SkyWAAtch

The Newsletter of Westchester Amateur Astronomers

March 2020

The Hockey Stick, the Whale and the Pup by Gary Miller

Among the attractions in the spring sky visible in amateur telescopes are three interesting galaxies in Canes Venatici. NGC 4656 (left), magnitude 10.5, is also known as the Hockey Stick or Crowbar Galaxy. About half a degree to its north are NGC 4631, the Whale (magnitude 9.8), and tiny NGC 4627, the Pup (magnitude 12.0). The Hockey Stick (distance 28.3 LY) is a spiral galaxy that is warped by tidal interactions with the more massive Whale, also a spiral galaxy (distance 28.4 LY), and the elliptical Pup (29.8 LY).

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Editor: Larry Faltz Assistant Editor: Scott Levine Editor Emeritus: Tom Boustead

WAA March Meeting

Friday, March 13th at 7:30 pm

Wilcox Hall, main floor
Pace University, Pleasantville, NY

Microquasars: What Can We Learn From Them (and Why Bother)

Diana Hannikainen, PhD
Observing Editor, *Sky & Telescope*

Most of us are familiar with quasars – supermassive black holes in galaxies far away – and their iconic jets that spew matter at relativistic velocities into intergalactic space. Less well known are their smaller cousins, the quasars' miniature counterparts that we call – for reasons that shall become obvious – "microquasars." What does unite the two classes of object is the process of accretion around a black hole and the subsequent ejection of matter at speeds approaching that of light. In this talk, you'll hear about the history of microquasars, how we use X-ray and radio observations to understand them better, and what they can tell us about the behavior of matter in extreme gravitational fields.

Diana Hannikainen studied for her BSc in Physics and Astronomy at the University of Edinburgh in Scotland, and then moved to Finland, in part to explore her Finnish roots. While there, she embarked on graduate studies at the University of Helsinki, and received an MSc followed by a PhD in astrophysics, the latter in conjunction with the University of Sydney in Australia. The subject of her PhD thesis was multiwavelength observations (X-ray, radio) of microquasars, a topic she continued throughout her time in research. A couple of years ago, she switched careers and moved to Cambridge, MA, to take up the position of Observing Editor at Sky & Telescope magazine.

Pre-lecture socializing with fellow WAA members and guests begins at 7:00 pm!

Starway to Heaven

Meadow Parking Lot, Ward Pound Ridge Reservation, Cross River, NY

We will ring in the equinox with a star party on March 21st, with a rain/cloud date of March 28th.

WAA April Meeting

Friday, April 3rd at 7:30 pm

Wilcox Hall
Pace University, Pleasantville, NY

Light Pollution and the International Dark-Sky Association

Charles Fulco
Science Educator and IDA Representative

WAA Members: Contribute to the Newsletter!
Send articles, photos, or observations to waa-newsletter@westchesterastronomers.org

Call 1-877-456-5778 (toll free) for announcements, weather cancellations, or questions. Also, don't forget to visit the WAA website.

New Members

Gregory Estevez	Yonkers
Darren Johnson	Pelham
Jinu Kim	Bedford
James Vanderheof	White Plains

Renewing Members

Rob & Melissa Baker	West Harrison
Steven Bellavia	Mattituck
John Markowitz	Ossining
Barbara Matthews-Hancock	Greenwich
William Sawicki	Bronx
Chris Sordellini	Bedford Hills

Plan to attend NEAF April 4-5
Rockland Community College, Suffern NY
Stop by the WAA booth and meet fellow members

Also In This Issue

ALMANAC For March 2020

Bob Kelly, WAA VP for Field Events


1Q
Mar 2


Full
Mar 9


3Q
Mar 16


New
Mar 24

There are four bright planets in the morning sky this month, but they are low, hiding in plain sight so you might not notice them. At my house, trees block the lower southeastern sky where Jupiter, Mars, Saturn and Mercury cavort. From now through the summer, we'll be watching Saturn and Jupiter as they traverse the southern part of the ecliptic. They are about as far south as they get, visible overhead in Australia, South Africa and South America, but depressingly low in the sky from our location. Mars will be the only bright outer planet to head northward this year. Let's throw a welcome party for Mars in October!

Finding a good place to see Mars, Jupiter and Saturn this month will be rewarding, as you'll want to see how the three resemble a street dealer's three-card monte game. Mars will be the one to keep track of as it slides between Jupiter and Saturn starting on March 20th. On the 20th a medium-power telescope may catch Mars and Jupiter in the same field of view, while on the 31st it will be Mars and Saturn's turn. This is a great way to compare magnitudes, colors and sizes of these outer planets. If you catch Saturn in a telescope, the rings are tilted 23° wide as seen from our planet. It's a pretty sight!

Receivers in American football do their best to get separation from the defensive backs as they try to catch the quarterback's pass. Mercury gets lots of separation from the Sun this month, maxing out for 2020 at 28 degrees from our star on the 24th. But the low angle of the ecliptic keeps Mercury from rising more than an hour ahead of the Sun. Most of us won't get to see it, which is too bad. If you can, Mercury will appear larger than Mars to us Earthlings.

Venus also reaches greatest elongation from the Sun in March, on the evening of the 24th, 46°. Don't worry about missing it, since Venus will be blazing in the evening sky well into May. Even if it wasn't a shimmering beauty, Venus is easier to find than Mercury. It's riding a like a rocket high into the evening sky, as it heads for the northern arc of the ecliptic. The Evening Star will be a jaw-dropping magnitude -4.5 by the 24th and will take it up a notch or two to magnitude -4.7 in late April and early May! Venus looks like a half-moon in the telescope this month. You'll need to use a neutral density filter to darken the glare or find it in the late afternoon sky before sunset in order to make out anything but the celestial equivalent of a high-beam headlight. Try it!

If you want to see Jupiter and Saturn in the daytime sky, they are highest, at due south, about 9 AM EDT, but still not even reaching 30 degrees above the horizon.

Everyone seems excited about Venus passing 2° away from Uranus on the 9th. Try to see them together in a pair of binoculars. Uranus is brighter than Neptune, which had a much closer pass by Venus last month (it was cloudy here). Venus stands in a dark sky, setting two hours after the end of twilight, so this conjunction may be easier to see. The Moon will strike a pose with Jupiter, Mars and Saturn on the 18th.

We can view the largest full Moon of the year in the middle of the afternoon on the 9th, if we were on the other side of the planet. But, lunar perigee is at 2 AM, 13 hours after Full Moon. So we get the (very slightly) larger Moon than when full. So there, eastern hemisphere! Watch out for higher than normal tides during and a few days following full Moon. A classic March nor'easter that week near the times of high tides would magnify coastal flooding.

The vernal equinox occurs at 11:48 PM EDT on the 19th so our nights will now be shorter than our days. The equinox officially occurs when the Sun crosses the celestial equator, a place known as the First Point of Aries (although it's now in Aquarius). As a result, the waxing crescent Moon rides high, making it easy to explore in the evening sky.

Daylight Savings Time pushes the clocks one hour ahead beginning March 8th to make the Eastern Time zone four hours behind ("– 4" in your observing software) Coordinated Universal Time, abbreviated as UTC. There is an international agreement to use "UTC" with Roman letters in all languages. Even Chinese!

People who have looked for comet C/2017 T2 (PANSTARRS) say they needed large binoculars and dark skies. Some observers note that the many faint stars in the field near Cassiopeia make the tiny nucleus seem faint. But T2's up all night so you won't have to be.

Passes of the International Space Station are visible in the morning through the 15th and then in the evening starting on the 17th. ■

Member Profile: Carl Gebauer

Home town: Somers

Family: Wife Thuy and son Michael (thirtyish)

How did you get interested in astronomy? Looking at the stars and picking out constellations has always been a favorite activity while camping with family or as a scout. Growing up during the race to the Moon certainly accounted for some of that interest.

Do you recall the first time you looked through a telescope? What did you see? I probably looked through some low-quality scopes in my youth, but the first that really impressed me was seeing Jupiter and its Galilean moons in a large reflector on our honeymoon in Hawaii. It was setup by an amateur at the hotel, and since it wasn't yet my hobby I did not note the specific type or aperture. However, it was a great "wow" moment.

What's your favorite object(s) to view? The Moon, particularly watching the terminator on successive nights as it travels across the face, highlighting features with contrasting shadows. It's also the easiest. I've really enjoyed locating and trying to image nebulas, but with limited success.

What kind of equipment do you have? One year, my wife generously gave me the choice of her company's service award gift, and I chose a Celestron 102-mm NexStar SLT refractor on an alt-azimuth go-to mount. It is a nice size that I can even fit in a backpack and take to remote sites that I cannot reach by car, such as Scout camps. I've gotten some better eyepieces from a friend, and have upgraded the focuser to a two stage Crayford, which helped a lot. Lately I've gotten adapters so I can use a Lumix mirrorless DSLR and so I started doing some imaging.

What kind of equipment would you like to get that you don't have? I'd like to get something that can track better and have a more stable mount so I can try imaging deep sky objects. For my current scope I'll get a lithium battery, a Barlow, and an intervalometer for my camera.

Have you taken any trips or vacations dedicated to astronomy? Tell us about them. Not yet, but I'd love to get to Stellafane or another remote site for a few days dedicated to observing. I'm an early riser, which does not always work well with this hobby, so it would be an opportunity to shift my wake hours to get more viewing time before getting sleepy! I'll certainly be in Western New York or the Adirondacks for the 2024 eclipse. I was at Pace University with my scope for the partial eclipse. I was impressed, and was sorry I did not travel to get in the path of totality.

Are there areas of current astronomical research that particularly interest you? Use of spectral analysis to determine the composition of planet atmosphere is interesting to me because of my chemistry background, but I find every subject at our monthly talks to be fascinating.

Do you have any favorite personal astronomical experiences you'd like to relate? My first attempt with the DSLR on my scope was with the Moon, an easy subject. But I really got enthused when looking at Orion and saw its nebula pop out in vivid color with a longer exposure. It was amazing to me because I could not see any of it in my scope visually. I was quite proud to get an image of M17 (the Omega or Swan nebula) that was as good as any visual observation in the mid 19th century. There is certainly room for growth.

What do you do (or did you do, if retired) in "real life"? I'm a chemist by training, with a doctorate in analytical chemistry. For a portion of my career I developed new clinical chemistry technologies and methods, but then later switched to clinical instrument development as a systems engineer. I retired in 2015. I do miss the daily contact with other scientists and engineers, so the WAA fills some of that vacuum for me.

Have you read any books about astronomy that you'd like to recommend? Nothing that can top Larry Faltz's awesome in-depth articles in SkyWAAtch. [Unsolicited!]

How did you get involved in WAA? I don't remember if it was a lecture or a star party first, or how I heard about the club, but once there I was hooked. Club members were very helpful with advice on how to get the best use out of my scope and what to view, and the lectures are quite good.

What WAA activities do you participate in? I really enjoy doing the local outreach sessions. The enthusiasm of kids and their parents, when seeing objects in a telescope for the first time, is quite rewarding. After years of seeing Hubble images you would think that seeing the Moon, and slightly magnified planets and double stars would be underwhelming, but the power of seeing things firsthand shouldn't be underestimated.

If you have a position in WAA, what is it, what are your responsibilities and what do you want the club to accomplish? No position. I'd like to see the great lectures and outreach programs continue.

Provide any other information you think would be interesting to your fellow club members, and don't be bashful! I have been involved in Boy Scouts for a long time and try to include astronomy wherever I can. In 1969 I was attending a Scout summer camp and we gathered around a tiny black-and-white TV to watch the Moon landing. In setting up and teaching several outdoor courses on high adventure activities, I've been able to recruit members of WAA and other area clubs to help with mini-star party sessions. Participants considered it a highlight of the courses and appreciated the opportunity to look through several scopes and talk with amateur astronomers. The best observation was an Iridium flare, successfully predicted and pointed out during one of these sessions. Hopefully they will take an astronomy program back to their youth and interest another generation in the field. At the least, I got to meet several very interesting members of our club and Mid-Hudson and Albany Area clubs.■

M42 Orion Nebula 3/26/18, 6x 30sec exposures, stacked with RegiStax 6, cropped with Photoshop Elements 9

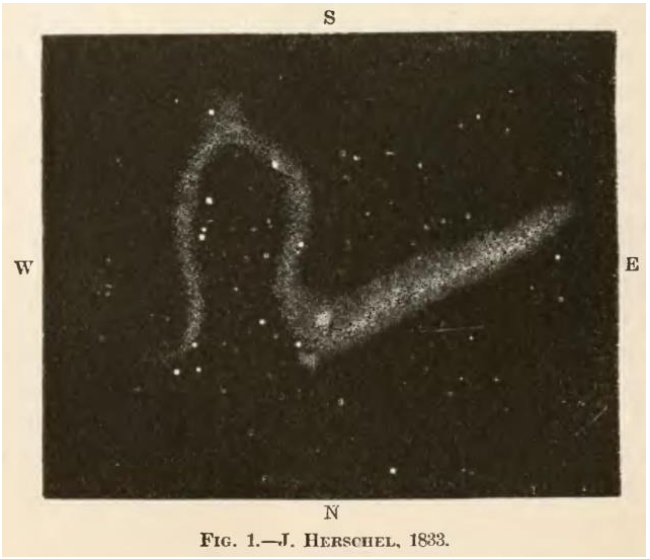


FIG. 1.—J. HERSCHEL, 1833.

M17 Omega or Swan Nebula 7/7/18. I'm almost up to 19th century capability!

In the Naked Eye Sky: *Le Lapin Agile* — Scott Levine

A lifetime ago, my not-yet-wife and I grabbed some *carne adovada* and some last-minute tickets and went off to see a show at a local theater in Albuquerque, New Mexico. "Picasso at the Lapin Agile," she told me, was written by Steve Martin – that Steve Martin. How could I say no?

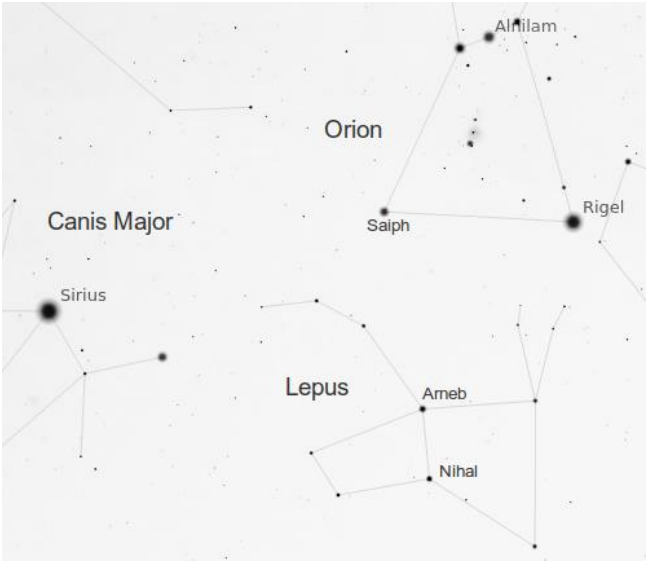
Afterward, we strolled along empty streets and busy avenues under skies that were surprisingly deep and starry for just outside downtown. Orion and the broad and scattered stretch of nameless stars under Sirius led us back to our apartment.

I often think of Sirius as marking the rough boundary between the upper and lower parts of the sky. The area under it, below around 30° above the horizon, has always been a favorite of mine, though it wasn't until years after that night that I learned what stars and constellations hang around down there. It usually doesn't get the attention it should, but it's a good stretch for us lazy sky fans, and a good way to keep track of time throughout the year. When we look "up" at those stars, it's more like we're looking out at them, watching them on a giant TV; no exhausting neck-bending needed. They float along just above the horizon on a celestial parade route for misfit constellations. As grey has crept into my beard, I've spent countless chilly spring nights watching crows and cups come and go, and then as the nights grew hot and sticky, countless terrified scorpions running screaming from maniacal teapots.

That night, coincidentally enough, mixed up in the fray was what has become one of my favorite of the low constellations. Lepus's name is the Latin root of Lapin, the French word for rabbit. It's is one of Ptolemy's original 48 constellations, and it almost actually looks a bit like what he wanted us to see. There aren't a lot of myths associated with it, but my old copy of the *National Audubon Society's Field Guide to the Night Sky* (Knopf, 1991) explains that rabbits are often associated with the Moon. It also suggests that maybe Orion might have been hunting rabbits. I'm not sure I buy it. That's quite a task while he was also fending off Taurus. Elmer Fudd he ain't. I picture a busy rabbit hopping at Orion's aching feet, distracting his dogs, splashing in and out of the river Eridanus, and generally irritating everyone, but, still… who can stay mad at a bunny?

I'll admit, it's a bit of a challenge to see. Under city lights, the only of Lepus's stars that's likely to be visible is Arneb (α Lep), a third-magnitude double anywhere from 900 to about 2200 LY away. It sits at the bottom of a small and spritely inverted equilateral triangle about 10° below Saiph (κ Ori) and Rigel (β Ori), Orion's knees. It's always fun to try to imagine how big and luminous stars like it must be in order for us to see them from so far away. Along with Nihal (β Lep), it forms the middle part of the rabbit's body. Toward the east (to our left) is Lepus's hind quarters. If your skies cooperate, you should just be able to make out its ears poking through Westchester's sky glow to the west of Arneb.

Over the years since that night, we've snapped our fingers and rebooted our lives a few times, but it wasn't until we moved here that I was able to see Lepus's full asterism, and it always brings me back to that night. It's a challenge, but one that I'm always happy to try to see hopping along every spring.



Scott Levine's astronomy blog, *Scott's Skywatch*, can be found at https://scottastronomy.wordpress.com/ or email him at astroscott@yahoo.com

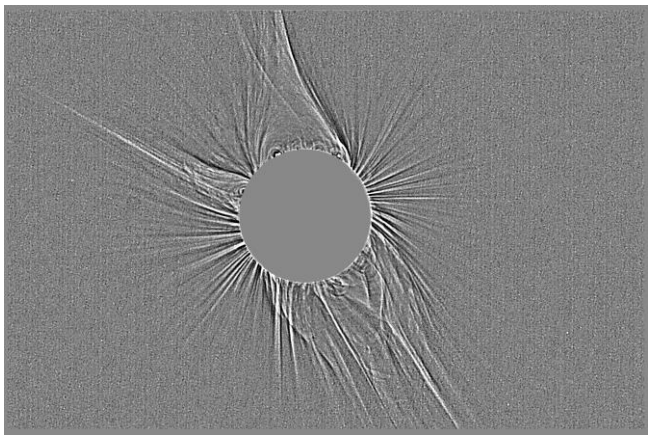
Editor's note: *Le Lapin Agile* is a famous cabaret in Montmarte, Paris, once frequented by struggling artists and writers, among them Picasso, Modigliani, Utrillo, and Apollinaire. Picasso's painting *Au Lapin Agile* is on display at the Met. Steve Martin's play imagines a conversation between Picasso and Albert Einstein in 1904, each man on the verge of his first great breakthrough, though Einstein was not in Paris in 1904.

2017 Solar Eclipse Image Revisited & Reprocessed — Robin Stuart

I read somewhere that there are people who take years to process their solar eclipse photos. Well it turns out I'm one of them! I am not alone: there's an article in the March 2020 edition of Sky & Telescope showing some processing methods being applied to images of the 2017 solar eclipse.

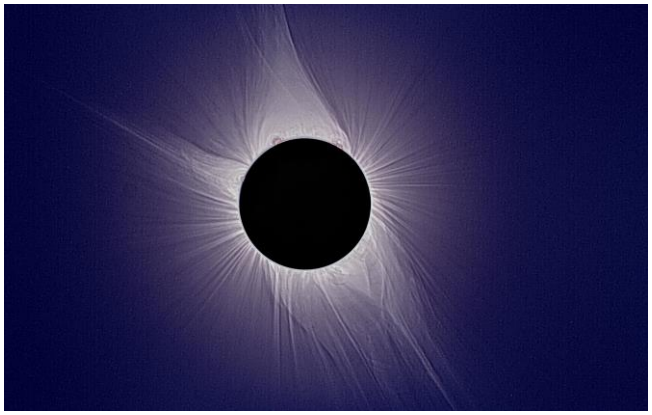
Ever since the event I've been aware that my photos individually held a lot of detail that I had not been able to pull out and combine into a single image. I've spent countless hours experimenting with wavelets and other tools but was not fully satisfied with the results. Recently I took the problem up again and, using *Mathematica* image processing tools, finally made what I think is some reasonable progress.

One lesson I've learned is to avoid creating a High Dynamic Range (HDR) image first and then trying to sharpen it. Combining images over a wide range of exposures will tend to wash out some of the detail present in the individual frames.

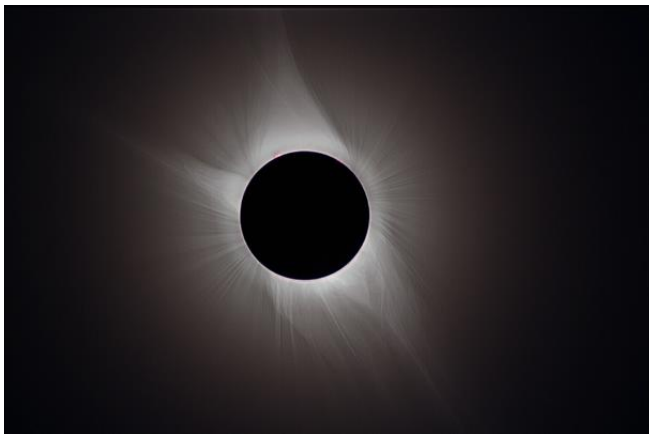


Instead I used a "Laplacian of Gaussian" filter to extract the detail from individual images. This filter applies a convolution kernel to the image that effectively yields its 2nd derivative. This kernel is sometimes referred to as the “Mexican hat wavelet.” The result is a series of images that only show variation where detail is present but are flat in regions that are over- or under-exposed. These filtered images can be scaled to match in brightness and combined sequentially to show detail over the full extent of the visible corona. The result is the gray image, above. It has been stretched to enhance visibility but there is a tremendous amount of subtle coronal structure that can now be seen. Here 50% gray represents zero and lighter/darker pixels represent positive/negative differences. A second lesson that can be learned from this image is that it would be a good idea to shoot flat and dark frames when capturing the outer regions of the corona. This I hadn't done.

The variations from the gray image and one of the Moon's disk can be overlaid on an unsharpened HDR image showing the general coronal glow. This is shown in the picture below. A blue cast has been added to the sky since that seems to be the artistically fashionable thing to do.



There are a couple of other lessons that are perhaps worth noting. The prominences are very bright compared to corona. Even at ISO 200 and an exposure of 1/500 second I have saturated pixels in the red channel meaning that my photographs don't show their true color. Finally, and perhaps most importantly, automate your eclipse exposure sequence using software like *Eclipse Orchestrator* or *Images Plus Camera Control*. You absolutely need to watch the event unfold directly and not through a camera viewfinder. It's definitely worth it. ■



This was Robin’s original image in the October 2017 SkyWAAtch

Celestial Globes — Larry Faltz

Museum visits last fall called my attention to the beauty and history of celestial globes. I've mentioned them in previous articles after seeing them in Johannes Vermeer's *The Astronomer*, in the Louvre (January 2011) and Gerard Dou's *The Astronomer by Candlelight* at the Getty Museum (June 2019).

Celestial globes show the stars and constellations as if we were outside of the celestial sphere, a realm that can only be imagined if we compress the entire universe beyond the solar system into a shell, and then put ourselves "outside," wherever that could be. The stars and constellations on a celestial globe have to be mirror images of their appearance from Earth but it's the only way to show their actual relationships. Some globes are made of transparent material so one can see through for a correct Earthly orientation (but then, which way do you orient the labels?). *Sky & Telescope* sells a beautiful celestial globe with the stars and constellations in a geocentric perspective, as if a flat star map was wrapped around a sphere with the map facing outward. The celestial hemisphere will be distorted the further away you go from the position directly facing you, but it's easier to use for relatively smaller angular views. The S&T globe doesn't include constellation figures, just lines to link the important stars in each constellation.

Passing through the display of old masters at the Metropolitan Museum of Art last fall, I came upon a portrait by Anthony Van Dyck of Flemish merchant Lucas van Uffel. The 1622 canvas shows Van Uffel as a man of varied interests, with a divider, a recorder, the bow of a viol, an antique head, and a celestial globe. The wealthy merchant class could afford to indulge themselves in non-business pursuits and portraits often emphasized the subject's diverse and refined accomplishments. If Van Dyck painted your portrait, what objects would you choose to show your status and the range of your interests?

The Age of Discovery, which commenced with voyages organized by Prince Henry the Navigator in the 15th century, required both terrestrial and celestial maps and charts. The success of the Netherlands as a maritime power by the end of the 16th century was accompanied by the publication of increasingly accurate maps by Dutch cartographers. The first mass-produced celestial globes were a product of this cartographic environment. Paper "gores," engraved map segments bounded by two meridians from pole to pole, usually 30 degrees wide, were printed, hand colored and pasted onto wooden spheres.

Anthony Van Dyck, Portrait of Lucas van Uffel. (1622) Oil on canvas, 49 x 39 5/8 in. Metropolitan Museum of Art

Up to that point, the constellations and star positions recognized by astronomers were almost all those visible from Greece and Egypt, as recorded in Ptolemy's *Almagest*. Petrus Plancius, a founder of the Dutch East India Company, made a celestial globe in 1589 that showed the Large and Small Magellanic Clouds, but otherwise the deeper southern skies were blank. Plancius asked Pieter Dirkszoon Keyser to plot southern star positions during the first voyage of the Company to Sumatra in 1595 under the captaincy of Cornelius de Houtman. Keyser, the navigator, did most of his observations from Madagascar, plotting about 120 new stars and 12 new constellations. Although Keyser died during the voyage, de Houtman survived (only 81 of the original 248 crew made it back, many succumbing to scurvy) and the data arrived in Holland in 1597. Plancius made a new celestial globe in 1598

that was published by cartographer Jocodus Hondius. The new stars and constellations were incorporated into Johann Bayer's 1603 *Uranometria*, generally regarded as the first "complete" stellar atlas.[1]

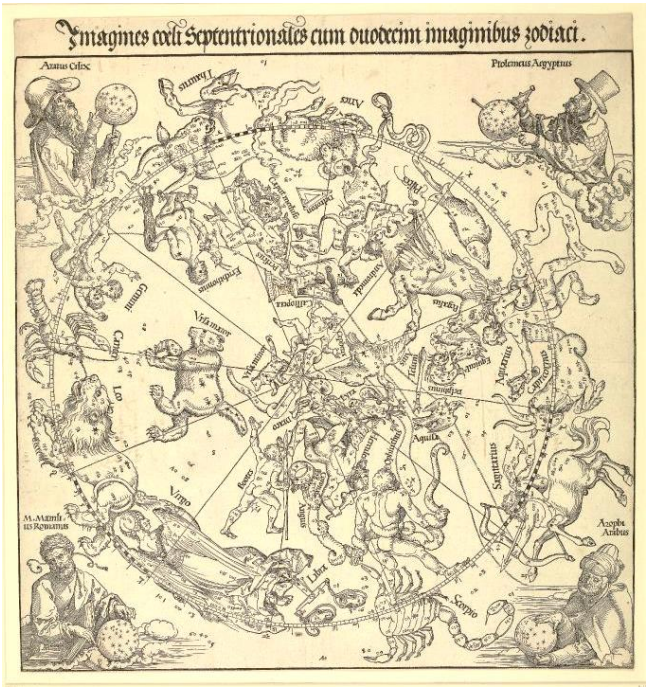
Willem Jansz Blaeu studied with Tycho Brahe from 1594 to 1596 and became an instrument maker and cartographer. Around 1598 he made a celestial globe based on Brahe's star positions, but he had not included southern constellations. He rectified this in a new version of his globe in 1603 using Keyser's star positions. For the next 25 years, Hondius and Blaeu produced new editions of their globes in various sizes (Blaeu for example made them in diameters of 4, 6, 9, 13.5, and 26 inches). Hondius's son continued their family cartographic business into the mid-17th century. Blaeu later became the chief cartographer for the Dutch East India Company.

Globes by both Hondius[2] and Blaeu[3] are visible on the internet in 3D interactive modes. The figures on them are nearly identical, distinct from those in *Uranometria*. The hemisphere shown to us in Van Dyck's painting, with Boötes prominently displayed, is less detailed than either Vermeer or Dou, both of whom showed a Hondius globe. Van Dyck's globe was probably also a Hondius but it's hard to be sure. Perhaps the two cartographers economized and shared the engraving plates, making only minor alterations for each new edition.

Boötes as shown (L-R) by Hondius, Blaeu and Van Dyck

There do not seem to be any mass-produced globes from earlier times, but museums (and a few antiquarian art dealers) around the world display a small number of one-of-a-kind 16th century globes. The Met has an exquisite 5½-inch diameter engraved silver celestial globe from 1579, made in Vienna by Gerhard Emmoser for that great patron of art and science (and employer of both Tycho Brahe and Johannes Kepler) Holy Roman Emperor Rudolf II.[4] This globe shows the typical constellation figures and even has clockwork that rotates the sphere. Its representation of Boötes is similar to the figures on the Dutch globes but in the Emmoser globe he's only wearing shorts, not a tunic. A glass globe was made in 1552 by the great cartographer Gerard Mercator but it is lost.

These artists undoubtedly worked from sky charts that showed constellation figures, such as a woodcut made by Albrecht Durer in 1515, said to be the first printed sky map. A painted 17.2 cm diameter globe by Jacob Rabus from 1546 was based directly on Durer's images. This globe had been owned by the Princely Collection of Oettingen-Wallerstein in Liechtenstein but was apparently sold sometime in the late 1990's and its current whereabouts are unknown.



Albrecht Durer, The Celestial Globe, 1515, printed woodcut, 17.9 x 16.9 inches, British Museum

In Durer's print, Boötes is naked, as are all of the human celestial figures on the map. In the corners are 4 clothed figures: the ancient celestial astronomers Aratus, Ptolemy, Manilius (a Roman astrologer), and

[1] https://www.wallhapp.com/urano/johann-bayer

[2] https://gallica.bnf.fr/ark:/12148/btv1b550087450/f0.item.r=3D%20Jodocus%20I%20Hondius

[3] https://oshermaps.org/browse-maps?id=13605

[4] https://www.metmuseum.org/art/collection/search/193606

Al-Sufi (named as Azophi Arabus). Each holds a celestial globe but they appear to only have stars on them. Interestingly, Durer's woodcut shows the constellations as if they were seen from outside the spherical heavens, just like a true celestial globe. We generally expect star maps on paper to show the stars as if we were seeing them from Earth. This suggests that Durer saw celestial globes with constellation figures, but there may have been very few figured European globes before 1515.[5] Durer certainly had seen sky maps with constellation figures produced by Renaissance scholars, among them a collection of 4 charts made in 1426 by Conrad of Dyffenbach, now owned by the Vatican Museum. The British Library owns the Planisphere of Geruvigus,[6] dating from 830 CE. It has constellation figures based on Aratus' *Phaenomena*.

(L) al-Sufi's Boötes, (R) al-Sahlì's globe (in a modern mount)

Islamic astrolabes and armillary spheres show stars but don't usually show constellation figures. They would be too distracting on these scientific measuring instruments. There are also some Islamic globes with silver inlaid stars but no figures. A few Islamic celestial globes with constellation figures are on display around the world. The British Museum has a 29 cm brass globe made in Mosul in 1275 by Muhammad ibn Hilal al-Munajjim al-Mawsili. A similar brass globe, 14.4 cm in diameter, is in the Staatliche Kunstammlungen (state art collections) in Dresden. It dates from about 1300 and was made by Muhammad ibn Mu'ayyad al-Urdî. The Museo Galileo in Florence has a beautiful 22-cm brass globe made in Spain in 1085 by Ibrâhim 'Ibn Saîd al Sahlì, purportedly the oldest Arab celestial globe in the world. The constellations on these globes are very roughly based on those drawn by 'Abd al-Rahman al-Sufi, the most famous of the Islamic astronomers, in his *Book of the Constellations of the Fixed Stars* of 964.[7] al-Sufi lived in Persia in the 10th century CE. He made updated measurements, plotted star positions and drew maps of the constellations described by Ptolemy.

While the constellation figures shown by al-Sufi and on the Islamic globes are artistically distinct from those on European globes and maps, they are recognizably the same beings or objects. al-Sufi gives the constellation figures in both orientations, as seen from Earth and from outside the celestial sphere. The oldest surviving edition of al-Sufi, in Oxford's Bodlean Library, was written by al-Sufi's son in 1009. Since these books are hand-written, there are some stylistic differences among the editions and the stars aren't always in exactly the same place on the drawings. See the top pair of images on page 15.

Ursa Major by (L) al-Sufi [Library of Congress] and (R) Durer

There seem to be no earlier celestial globes in existence until we get to Roman times. The Vatican Museum has a large first century marble celestial globe but it just shows the zodiacal figures and has random stars on the rest of the sphere. There are three celestial globes showing all the known constellations that survive from antiquity. An 11-cm diameter brass celestial globe dating from 150-220 CE is on display at the Römisch-Germanischen Museum in Mainz, Germany. It was probably the crown of the gnomon on a sundial. A small silver globe (exact diameter is not given) was displayed in an exhibition in 2002 at Gallerie J. Kugel in Paris. It is claimed to date as far back as the second or third century BCE but no definitive

[5] The earliest is a 27-cm diameter wooden globe with Ptolemy's constellation figures and stars from the late 13th century, now in Bernkastel-Kues, Germany. It is probably of Czech origin and is known as the Premyslid Globe.

[6] http://www.bl.uk/onlinegallery/onlineex/illmanus/harlmanucoll/p/011hrl000000647u00021v00.html

[7] You can find the Library of Congress' 14th century edition at https://dl.wdl.org/18412/service/18412.pdf

information is available. Apparently there are errors in the placement of some of the figures that make it hard to correct for precession of the equinoxes and thus constrict the date of this object within a reasonable range. It may have been made in Roman imperial times. The third and most famous of the antiquarian globes is in Naples, and we'll come to it shortly.

(L) Vatican sphere, (C) Kugel Globe, (R) Mainz Globe

Around 150 CE, Claudius Ptolemy (c. 100-c. 170 CE) wrote Μαθηματικὴ Σύνταξις, in Latin *Syntaxis Mathematica*, but better known as the *Almagest*, the English corruption of its Arabic title. Comprehensive and enormously influential for the next 1,500 years, the *Almagest* assembles 1,028 stars into 48 constellations, most of which had been described by earlier astronomers. The star positions are given in tabular form. The *Almagest* does not contain a star map. So, from whence came the constellation figures, which seem so similar among all of the globes and maps?

Grouping stars into distinct patterns goes back to Babylonian times and there is even evidence that earlier civilizations made constellation figures. We know that the zodiac, with its distinct characters, was well established by about 1,000 BCE. The figures were merely descriptive: "The Lion," "The Bull," and "The Twins" for example. By allowing observers to recognize the patterns more easily, the zodiacal figures could be used for telling time (approximately) at night in addition to their value in astrology, also a Mesopotamian construct.

The Greeks arranged stars outside the zodiac into figures and later provided backstories for them. Homer (probably 800 BCE) refers to the Pleiades, Orion and the Great Bear, and there are astronomical references in Hesiod's *Theogony* and *Works and Days*, which date from perhaps 700 BCE. By the time of Plato and Aristotle in the mid-4th century BCE, the constellations and their myths were well established. Constellations like "the Kneeler" became Hercules and "the Bird" became Cygnus. No single story was agreed upon, however, and there were many variations of the origin stories and even relations among the characters. For example, Orion and Scorpius are on the opposite side of the sky. One story is that the scorpion was chasing Orion (one rises in the east as the other sets in the west), another that because the scorpion had killed Orion Zeus wanted to keep them as far apart as possible when he put them in the sky, protecting Orion from further harm.

The astronomer Eudoxus (c. 390-c. 337 BCE), to whom we owe the first complete theory of planetary motion (see the January 2020 SkyWAAtch) also seems to have been the first to describe the constellations visible from Greece. None of Eudoxus' writings have been preserved, but his constellation delineations were handed down to us in the form of a poem by the Greek writer Aratus (c. 315- c. 240 BCE), called *Phaenomena*. It's said to be a versification of and expansion on Eudoxus's treatise with the same name. The *Phaenomena* was a wildly popular book in its time, serving as the basic textbook for astronomy in the century after it was written.

The Greek polymath Eratosthenes (c. 276-c. 195 BCE) calculated the circumference of the Earth and the tilt of the Earth's axis. He was also a musician, mathematician, geographer and poet. He became the chief librarian at the famous library in Alexandria. Although almost everything he wrote is lost, a work attributed to him called *Catasterismi,* Greek for "places among the stars," has survived. It describes the constellations and tells their origin stories. It is sometimes considered to be the product of a later writer who is called "Pseudo-Eratosthenes." *Catasterismi* is clearly indebted to Aratus. The Roman scholar and librarian Gaius Julius Hyginus (c. 64 BCE – 17 CE) wrote two treatises on constellation myths, *Fabulae* and *De Astronomica.* These are obviously based on Greek sources. Hyginus describes the star positions more explicitly than *Catasterismi*, but they are still presented in very vague terms and only in relation to the constellation figures, whose back stories are presented in great detail, including alternative versions.

Although the constellations seemed to have been more or less standardized by the mid-4th century BCE, there were multiple stories about how they actually got into the heavens. Eratosthenes and Hyginus each present a variety of explanations, sometimes quoting

earlier poets and playwrights. In one telling, Ursa Major is Callisto, a maiden who hung out with Artemis in the forest. Zeus impregnated her (as he did with many attractive young ladies) and when Artemis saw she was no longer a virgin, she turned her into a bear. Later on, after a number of twists and turns, some definitely not for children, she was placed in the sky as Ursa Major. But an alternative story is that the bear was one of Zeus' nurses whom he honored by placing her in the heavens.

Rather than regale you with the multiple charming and contradictory stories of the constellations, I refer you to an excellent translation of Eratosthenes, Hyginus and Aratus, *Constellation Myths* by Robin Hard, who also provides commentary and notes about the stories and their origins. It was published in 2015 by the Oxford University Press.

The Farnese Atlas (photo by the author 10/13/19)

This past October Elyse and I found ourselves (well, we planned it) in the spectacular *Museo Archeologico Nazionale di Napoli*, the great treasury of frescoes, mosaics, sculpture and artefacts from Pompeii and Herculaneum but also housing the grand collection of sculpture of the Farnese family. Among the monumental marble statues (mostly fine 1st and 2nd century Roman copies of lost Greek originals) is the Farnese Atlas, which is taken to be the oldest depiction in the world of a celestial sphere (assuming the Kugel globe does not pre-date it).

The Farnese atlas is an imposing work, standing (or rather, kneeling) 7 feet in height above its pedestal. It is one of two large sculptures in the museum's huge Hall of the Sundial, the other being an elegant life-sized bronze horse from the Villa of the Papyri in Herculaneum, the up-scale seaside Roman town that was buried, like Pompeii, in 79 CE by the eruption of Mount Vesuvius. Although the Atlas dates from the time of the Roman Emperor Hadrian in the early second century CE, it has been suggested that the original sculpture on which it is based could have been carved as early as 300 BCE, a time when Greek astronomy was beginning to flourish.

The most commonly accepted myth (all Greek myths have variations) is that the giant Atlas, son of Iapetus and father of the Hyades and Pleiades among many other offspring, picked the wrong side in the fight between the Titans and the Olympians. The victorious Zeus condemned Atlas to stand at the western edge of the Earth (Gaia) and hold up the heavens. The western edge of meant the Pillars of Hercules (now called the Strait of Gibraltar) to the Greeks, and the ocean beyond was name "Atlantic." The Atlas Mountains are at the western edge of Africa.

The appearance of European figured celestial globes after 1500 might be traced back to this sculpture. Documents concerning it appeared around that time. It was first mentioned by one Petrus Sabinus in a description of statuary found in the vineyards of the del Bufalo family in what is now central Rome, close to where the Fontana di Trevi is located.[8] Only the torso and globe were intact, but it nevertheless became an object of interest to travelers and scholars. Michelangelo may have sketched it around 1530. In the 1550's it was restored, with a new face, arms and legs. It was purchased by Cardinal Alessandro Farnese in 1562 (for 250 *scudi*, we are told). In 1800 it was sent to Naples along with the other Farnese sculptures as part of the inheritance of Charles of Bourbon, who was heir to the Farnese

[8] Visiting that densely urban area in October 2019, I found it completely impossible to visualize a vineyard among the buildings, paved streets, the magnificent fountain and the crowds.

fortune. In 1860, with the unification of Italy, it was transferred to state ownership, and it now resides in one of the great museums of the world.

The statue was once thought to depict Hercules, not Atlas. Hercules' 11th labor was to steal the golden apples that had been a wedding gift to Hera. The hero cut a deal with Atlas: he would temporarily relieve Atlas of the burden of carrying the world while the latter retrieved them. Atlas knew where they were because they were growing in the garden of his daughters, the Hesperides, guarded by the dragon Draco (also called Ladon). After killing Draco and securing the apples, Atlas didn't want to resume bearing the immense weight of the heavens, but Hercules tricked him into taking back his burden.

The 65-cm diameter celestial sphere on the Farnese Atlas depicts 41 or 42 of Ptolemy's 48 constellations. One or two near the top seem to be damaged but the rest are in beautiful relief. The path of the zodiac is plotted, as well as the Tropics of Cancer and Capricorn, the Arctic and Antarctic circles (well before any exploration of these areas) and the equator. The two colures[9] are also shown.

Did the sculptor take the constellation map from Ptolemy's *Almagest*, which was written about the time the Roman copy was carved, or was it derived from an earlier astronomical work?

In 2005 Bradley Schaeffer, an astronomer at Louisiana State University, expanded on a suggestion by an obscure German classicist Georg Thiele, who proposed in 1898 that the lost star catalog of Hipparchus was the direct source of the constellations on the Farnese Atlas. Hipparchus (c. 190 – c. 120 BCE) is considered the greatest of all ancient astronomers. He invented trigonometry, discovered the precession of the equinoxes and made precise models of the motion of the Sun and the Moon, allowing him to make accurate eclipse predictions. He also invented the magnitude system, ranking stars from 1 (brightest) to 6 (faintest). In the *Almagest*, Ptolemy wrote that Hipparchus had made a celestial globe. In Raphael's *School of Athens* he is the representative of astronomy, carrying a blue ball dotted with stars. Many of Ptolemy's star positions were derived from Hipparchus, whose catalog was said to contain 850 stars with a positional accuracy of about one-half degree.

Hipparchus' only surviving work is a commentary on the *Phaenomena* of Aratus. It contains stellar positions based primarily on risings and settings of the various stars in each constellation and the separations among them. He also clarified Aratus' vague descriptions, corrected errors and argued with another Greek astronomer, Attalus of Rhodes, who also wrote a commentary on the *Phaenomena*. As an example, Aratus has only this to say about Boötes:

> Behind Helike [Ursa Major], as though driving her forward, comes the Bear-guard, whom men also call the Ox-herd, because he seems to be whipping along the

9 The colures are the two great circles of the celestial sphere intersecting each other at the poles, one passing through both equinoxes (ecliptic crossing the equator) and the other through both solstices (ecliptic at maximum height above and below the equator).

> Wagon-Bear [Ursa Major was also known as the Wagon]; he is very conspicuous throughout, and below his belt wheels Arcturus itself, a brilliant star above all.

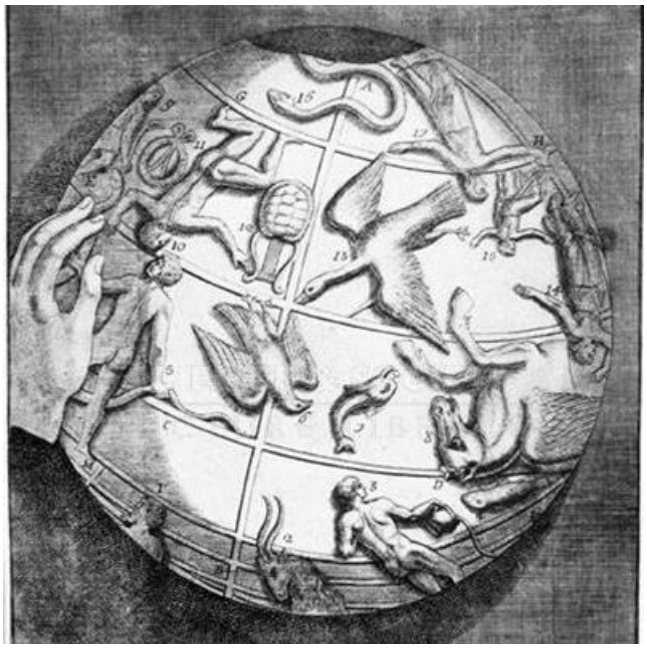
Hipparchus provides much more useful detail:

> And so Boötes rises simultaneously with the zodiac from the beginning of the Maiden until the 27th degree of the Maiden. While this rises, the section of the zodiac from the middle of the 27th degree of the Bull until the 27th degree of the Twins is in mid-heaven. And the first star of Boötes that rises is the one in the head, and the last is the one in the right foot. Of the other stars at the start of Boötes' rising both the left shoulder and the left foot of Orion are in mid-heaven, having gone forward a half-cubit beyond the meridian. When Boötes ceases rising the bright star in the haunches of the dog is in mid-heaven. The whole of Boötes rises in approximately two equinoctial hours.

Hyginus is far less detailed. He first notes Boötes' relation to other constellations and the various celestial circles and then he positions the stars:

> On his left foot he has four stars which are said never to set, and he has one star on his head, one on each shoulder, one on each nipple, that on the right being brighter and standing above the other, which is faint, and a bright star on his right elbow, and one on his belt which is brighter than all the others, which is known as Arcturus, and a star on each foot. In all, fourteen.

Although there are no actual stars on the Farnese globe, the positions of the constellations relative to the lines, particularly the colures, suggested to Schaeffer that the sky map was not accurate for the mid 2nd century CE. Correcting for precession, he dated the positions of the constellations to around 125 BCE ± 55 years, overlapping the date that Hipparchus was said to have catalogued his stars, 129 BCE. This would suggest either that the original sculpture was made later than the suggested date of 300 BCE, which seems unlikely given what is generally believed about the provenance of Roman copies of Greek sculptures, or that the Roman sculptor used Hipparchus' data directly. Schaefer's analysis was presented at the 2005 meeting of the American Astronomical Society. The proposal gained substantial publicity, but strong counter-arguments arose immediately, particularly from Dennis Duke of Florida State University, who argued that there was enough imprecision in the positions of the figures to limit its origin to a span of 400 years. Both of these very detailed analyses are available on the web[10,11] and make fascinating reading.

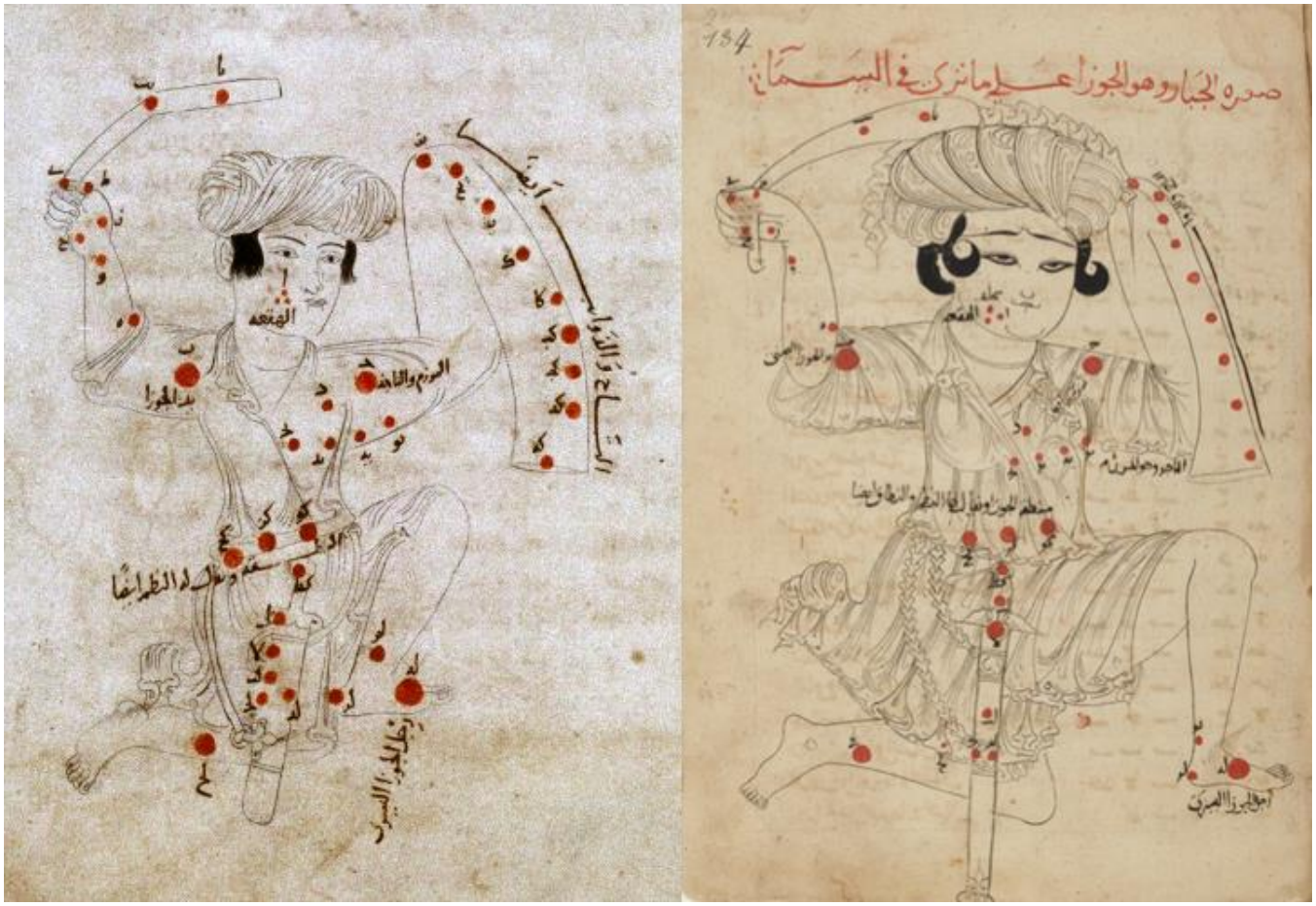


Engraving of one hemisphere of the Farnese Atlas possibly by Giovanni Battista Piranesi (1720-1778)

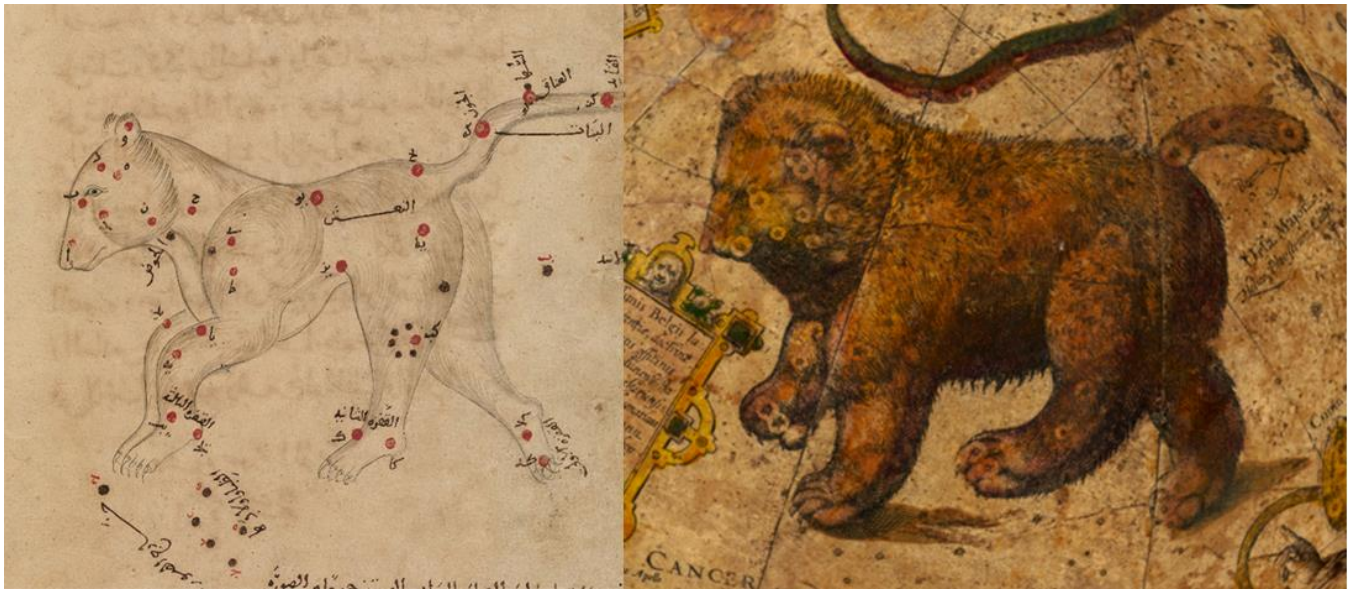
Try as I might, I can't see most of the constellation figures among the stars. I know most of the constellations, but to me only Cygnus, Scorpio and Orion resemble their pictures to any extent. Ursa Major is reduced to the ladle of the Big Dipper (or the Plough as the British call it), Hercules is a mere trapezoid, Pegasus a square and Sagittarius the Archer is simply a teapot. We only see Cassiopeia's chair and not the queen herself. We're happy to use constellation names and perhaps their stick-figures to orient ourselves in the sky but our modern sensibilities might find the classical figures to be merely charming, faintly silly or even distracting. We no longer have command of the origin stories, and that's not just because we don't worship Zeus. Yet, thinking about them and trying to envision these mythological creatures and objects when we look at the celestial vault can inject a bit of historical and cultural wonder into what might otherwise be a more dispassionate view of the universe, exciting but a bit less human. ■

[10] http://www.phys.lsu.edu/farnese/JHAFarneseProofs.pdf,

[11] https://people.sc.fsu.edu/~dduke/farnese4.pdf



Orion, as seen from a geocentric position, from al-Sufi's *Book of the Constellations of the Fixed Stars.* On the left is the image in the 1009 edition from the Bodlean Library, Oxford. On the right is Orion in the 14th century Library of Congress volume.



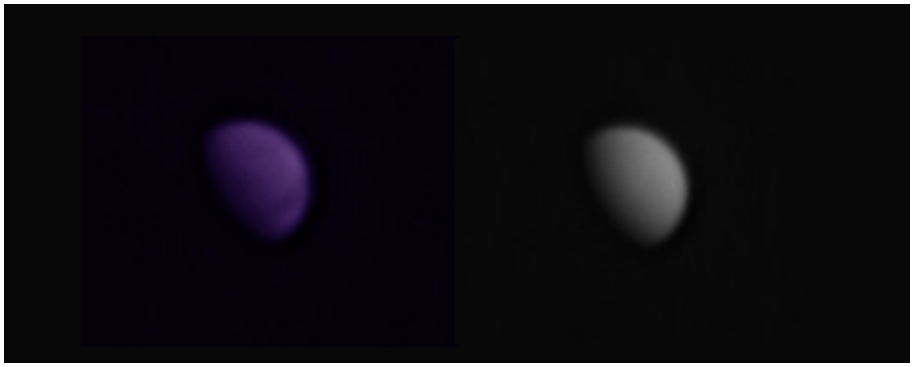
Ursa Major, as seen in the typical celestial globe view from outside the heavens, in the Bodlean Library's 1009 copy of al-Sufi and on a 14.3-inch diameter celestial globe from 1600 by Hondius (Bibliothèque Nationale de France). Images of Ursa Major from a later edition of al-Sufi and by Albrecht Durer are on page 10.

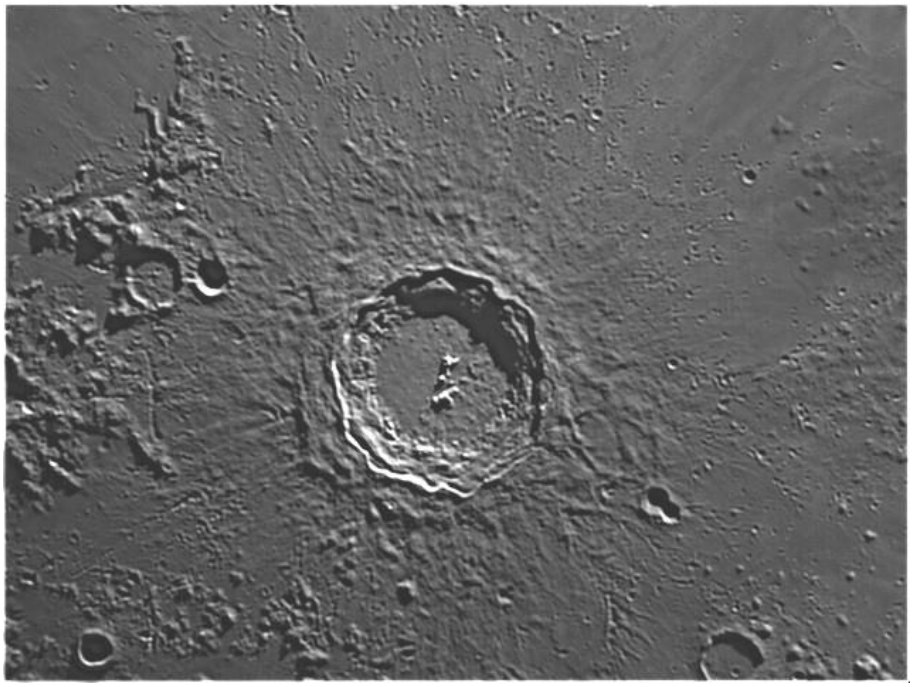
Images

Tom Boustead's excellent-image of the first quarter Moon was a "first light" photo through his new Zenithstar 61 telescope using a Canon T3i DSLR.

The William Optics Zenithstar 61 is an f/5.9 two-element apochromat using FPL-53 glass. It has a 2" focuser that provides full-frame illumination on an APS-C sensor, which is usually around 24x16-mm (as compared to the regular 36x24-mm full-frame DSLR sensors).

Gary Miller sent this wide-angle view of Markarian's Chain, a stretch of galaxies in the Virgo cluster. The two brightest members are, starting in the lower right corner, M84 and M86. NGC 4435 (upper) and NGC 4438 (lower) are the pair of galaxies in the center of the image. The giant elliptical M87 is located just outside of the left lower edge of the frame. The Virgo Cluster is well-placed for viewing on spring nights. 127 mm refractor, DSLR.





John Paladini imaged Venus on February 3rd with a 9.25" SCT. The left image shows the planet in the ultraviolet, using a 390-nm filter. The right image shows it through a red filter.

John also sent this high-definition image of Copernicus, taken through one of his many unusual telescopes, this one an 8-inch Classical Cassegrain (parabolic primary mirror and hyperbolic secondary mirror, no corrector plate).

John writes: "I got a GSO 8-inch CC at reduced price but it was out of alignment. It took me 5 hours to get it right. It's not like any other scope to align, a different procedure, but it now appears to give good images. On plus side, quick cool down."

John used a ZWO ASI120MM monochrome CMOS camera for both photos.

New member **Greg Borrelly's** intrepid first astrophoto, through the window of his Yonkers apartment. The Hyades and Pleiades are clearly visible on either side of the Moon in this Canon T6i image, lens focal length 50 mm, static tripod mount.

Research Highlight of the Month

B. Ladjelate, et. al., The Herschel view of the dense core population in the Ophiuchus molecular cloud

An international team used the infrared and submillimeter capabilities of the Herschel Space Observatory to study star formation in our galaxy. This area of intense star formation is just 139 ± 6 parsecs from the Sun. The authors summarize their results as follows:

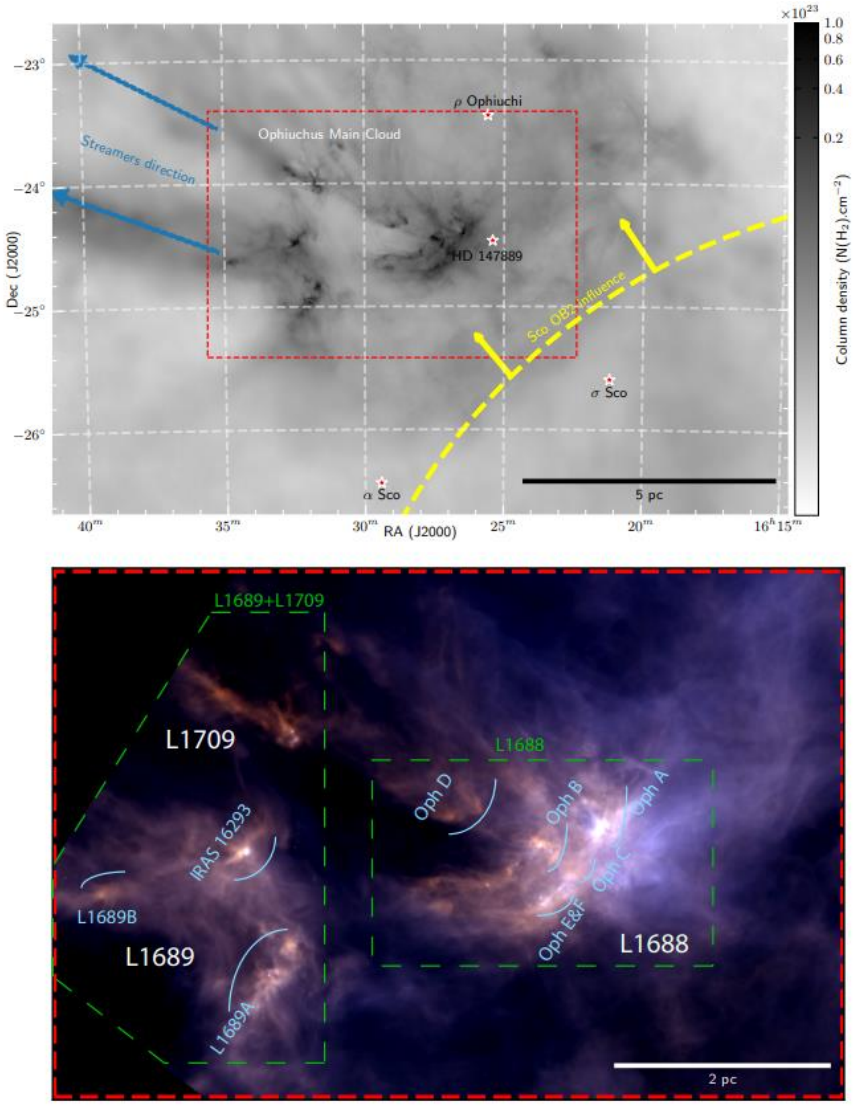


Fig. 1. (Top) Multi-resolution column density map of the Ophiuchus complex derived from *Planck*/*Herschel* data (see text). The red rectangle shows the area encompassing the Ophiuchus main cloud covered by the *Herschel* data discussed in the paper. The effective resolution ranges from 18.2″ in this area to 5′ in the outer parts. **(Bottom)** Composite three-color image of the field outlined by the red rectangle in the top panel, combining *Herschel*/PACS 160 μm data as a blue layer, *Herschel*/SPIRE 250 μm data as a green layer, and *Herschel*/SPIRE 350 μm data as a red layer. The main clumps and sub-regions of the field are marked. The green dashed polygons highlight the regions defined as L1688 and L1689+L1709 in the rest of the paper.

The densest clouds of the Ophiuchus complex, L1688 and L1689, which thus far are only indirectly described as filamentary regions owing to the spatial distribution of their young stellar objects (YSOs), are now confirmed to be dominated by filamentary structures. The tight correlation observed between prestellar cores and filamentary structures in L1688 and L1689 supports the view that solar-type star formation occurs primarily in dense filaments. While the sub clouds of the complex show some disparities, L1689 being apparently less efficient than L1688 at forming stars when considering their total mass budgets, both sub clouds share almost the same prestellar core formation efficiency in dense molecular gas. We also find evidence in the Herschel data for a remarkable concentric geometrical configuration in L1688 which is dominated by up to three arc-like compression fronts and presumably created by shockwave events emanating from the Sco OB2 association, including the neighboring massive (O9V) star σ Sco.

Read the article at arXiv 2001:11036.pdf. It will be published in *Astronomy and Astrophysics.*

Member & Club Equipment for Sale

Item	Description	Asking price	Name/Email
Celestron CPC800 8" SCT (alt-az mount)	Like new condition, perfect optics. Starizona Hyperstar-ready secondary (allows inter-changeable conversion to 8" f/2 astrograph if you get a Hyperstar and wedge). Additional accessories: see August 2018 newsletter for details. Donated to WAA.	$1000	WAA ads@westchesterastronomers.org
Explore Scientific Twilight I Mount	Manual Alt/Az, capacity 18 lb. Steel tripod. Excellent condition. Used fewer than 10 times. Great for grab-and-go viewing. Owner upgrading to an EQ mount.	$100	Eugene Lewis genelew1@gmail.com
Meade 395 90 mm achromatic refractor	Long-tube refractor, f/11 (focal length 1000 mm). Straight-through finder. Rings but no dovetail. 1.25" rack-and-pinion focuser. No eyepiece. Excellent condition. A "planet killer." Donated to WAA.	$100	WAA ads@westchesterastronomers.org
Meade LX-70 Equatorial Mount	Dual Axis Drive and Polar Scope - Brand New. Bought during the closeout sale of these mounts. Owner thought he might like to have a light GEM, but decided to stick with alt-az mounts. Set up once in the garage to be sure it all works, and it does, but never saw first light in the field. Price paid: $365.	$240	Eugene Lewis genelew1@gmail.com
Sky-Watcher 10" f/5 reflector OTA **New Listing**	Brand new in box. Newtonian optical tube, 2" focuser, tube rings. No eyepieces, finder or dovetail. Would make a great Dobsonian or use on a decent sized GEM. These listed at over $500 when new. Donated to WAA.	$250	WAA ads@westchesterastronomers.org
Celestron 6-inch f/5 reflector OTA	Same tube as the Orion 6" StarBlast. 1¼" rack-and-pinion focuser, Celestron 25 mm EP, tube rings, dovetail plate. 5x30 straight through finder. Dark canvas carrying case with compartments, room for accessories. Excellent condition, unblemished optics. This size OTA is hard to find without a mount. An Orion StarBlast 6 with 1¼" focuser and table-top Dobsonian mount lists for $379. Meade's 6" f/5 OTA, admittedly with a 2" Crayford focuser but no case, lists for $339. Donated to WAA.	$175	WAA ads@westchesterastronomers.org

Want to list something for sale in the next issue of the WAA newsletter? Send the description and asking price to ads@westchesterastronomers.org. Member submissions only. Please submit only serious and useful astronomy equipment. WAA reserves the right not to list items we think are not of value to members.

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