Not a bad thing either to encourage people to know more science. That's especially important in the pop-culture world which celebrates pseudo-science all to readily. So come and join us in celebrating Astronomy Day 2014. I hope by now you have given Outreach Coordinator Cassie Etmund all your names and are ready to participate.

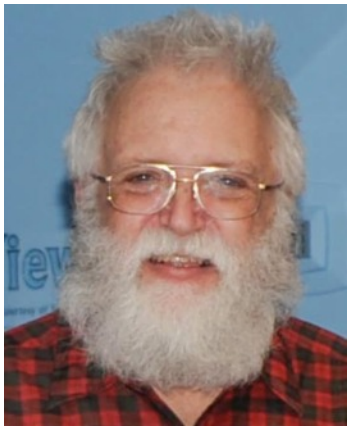
Designing My Remote Observatory Part II—Rick Johnson

Matching the Camera and Telescope

After doing only a small amount of research I realized that to do the high resolution work I wanted to do I'd need to consider the camera and telescope as a whole. First off you have to forget much you learned about visual astronomy. Power is meaningless to CCD work. What matters is to try and capture resolution equal to the best long term seeing at your sight. Visually you might get instants of very fine resolution but then the star gets fuzzy then sharp again or it moves one way or another like seeing a stone under running water of a stream. Since your shutter will be open for many minutes it will catch both the star in and out of focus as well as its motion around the field. All this reduces your resolution. A typical location (not atop one of the premier observing mountains) has resolution of about 2.5" of arc on a typical night though it can sometimes dip below 2" a few nights of the year. Others will be far worse. Testing my location showed 2.5" was typical of my location as well.

Sampling theory for high contrast features says you need to sample as twice the rate of what you are sampling. That would mean for those best nights you'd want to sample at 1" per pixel for on a 2" night. WRONG! That doesn't apply here as the Airy disk is round but the camera's pixels are square! A bit of drawing on graph paper will show you that this sampling rate is too low. It needs to be 3 to 3.5 times that of what you are sampling, so for a 2" night you would want to sample at 0.67" to 0.57" per pixel.

I had my sampling rate. I'd need to use a camera that, on whatever scope I bought would resolve 0.67" or better. Now comes the mathematics. You can determine what focal length is needed for a given pixel size to achieve a given resolution with the simple formula Fl=206 x pixel_size / resolution in seconds of arc. Fl in mm and pixel size in microns. Since I wanted a resolution of about 0.6" the formula became Fl=343 x Pixel_size. While telescopes came in all sorts of focal lengths camera pixel size is more limited. At that time Kodak was the main supplier of amateur chips and it made cameras with 9 and 6.8 micron pixels and



one with rectangular pixels of 23x27 microns. A few small Sony chips were coming to market sold by an English company but otherwise this was about all I had to choose from in 2004. At the time the Sony chips were pretty unknown so that left the Kodak chips. Most Sony chips used rectangular pixels which added a processing step to square them up. There were some exotic (read expensive) chips from Fairchild and other sources but they had 12 micron or larger pixels.

Applying the formula I found that for pixel sizes of 23, 12, 9 and 6.8 microns I needed a scope with a focal length of 7889mm, 4112mm, 3087mm, and 2332mm. Those are some rather long focal lengths, especially the first two! Fortunately the last two were possible. Since long focal length means a rather small field of view for a given size chip I'd want as large of a chip as I could afford or was made. That boiled down to 4 chips. Two at 9 microns, the KAF 1600 that was small at 13.8x9.2mm and the KAF 6303 just on the market with a size of 27.65x18.48mm, 4 times larger in area. At 6.8 micron there was the KAF 3200 and 14.9 x 10mm in size and finally the KAI 11000 which has a 9 micron pixel and is far larger at 36 x 24.7mm. The latter is the same size as a standard 35mm film frame.

There's a lot more to picking a imaging chip than these simple factors. Like everything in this hobby there are lots of compromises to be made. Factors to consider are read noise, dark current, full well capacity and blooming and quantum efficiency to name the more important ones. Large read noise means longer sub exposures and less dynamic range (brightest to dimmest things it can record in one exposure). High dark current means you need more cooling and will likely have more hot pixels to deal with. Large full well capacity increases dynamic range. Read noise reduces it. Some chips have anti blooming gates to eliminate the need to process out blooms (overflowing of

pixel wells) but these reduce quantum efficiency. Quantum efficiency is the percent of photons that get recorded. This ranged from below 40% to

	Chip Read noise	Dark Current	Well Capacity	Max QE	Anti-blooming
KAF 1600	15e-	1e-@0C	100,000e-	86% (35%)	No (yes with special order)
KAF 3200	10e-	.5e-@0C	77,000e-	87%	No
KAF 6303	11e-	.3e-@0C	100,000e-	68%	No
KAI 11000	13e-	.5e-@0C	50,000e-	52%	Yes

over 85% depending on frequency and the chip. With these issues in mind it was time to consider a telescope. At a 0.6" pixel, aperture is pretty much the sole determinant of how faint I could go and how fast I could get there. So larger is better. A 10" scope puts 4 times as many photons into a 0.6" pixel than does a 5" scope. Notice f ratio IS NOT INVOLVED! No matter what the f ratio of the scope at a given aperture and pixel resolution (0.6" in this case) only aperture is involved. So in choosing a scope the f ratio was not important, only that I could achieve the resolution I wanted. For such long focal lengths and large aperture I would need a reflector. Since balance is an issue with a Newtonian with a heavy camera hanging on the side, not to mention cables that could snag simply because I couldn't see what they were doing as the Paramount's cabling system was designed for cameras in the back, I quickly decided on a Cassegrain design as necessary. Best would be an RC type but those were out of my price range. Vixon made a modified Dall Kirkham that had a pretty good field of view but its focal length was a poor match to these cameras and users complained greatly about its very thick spider and its square attachment to the secondary causing stars to look square. I quickly bypassed it as well. That left Schmidt Cassegrain scopes. Those however have a strongly curved field of view so needed a corrector to flatten the field — So does the RC with large fields like I wanted. These for SCTs only also reduced the focal length from f/10 to f/6.3. SCTs came in sizes up to 14" that I could afford. A 14" f/10 at f/6.3 with the KAF 3200 chip would give a 0.62" pixel. No other combination worked. So that decided it, I thought. Before I moved and started construction Meade announced a new design with a flat field needing no corrector that worked at f/10. The 12" using a 9 micron chip would give almost exactly the 0.6" pixel I wanted. That meant either the KAF 6303 or KAI 11000. I'd rule out the KAF 1600 and 3200 as too small. The KAF6303 had a lot going for it. It matched the field of the 12" LX200r, Had good dynamic range and pretty good QE. Its only drawback was severe blooms. So I looked to ordering the 12" LX200R. Oops, it only came on their mount which was far inferior to the one I already had. An OTA version was announced. But I was still in Lincoln so it likely would be out by the time I would be ready for it.

Time to consider which manufacturer of a camera with the KAF 6303 I would go with. There were about 7 at the time. 4 of those are now history. I felt that was the case and only looked to the three that seemed like they were sound. FLI, Apogee and SBIG. The SBIG version included a filter wheel inside the camera while the others used an external filter wheel. SBIG's camera also included a guider chip while the others needed a separate guider. Since a separate guider goes ahead of filters that means far more guide stars to choose from, especially if using narrow band filters. Also the internal wheel held 5 filters not the 7 or 8 needed for full coverage. Total cost was similar, a bit higher for the 7/8 filter system. I left that open for now.

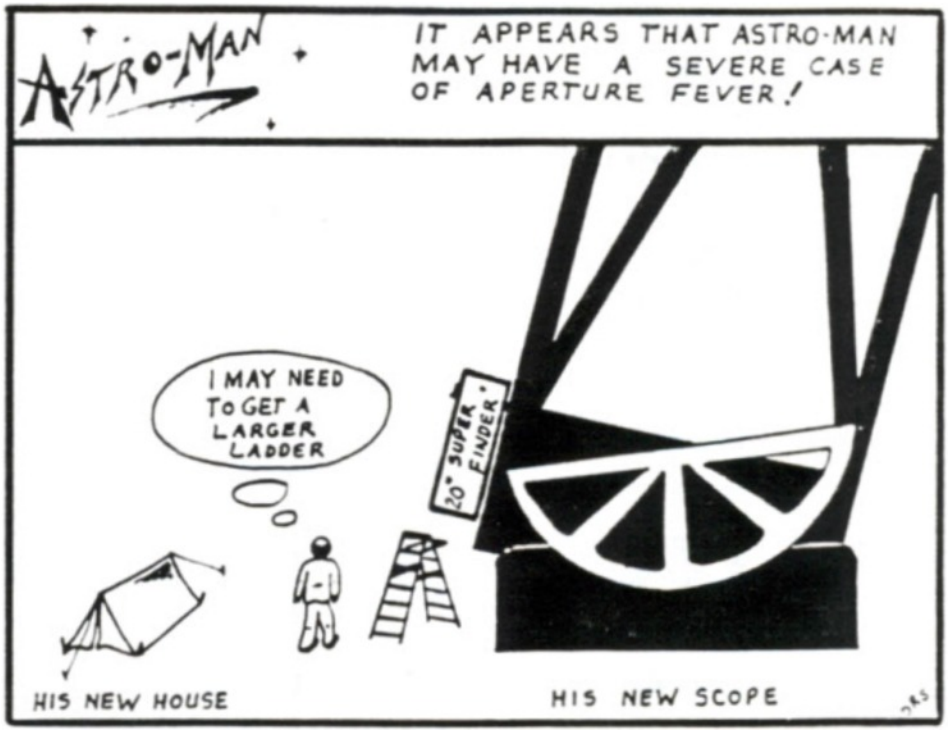
The house was now under construction and the observatory pier in. The observatory itself was under construction when we moved into the house in 2005. I still only had a mount. By March 2006 the building was done but had no roof, no scope had been purchased as the LX200R series was still only available with the mount. Turns out this was fortunate but I didn't see it that way at the time. I even considered buying it and trying to sell the mount alone but it was so bad for imaging from all reports I wouldn't want to even give it away. Nor did I have a camera.

Designing My Remote Observatory Part II, Continued

Turns out there was still more to consider about that, OSC or Mono. OSC had just been announced. That saves filters and filter wheel costs. Sounds good, but is it? The KAI 11000 came in an OSC version but not the KAF 6303.

OSC was new, I needed to do more research into this as I now had even more options. How to decide between them? Though the observatory was now being built (but for the roof) I still didn't know which camera to get for the 12" LX200R. Even after two years I still needed more research. This was turning out to be much more complicated than I thought when I started. How that changed things I'll cover next month. I'll also cover why no roof which is another snag I didn't expect.

Rick Johnson is one of the founders of the Prairie Astronomy Club. He and his wife Holly now live in Minnesota, but usually about once a year they return to Lincoln for a PAC event.



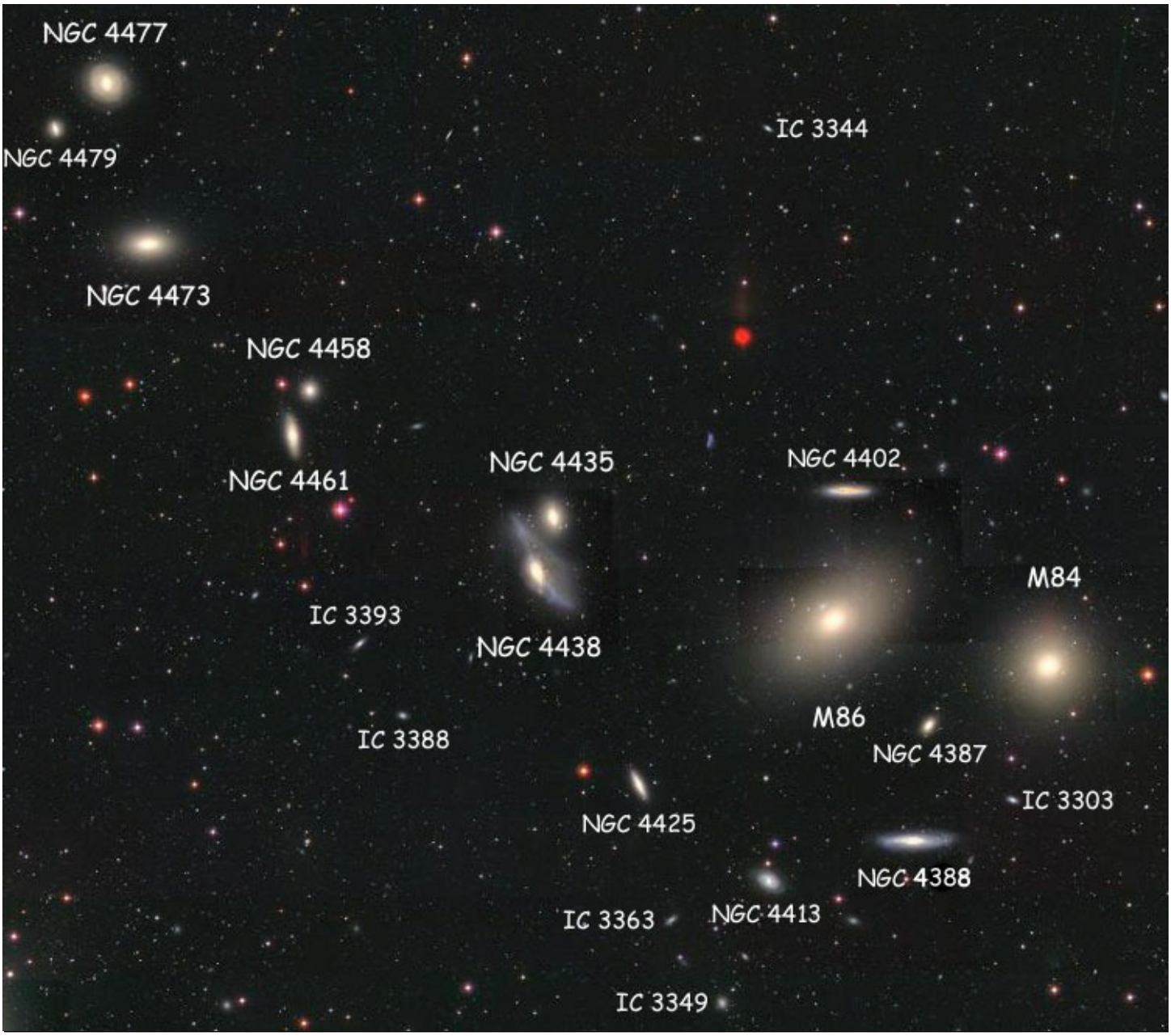
NGC Objects—Jim Kvasnicka

Markarian's Chain

Between the stars Denebola in Leo and Vindemiatrix in Virgo you will find the Virgo Galaxy Cluster. Across the heart of this galaxy cluster stretches Markarian's Chain. The chain contains eight bright galaxies. On the west the chain starts with bright galaxies M84 and M86. From these two galaxies the chain stretches to the northeast where we first find the galaxy pair of NGC 4435 and NGC 4438. Next in the chain is another galaxy pair consisting of NGC 4458 and NGC 4461. After this we find NGC 4473 and from there the last galaxy in the chain NGC 4477. There are other dimmer galaxies in the chain that you may see depending on the size of your telescope.

The chain's name honors Armenian astronomer Beniamin Egishevich Markarian (1913-1985) who discovered an energetic class of galaxies.

The key to observing Markarian's Chain is a good finder chart. The finder chart will show much more area and more galaxies. I find it the easiest to locate M84 and M86. Once you find these on your finder chart and in your telescope you can move to the northeast and locate the other galaxies in the chain.



May Observing—Jim Kvasnicka

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

Planets

Venus: Low in the east at dawn shinning at -4.0.
Uranus: Look for it 1.5° north of Venus on May 15th and 16th.
Neptune: Above Uranus at magnitude 7.9.
Mercury: From May 16th Mercury is more than 10° above the NW horizon 45 minutes after sunset.
Jupiter: Shines at magnitude -1.9 with a disk 33" in diameter.
Mars: Dims in magnitude in May from -1.5 to -0.5.
Saturn: Reaches opposition on May 10th. The rings remain 22° from edge on.

Messier List

M49/M61: Galaxies in Virgo.
M51: The Whirlpool Galaxy in Canes Venatici.
M63: The Sunflower Galaxy in Canes Venatici.
M64: The Black Eye Galaxy in Coma Berenices.
M85: Galaxy in Coma Berenices.
M94: Galaxy in Canes Venatici.
M101: The Pinwheel Galaxy in Ursa Major.
M102: Look for NGC 5866
M104: The Sombrero Galaxy in Virgo.
Last Month: M40, M65, M66, M95, M96, M105, M106, M108, M109
Next Month: M58, M59, M60, M84, M86, M87, M88, M89, M90, M91, M98, M99, M100

NGC Galaxies that fit in the same FOV

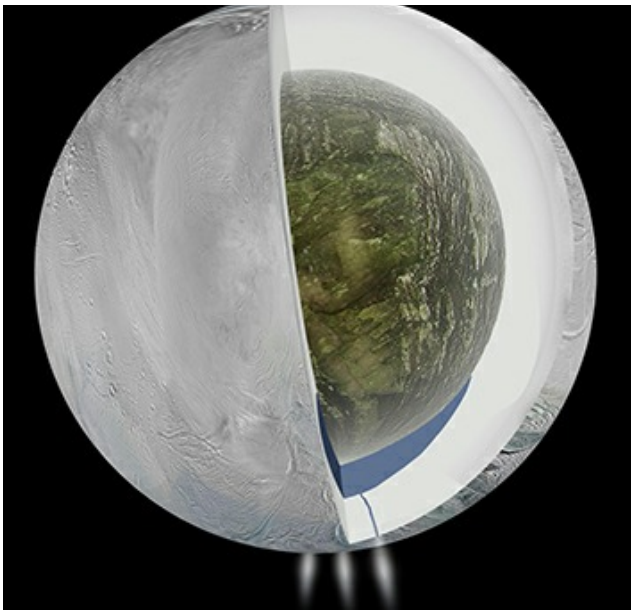
NGC 4473/4477: Galaxy pair in Coma Berenices.
NGC 4527/4536: Galaxy pair in Virgo.
NGC 4631/4656: Galaxy pair in Canes Venatici.
NGC 4762/4754: Galaxy pair in Virgo.
NGC 5363/5364: Galaxy pair in Virgo.

Double Star Program List

Kappa Bootis: Yellow and blue pair.
Iota Bootis: Yellow primary with a pale blue secondary.
Pi Bootis: Pair of white stars.
Epsilon Bootis: Yellow and greenish-yellow stars.
Xi Bootis: Pair of yellow stars.
Delta Bootis: Yellow primary with a blue-white secondary.
Mu Bootis: Yellow pair.
Zeta Corona Borealis: Light blue and greenish-yellow stars.

Challenge Object

Markarian's Chain: How many galaxies can you fit in your FOV?



NASA Space Assets Detect Ocean inside Saturn Moon

Gravity measurements by NASA's Cassini spacecraft and Deep Space Network suggest that Saturn's moon Enceladus, which has jets of water vapor and ice gushing from its south pole, also harbors a large interior ocean beneath an ice shell, as this illustration depicts. Image credit: NASA/JPL-Caltech

After The Flood: Ancient Waters Carved These Martian Channels—Elizabeth Howell, Universe Today

A December 2013 image of Osuga Valles taken by the European Space Agency's Mars Express spacecraft, highlighted by the agency in April 2014. Credit: ESA/DLR/FU Berlin

This picture is an example of why Martian scientists like to get their groove on. This late 2013 snapshot of Osuga Valles — a part of the vast Valles Marineris gorge that cuts across the Red Planet — shows the leftovers of an ancient flood. The European Space Agency highlighted the area in a release this week.

"Catastrophic flooding is thought to have created the heavily eroded Osuga Valles and the features within it. Streamlines around the islands in the valley indicate that the direction of flow was towards the northeast … and sets of parallel, narrow grooves on the floor of the channel suggest that the water was fast flowing," the European Space Agency stated.

"Differences in elevation within the feature, along with the presence and cross-cutting relationships of channels carved onto the islands, suggest that Osuga Valles experienced several episodes of flooding."

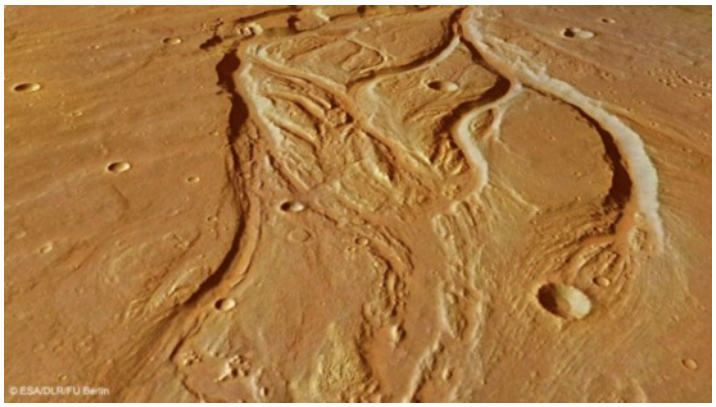
Things get even more interesting when you look a bit closer up, as you can see below.

"The grooved nature of the valley floor suggests the water was fast flowing, carving out the features as it flooded the region," ESA added. "The elevated 'island' blocks are also carved with small channels, recording the history of previous flood episodes."

You can read more about Mars Express' 10 years of exploration at this ESA website. We've also highlighted the top 10 discoveries in this past Universe Today story.

Source: European Space Agency

Read more



A close-up view of Osuga Valles created from data acquired with the Mars Express' High Resolution Stereo Camera. Water flowed towards the top of this image. Credit: ESA/DLR/FU Berlin

Faraway Moon or Faint Star? Possible Exomoon Found

Titan, Europa, Io and Phobos are just a few members of our solar system's pantheon of moons. Are there are other moons out there, orbiting planets beyond our sun?

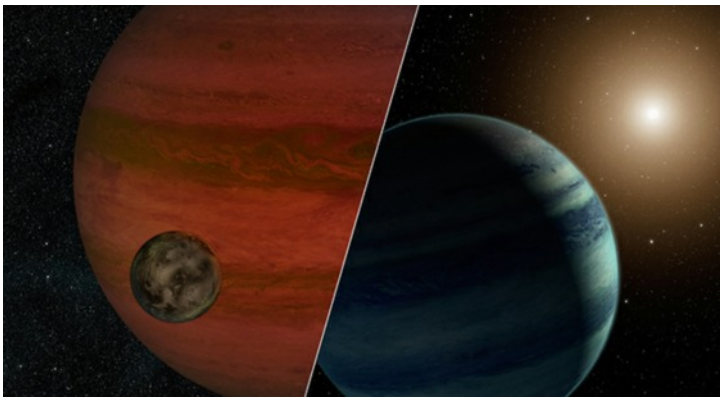
NASA-funded researchers have spotted the first signs of an "exomoon," and though they say it's impossible to confirm its presence, the finding is a tantalizing first step toward locating others. The discovery was made by watching a chance encounter of objects in our galaxy, which can be witnessed only once.

"We won't have a chance to observe the exomoon candidate again," said David Bennett of the University of Notre Dame, Ind., lead author of a new paper on the findings appearing in the Astrophysical Journal. "But we can expect more unexpected finds like this."

The international study is led by the joint Japan-New Zealand-American Microlensing Observations in Astrophysics (MOA) and the Probing Lensing Anomalies NETwork (PLANET) programs, using telescopes in New Zealand and Tasmania. Their technique, called gravitational microlensing, takes advantage of chance alignments between stars. When a foreground star passes between us and a more distant star, the closer star can act like a magnifying glass to focus and brighten the light of the more distant one. These brightening events usually last about a month.

If the foreground star -- or what astronomers refer to as the lens -- has a planet circling around it, the planet will act as a second lens to brighten or dim the light even more. By carefully scrutinizing these brightening events, astronomers can figure out the mass of the foreground star relative to its planet.

In some cases, however, the foreground object could be a free-floating planet, not a star. Researchers might then be able to measure the mass of the planet relative to its orbiting companion: a moon. While astronomers are actively looking for exomoons -- for example, using data from NASA's Kepler mission - so far, they have not found any.



Researchers have detected the first "exomoon" candidate -- a moon orbiting a planet that lies outside our solar system. Image credit: NASA/JPL-Caltech

In the new study, the nature of the foreground, lensing object is not clear. The ratio of the larger body to its smaller companion is 2,000 to 1. That means the pair could be either a small, faint star circled by a planet about 18 times the mass of Earth -- or a planet more massive than Jupiter coupled with a moon weighing less than Earth.

The problem is that astronomers have no way of telling which of these two scenarios is correct.

"One possibility is for the lensing system to be a planet and its moon, which if true, would be a spectacular discovery of a totally new type of system," said Wes Traub, the chief scientist for NASA's Exoplanet Exploration Program office at NASA's Jet Propulsion Laboratory, Pasadena, Calif., who was not involved in the study. "The researchers' models point to the moon solution, but if you simply look at what scenario is more likely in nature, the star solution wins."

The answer to the mystery lies in learning the distance to the circling duo. A lower-mass pair closer to Earth will produce the same kind of brightening event as a more massive pair located farther away. But once a brightening event is over, it's very difficult to take additional measurements of the lensing system and determine the distance. The true identity of the exomoon candidate and its companion, a system dubbed MOA-2011-BLG-262, will remain unknown.

In the future, however, it may be possible to

obtain these distance measurements during lensing events. For example, NASA's Spitzer and Kepler space telescopes, both of which revolve around the sun in Earth-trailing orbits, are far enough away from Earth to be great tools for the parallax-distance technique.

The basic principle of parallax can be explained by holding your finger out, closing one eye after the other, and watching your finger jump back and forth. A distant star, when viewed from two telescopes spaced really far apart, will also appear to move. When combined with a lensing event, the parallax effect alters how a telescope will view the resulting magnification of starlight. Though the technique works best using one telescope on Earth and one in space, such as Spitzer or Kepler, two ground-based telescopes on different sides of our planet can also be used.

Meanwhile, surveys like MOA and the Polish Optical Gravitational Experiment Lensing Experiment, or OGLE, are turning up more and more planets. These microlensing surveys have discovered dozens of exoplanets so far, in orbit around stars and free-floating. A previous NASA-funded study, also led by the MOA team, was the first to find strong evidence for planets the size of Jupiter roaming alone in space, presumably after they were kicked out of forming planetary systems. (See http://www.jpl.nasa.gov/news/news.php?release=2011-147).

The new exomoon candidate, if real, would orbit one such free-floating planet. The planet may have been ejected from the dusty confines of a young planetary system, while keeping its companion moon in tow.

The ground-based telescopes used in the study are the Mount John University Observatory in New Zealand and the Mount Canopus Observatory in Tasmania.

Additional observations were obtained with the W.M. Keck Observatory in Mauna Kea, Hawaii; European Southern Observatory's VISTA telescope in Chile; the Optical Gravitational Lens Experiment (OGLE) using the Las Campanas Observatory in Chile; the Microlensing Follow-Up Network (MicroFUN) using the Cerro Tololo Interamerican Observatory in Chile; and the Robonet Collaboration using the Faulkes Telescope South in Siding Spring, Australia.

Curiosity's View From Arrival Point at 'The Kimberley' Waypoint

NASA's Curiosity Mars rover recorded this view of various rock types at waypoint called "the Kimberley" shortly after arriving at the location on April 2, 2014. Image credit: NASA/JPL-Caltech

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