AOH OBSERVER

Spring 2017

The Newsletter of the Astronomers of Humboldt

Reflecting on the 60th Anniversary of the AOH

On February 11, AOH members gathered at the Humboldt Area Foundation for the "Annual" Potluck Dinner. This occasion also celebrated the 60th anniversary of the founding of the Astronomers of Humboldt (albeit a month late). The emphasis on "Annual" was because this was the first potluck dinner since 2009; the last one commemorated the 50th anniversary of the incorporation of AOH. It is our hope that this year's Potluck will mark the beginning of many more potlucks to come.

It was an enjoyable evening with new and veteran members coming together for fellowship and good food. We were fortunate to enlist HSU Professor C.D. Hoyle as our guest speaker. His talk entitled "100 Years of General Relativity and the New Era of Gravitational Wave Astronomy" was an enlightening account of our understanding of gravity from Newton to Einstein to the latest findings by LIGO. His talk also touched upon the research being done in his "Gravitational Research Lab" and the work they are doing to test Einstein's theory of relativity. As one of our members remarked, "I am so proud to live so near to a top tier university that is always at the cutting edge of contemporary research". HSU Professor Paola Hidalgo Rodriguez also joined us for the evening and gave her thoughts on black holes, gravitational waves, and the early universe. The discussion was quite lively, and unfortunately we did not have enough time for all of the questions (something that we will fix in the next iteration of the Annual Potluck Dinner).

The celebration of our 60th anniversary is an opportune time to reflect on the importance of the AOH in this community. In our 60 year history, the club has spearheaded the building of the three observatories in Humboldt County: Fickle Hill Observatory (HSU), College of the Redwoods Observatory and the Kneeland School Observatory. The AOH is an advocate for science, and we provide astronomy programs to schools, various youth organizations, and at public events. Some of the frequent comments we hear are "I've never looked through a telescope before", or "I didn't know that the moon looked like that" or "Wow, that is so awesome". All of the these activities are possible because of the generosity of our members who volunteer their telescopes, their expertise, and their time.

I want to thank Ken Yanosko and Mark Wilson for their help in planning the Annual Potluck. Ken did an excellent job as the master of ceremony, and making sure that we kept to the schedule. I am grateful to the members who helped set up and clean up afterwards. The room went from chaos to clean in 30 minutes! And finally, a big thank you to all who attended the Potluck. It was indeed a successful evening because of your participation. Save the date for 2018!

AOH members can access the photos taken at the Potluck at the "For Members Only" site at http://www.astrohum.org/members_only/potluck_photos.php.

Acknowledgment: Thank you to Ken Yanosko and Donald Wheeler for their comments and suggestions.

AOH Renewals and New Members

Our membership year started January 2017. The membership form (for both renewal and new) can be found at http://www.astrohum.org/membership.html. Both individual and family memberships are fifteen dollars. Your membership dues support the maintenance and purchases for our Kneeland Observatory, as well as our educational outreach. Thank you to all that have already renewed for 2017.

We are pleased to welcome the following new members who joined in early 2017:
Scott Osborn, Eva Laevastu, Kathy Blume, Vicki Vaughn Zeitlin, Shinazy, Jeff Goodman, and Mike Foster (a long time member just renewing).

AOH Calendar March-May 2017

Events listed below are from our "Upcoming Events" on our webpage. Be sure to check there for changes. If you are interested in helping out at any of our outreach events, contact grace@astrohum.org. Your help is always appreciated!

Friday March 24 or Saturday March 25. **Messier Marathon (from Ken)** . This is the primary weekend. We will hold the marathon on either Friday night or Saturday night, depending on the weather forecast. If the weather is not cooperative we will postpone the marathon until March 31 or April 1. The location is the Kneeland Airport. If you go, arrive in time to set up equipment before dark. But before leaving home, check both the up-to-date weather forecast and the Kneeland Airport Sky Cam at, respectively:

http://forecast.weather.gov/MapClick.php?lat=40.7187&lon=-123.9277 and

http://northcoastaviation.com/kneeland/kneeland_south.htm.

Friday March 31 or Saturday April 1. **Messier Marathon**. Secondary weekend. Held this weekend only if postponed from March 24 or 25.

Wednesday April 5. Science Night at Morris School. The AOH will be there with telescopes to observe the quarter moon. 5:30-6:30 p.m. 2395 McKinleyville Ave, McKinleyville CA. (If you would like to help out, contact grace@astrohum.org.)

Wednesday April 19, 2017, 6:00 PM PDT. ****NSN Webinar**: "Earth Science and Remote Sensing from the ISS." Presented by the staff from the Earth Observing Lab at NASA Johnson Space Center. You can register in advance for this webinar through the "Register" link on the "For Members Only" page at our website: http://www.astrohum.org/members_only/webinars.php.

Saturday April 22 from 12-4 p.m. **Earth and Solar System Day at HSU Natural History Museum**. Outreach event including daytime observing and sun/planets/solar eclipse presentations. 1242 G Street, Arcata CA 95521.

Saturday April 29. **Regular Monthly Meeting**. Location TBA

Wednesday May 17, 2017, 6:00 PM PDT. **NSN Webinar:** "NASA's Eyes." Presented by Kevin Hussey from NASA JPL. See the Webinar link above.

Tuesday May 23. **Astronomy Night in Willow Creek**. Outreach event for Creekside Arts and Education Learning Center.

Saturday May 27. **Regular Monthly Meeting**. Location TBA

**Past NSN Webinars can be found on the NSN Youtube Channel https://www.youtube.com/playlist?list=PLjLQn63Cw1AJ20U3iMY3dFaDga7Cn6G8R.

AOH Outreach

Six Rivers Montessori School

Our first school visit of 2017 was to the Six Rivers Montessori School where we met with students and their teacher Michele Gilbert. The students were learning about the solar system and working on projects about the planets. Mark Wilson gave a short introduction on the history and design of telescopes, and their use in space exploration. We then had a 45 minute observing session that included viewing the sun and Venus.

Mark set up his refractor telescope with a sun filter so that the students were able to view the sun disk and sunspots (one giant sunspot and a few smaller ones). We also set up a telescope with a “sun funnel” so that students could indirectly view the solar disk and sunspots (https://www.astrosociety.org/tov/Build_a_Sun_Funnel2.pdf).

We had originally planned to view the the 26 day waning crescent moon. However by the time we started, the sunlight had washed out moon disc and it was difficult to see any surface details. As an alternative to the moon viewing, the telescope was set up to find Venus. The students saw that Venus was in “quarter” phase, and they were shown a chart detailing the phases of Venus as the planet moved between the Earth and the Sun. They were quick to pick up that the Venusian phases were similar to that of the moon, i.e. full, gibbous, quarter, crescent, and new.

Students viewing the sun through a refractor telescope.

The Schmidt-Cassegrain was set up to view Venus.

A sun funnel was set up on a 4 inch refractor.

Venus at quarter phase was visible east of the sun.

The last activity was a cratering demonstration. A deep dish pan was filled with about 3 inches of flour and then dusted with cocoa. The students dropped large and small marbles into the flour with varying degrees of force. The students observed that the size, velocity and direction of the impactors determined the depth of the crater and the pattern of the ejecta (the underlying white flour that is excavated and splattered outward). This exercise gave us an opportunity to talk about what we see on the surface of the moon: craters, maria (the basaltic plains formed by massive impacts) and mountains (the rims of the craters). Students had different ideas as to why the moon is so heavily cratered and the Earth is not. It was a spontaneous bit of fun and the students enjoyed peppering the mock moon surface with our "meteorites". Michele Gilbert commented afterwards "we love experiments".
Mark and I were impressed that for such a simple exercise, it yielded a discussion that touched upon many topics.

Next time we'll be messier….

Thank you Debora Jacobsen, Michele Gilbert, and the students of Six Rivers Montessori for inviting us and for being such a great audience. We had a lot of fun and we look forward to seeing you all next year.

January 28, 2017 Kneeland School Star Party.

A star party in January is always an iffy proposition, and this year proved no different. It started out partly cloudy, and for a while, Mark Mueller and I thought that we would have to retreat into one of the classrooms for an indoor program. However by 6:30 p.m., sky conditions improved considerably, and it was particularly clear to the south/southeast. Several of us set up telescopes: Mark Mueller (8 inch Dobsonian), Don Wheeler (5 inch apo-refractor), Russ Owsley (14 inch Schmidt-Cassegrain in the Observatory), and Grace Wheeler (8 inch Schmidt-Cassegrain). Mark Wilson, Dan Eaton, and Greg Deja showed up to help with the observations. We were joined by new member Shinazy, future members Eva and Kathy, the Farrell family, and visitors Maggie and Lisa. Collectively, we found the following objects: Venus (crescent phase), Double Cluster in Perseus, Orion's Nebula (including a view of the Trapezium), Andromeda Galaxy, Pinwheel Galaxy, M71 (globular cluster in Sagitta), M79 (globular cluster in Lepus), Cigar Galaxy (M82) and Bode's Galaxy (M81) in Ursa Major, M35 (open cluster in Gemini), Crab Nebula (M1) in Taurus, Eskimo Nebula (NGC 2392) in Gemini, and the Little Dumbbell Nebula (M76) in Perseus. Dan had Sky Safari running on his Ipad so that we could access the background information on various sky objects that we found. It turned out to be a wonderful evening of stargazing. Thank you Shinazy for greeting and keeping track of the visitors. A big thank you to all who ventured up to Kneeland taking a chance that we would actually see something!

Shinazy viewing Venus through Mark's Dobsonian telescope.

Eva, Kathy, and Don musing about the night sky.

Night Sky Observing Notes: Planets

Venus: Throughout January and February, the Venusian disc has been growing larger and changing from quarter to crescent phase. Venus attained its highest altitude in the sky on Feb. 9th (setting at 9 p.m. PST). Since then, Venus has been setting earlier each day. Venus is at inferior solar conjunction on March 25 and will disappear from the evening sky. Venus reappears in the predawn sky in early April and will remain there until late November.

Venus is bright enough to be seen in the daytime. Image taken on 3/14/17 at 2 p.m.; disk was 5% illuminated.

Jupiter on 3/14/17 just after midnight. Note: Red Spot transiting on the disk

Jupiter: In March, Jupiter transitions from a planet that is best seen in the predawn hours to one that can be seen in the late evening. Jupiter is at opposition on April 7 and the planet rises at sunset; however, due to the glare of the setting sun, Jupiter is best seen after twilight. For April and May, Jupiter will be out all night so it is possible to view the planet from mid-evening to dawn. The opposition of Jupiter is the start of "double shadow moon transit" season (background on this: https://www.umich.edu/~lowbrows/reflections/2001/mdeprest.15.html. For 2017, there will be fifteen "double shadow moon transits" (aka double shadow transit or DST) occurring worldwide from early May to late June. Only three of these DST will be visible in our time zone.

May 18 : Double Shadow Transit (Europa, Io)
1st shadow: at sunset Europa shadow transit already in progress.
2nd shadow: 8:53 p.m. Io shadow transit begins (DST starts)
Europa shadow transit ends at 9:42 p.m. (DST ends)
Io shadow transit ends at 10:04 p.m.

May 25: Double Shadow Transit (Europa, Io)
1st shadow: 9:41 p.m. Europa shadow transit begins.
2nd shadow: 10:47 p.m. Io shadow transit begin (DST starts)
Europa shadow transit ends May 26, 12:36 a.m. (DST ends)
Io shadow transit ends May 26, 1:05 a.m.

June 2: Double Shadow Transit (Europa, Io)
1st shadow: 12:18 a.m. Europa shadow transit begins.
2nd shadow: 12:41 a.m. Io shadow transit begins (DST starts)
Io shadow transit ends at 2:59 a.m. (DST ends)
Europa shadow transit ends 3:13 a.m.

A search of Jovian events including occultation, eclipses, shadow transits, moon transits, can be found at these two websites:
https://www.calsky.com/cs.cgi/Planets/6/6?obs=90755129426634
http://rfo.org/jackscalendar.html

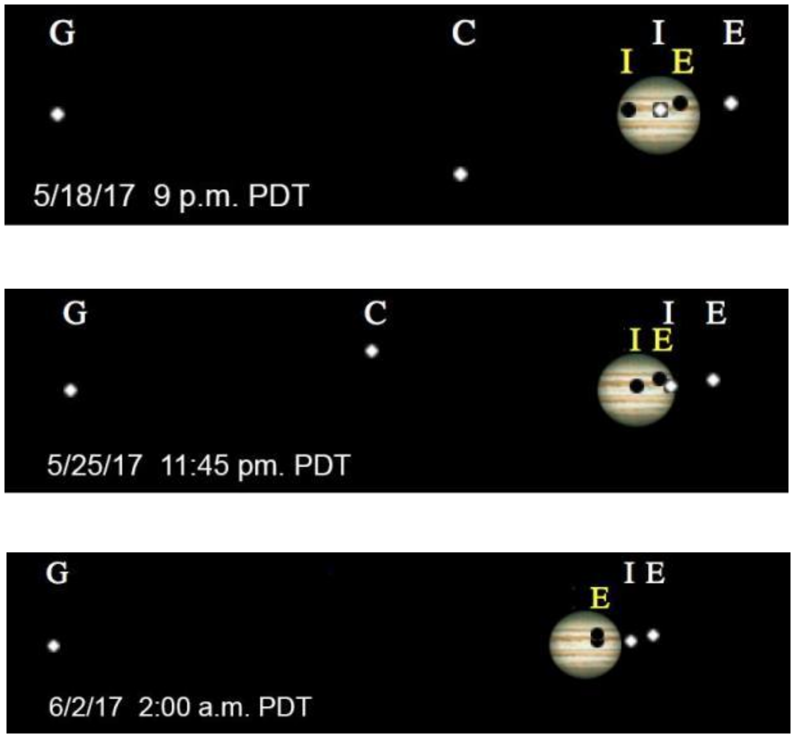


Figure 2: The transits of the Galilean moons and their shadows were generated on Javascript Jupiter http://www.shallowsky.com/jupiter/

Mercury: March 23 through April 8. Mercury is visible at about 8 p.m. and will be about 10 degrees above the western horizon. Mercury will be at its greatest eastern elongation on March 31. Like Venus, Mercury is bright enough to be seen in the daytime sky.

Saturn: Throughout March, Saturn rises after midnight and is best viewed in the predawn sky. Saturn rises 4 minutes earlier each day. By the end of May, the planet rises at around 9:30 p.m. Opposition for Saturn is on June 15th. Saturn will be visible in the in the early to late evening sky throughout the summer.

Night Sky Observing Notes: Constellations and Messier Objects

The spring constellations include Leo, Bootes, Canes Venatici, Coma Berenices, Ursa Major, Virgo, and Corvus as illustrated in the Star Chart below (Fig. 1).   Included on the Star Chart is the winter constellation Gemini (with M35), which can seen in the early evening sky, and the summer constellations Hercules (M13, M92) and Serpens Caput (M5) which rise late in the evening. Also shown is the open cluster M44 (The Beehive) which is in the constellation Cancer. The Beehive has a diameter of about 3 moons and is best viewed in March.

In this section of the "Observing Notes", the focus will be on the spring constellations and selected Messier objects found within these regions of the sky.   A complete listing of Messier objects and how to find them can be found here: http://www.messier-objects.com.   Happy hunting!

Leo (The Lion) is technically a winter constellation; however, it is most commonly associated with spring because of its ascent overhead in the March skies. The bright star Regulus (mag. 1.36) forms the end point of the the distinctive sickle of Leo. In the hindquarter region of Leo, near the star Chertan (Theta Leonis), lies the "Leo Triplet" (Fig. 2). The Triplet is made up of the intermediate spiral galaxies M66, M65, and the unbarred spiral galaxy NGC 3628 (aka Hamburger Galaxy). With a moderately sized telescope and low magnification (e.g. 5 inch Newtonian, 40 mm eyepiece) it is possible to fit all three in the same field.   M66 is the largest and brightest (mag. 9.4) of the Leo Triplet.
http://www.messier-objects.com/leo-triplet/

Bootes (The Plowman) is the 13th largest constellation and contains Arcturus, the third brightest star in the night sky (Sirius is the brightest followed by Canopus).   Although Bootes contains no Messier objects, Arcturus is often used as a guide for finding M3 in the constellation Canes Venatici, and M53 in Coma Berenices.   M3 lies halfway between Arcturus and Cor Caroli of Canes Venatici, and M53 is about 15 degrees west of Arcturus.
http://www.constellation-guide.com/constellation-list/bootes-constellation/

Coma Berenices: (Berenice's Hair) is a cluster of stars lying between Leo and Bootes. The three brightest stars are α−, β−, and γ−Comae Berenices. At 4^{th} magnitude, these stars are not particularly bright.   Coma Berenices is the home to eight Messier objects including globular cluster M53 (mag. 8.3) and the large spiral galaxy M64 (mag.9.3). M64 (Fig. 3) is also known as the Black Eye Galaxy because of the dark dust band surrounding its bright center. A large telescope is needed to see the dark dust belt.
http://www.constellation-guide.com/constellation-list/coma-berenices-constellation/

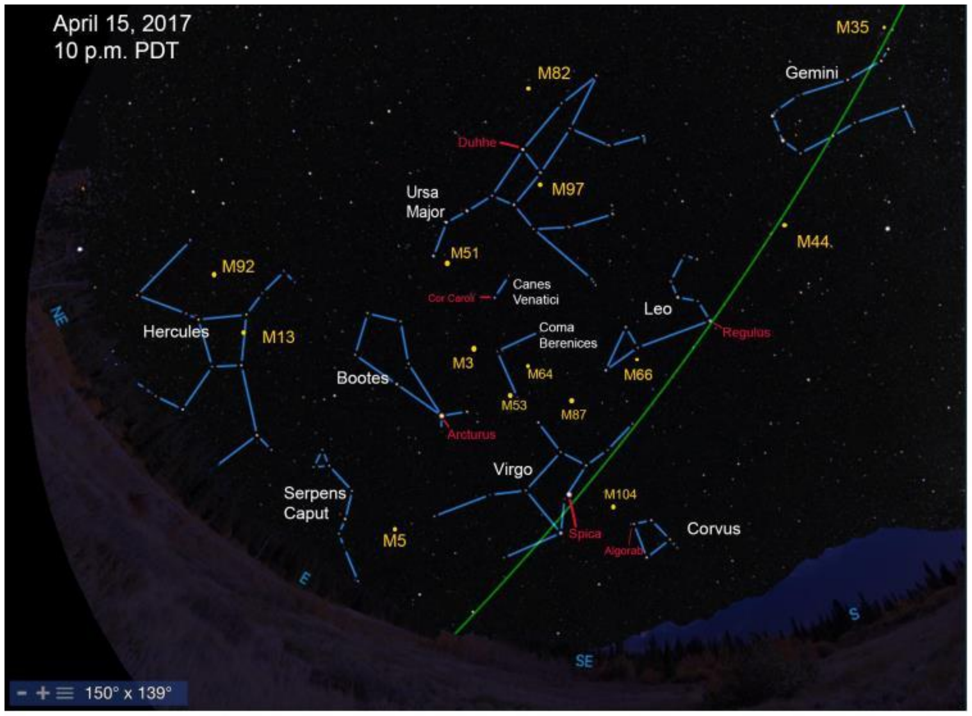


Figure 1. Star Chart for April 15, 2017 generated on Starry Night Pro. Yellow circles represent location of various Messier objects. In areas where there are galactic groups, e.g. Leo Triplet and Virgo Cluster, only one of the member galaxy is given to show the general location.

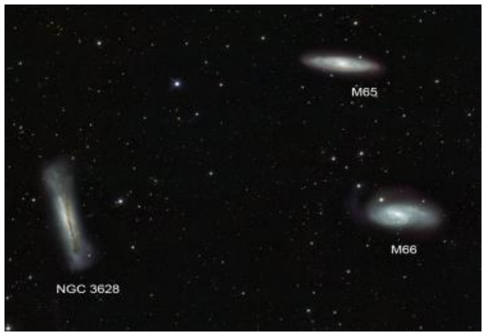


Figure 2. Leo Triplet imaged on ESO/INAF-VST/OmegaCAM. Credit: OmegaCen/Astro-WISE/ Kapteyn Institute http://www.eso.org/public/images /eso1126a/

Figure 3. The Black Eye Galaxy (M64) in Coma Berenices was imaged with a five inch refractor.   Credit: Jeff Johnson https://en.wikipedia.org/wiki/ Black_Eye_Galaxy#/media/ File:M64_JeffJohnson.jpg

Ursa Major (The Great Bear; UMa) is the third largest constellation in the sky and is best known for its asterism "The Big Dipper". UMa is always above the horizon in northern latitudes, but it is best viewed in the spring when it is high in the sky. M97 (Fig. 6) is located at the bottom of the bowl. This large planetary nebula is known as the Owl Nebula because of two large dark areas that resemble eyes. The galactic pair M81 and M82 (Fig. 7) are located about 10 degrees northwest of Dubhe. M82 and M81 have a separation of 0.5 degree (diameter of the moon) and can be viewed in the same field with a small telescope. M82 (mag. 8.4) is a starburst galaxy and its galactic center is 100x more luminous than that of the Milky Way Galaxy. http://www.constellation-guide.com/constellation-list/ursa-major-constellation/

Canes Venatici (The Hunting Dogs; CVn). CVn contains no bright stars, and the main stars, Cor Caroli (alpha CVn) and Chara (beta CVn) are 3rd and 4th magnitude respectively. Notable Messier objects include M3, a bright globular cluster (magnitude 6.19), and M51, the Whirlpool galaxy, the first galaxy to be classified as a spiral galaxy. Even though M51 is part of CVn, it is located near the star (Alkaid) at the end of the handle of The Big Dipper. In order to see the spiral structure of the Whirlpool, an 8 inch telescope or larger is needed. http://www.constellation-guide.com/constellation-list/canes-venatici-constellation/

Virgo (The Virgin) is the second largest constellation and is located in the southern skies. It is best seen in the spring and summer. Spica is its brightest star. Virgo holds the record for the most number of galaxies contained within its region of the sky. The Virgo Cluster spans about 5 degrees and may contain as many as 2000 galaxies. M87 is an elliptical supergiant galaxy and is at the center of the Virgo Cluster. http://messier.seds.org/more/virgo.html. The Sombrero Galaxy, M104 (mag. 8), is found about halfway between Virgo and Corvus (The Crow). The central glow of M104 is thought to emanate from thousands of globular clusters. M104 can be located in the night sky by star hopping from Spica or Algorab (delta Corvi) the left top star in the constellation Corvus. http://scienceblogs.com/startswithabang/2013/05/27/messier-monday-the-sombrero-galaxy-m104/

http://www.constellation-guide.com/constellation-list/virgo-constellation/

Figure 6. Owl Nebula (M97). Imaged with a C-14. Credit: Fryns https://en.wikipedia.org/wiki/Owl_Nebula#/media/File:M97.jpg

Figure 7. Mosaic of M82 and M81, imaged with a C14. Republished with kind permission of Mike Hankey http://www.mikesastrophotos.com/galaxies/a-galaxy-in-peril-m82/

Figure 8. The Whirlpool Galaxy (M51, CVn) and companion NGC 5195 imaged through an 8 inch Newtonian. Credit: Chase Preuinger https://commons.wikimedia.org/wiki/File:The_Whirlpool_Galaxy_(M51).jpg

Figure 9. M3 Globular Cluster imaged with a 5 inch Newtonian. Credit: G.W.

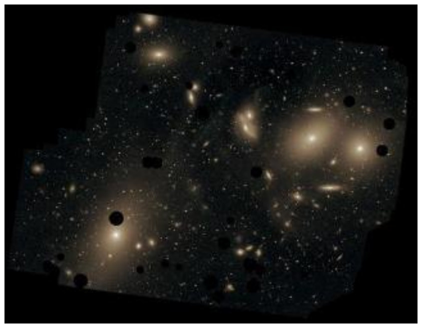


Figure 10. M87 (bottom left) in a deep image of the Virgo Cluster. The holes are the subtraction of the foreground stars. Chris Mihos (Case Western ReserveUniversity)/ESO http://www.eso.org/public/images/eso0919a/

The Sombrero Galaxy (M104) in Virgo. Atlas Image mosaic courtesy of 2MASS/UMass/IPAC-Caltech/NASA/NSF http://www.ipac.caltech.edu/2mass/gallery/m104atlas.jpg

Messier Half Marathon

By Mark Mueller

This March, if weather cooperates, Astronomers of Humboldt will host a Messier Marathon. A Messier Marathon entails staying up all night looking for all 110 Messier objects. What is a Messier (pronounced Messee-ay) object you might ask? Messier objects are deep sky objects i.e. not objects in our solar system, like nebulae, galaxies, open and globular star clusters. I enjoy looking at these. They are so beautiful. But Messier cataloged them because he was not interested in them. He was interested in finding comets and so he cataloged things that looked like comets (in a crappy old 18th century telescope) but weren't comets so that he would know not to spend any effort on them.

In a Messier Marathon astronomers set up before sunset and start looking for Messier objects in the west just after sunset and search the sky moving towards the eastern horizon just before sunrise. If you are super organized and are good at identifying the different objects, you might be able to see all 110 Messier objects. Of course it helps if the weather holds out all night. Ahh but that the is drama of astronomy in Humboldt County!

I have been to several Messier Marathons, all of them at Kneeland Airport and hosted by The Astronomers of Humboldt. I have not yet seen all of the Messier objects in a Marathon. Russ Owsley, past-club president, supplied us with a search sequence list compiled by Hartmut Frommert, using the work of Don Machholz. I am guessing that these lists are compiled by considering the brightness of objects, and the darkness of the sky near sunset and sunrise, and by their locations in the sky and efficiency of movement of the telescope in between when the sky is dark. I am going to make another guess that these search lists might differ depending on the type of telescope that you are searching with: Dobsonian, goto, or manual equatorial mount. Part of the reason I have not seen all of the Messier objects in one Marathon is that I get tired and go home around midnight or 1 AM. So I guess I have done a Messier Half Marathon.

There is a bit of that competitive thing going on, but mostly a lot of cooperation and collaboration. I guess it is the three “C”s. We enjoy looking at objects through each other's telescopes, admiring how some find certain things so easily. I remember a couple of years ago admiring how Grace and Don Wheeler worked so well together making sure they had properly identified galaxies in the Virgo Cluster.

Consider bringing some snacks and beverages. Hot tea is great to have. Also dress warm. It's a long time to be out. This is an event where you won't need sunscreen. There will be several of us that know what we are doing to various degrees. So you can always get help. We usually have plenty of telescopes and are happy to share views and work with others who don't have a telescope. My experience is that it is especially fun to have someone to share the view with and to double check just what it is that is in the view. So come up the hill and celebrate astronomy and looking at some of the coolest sights to see through modern a telescope!

References:

http://astrored.net/messier/xtra/marathon/marathon.html
https://en.wikipedia.org/wiki/List_of_Messier_objects
http://www.astras-stargate.com/holdm.htm

Additional references (http://www.astrohum.org/upcoming.html)

http://messier.seds.org/xtra/marathon/marathon.html
http://davidpaulgreen.com/free-astronomy-software/
http://www.custerobservatory.org/docs/messier2.pdf
http://www.everythingintheuniv.com/_eiu/new_books.htm#starhopper

Editor’s Note: This is republished from Feb. 2016 edition of the AOH Observer. Our date(s) for this year’s Messier Marathon is March 24/25 or April 1/2 at the Kneeland Airport. Whether you are up at Kneeland with the AOH, or do the Marathon your own, keep track of your found Messier objects and send your list to me at grace@aoh.org. We’ll post everyone’s list in the next issue of the Observer.

Hunt for Antarctica's “Missing Meteorites”

by Jonathan Amos, Science Correspondent, BBC News

The go-ahead has been given for the first British expedition to collect meteorites in Antarctica. Most of the space rocks now in collections worldwide have been picked up on the continent. The region's great expanse of ice makes searching for the blackened remains of objects that have fallen from the sky a particularly productive exercise. But the UK venture will target a strangely underrepresented class of meteorites – those made of iron.

When the flowing ice hits a barrier, such as a mountain range, it is forced upwards. Credit: Ansmet/K.Joy.

These are the smashed up innards of bodies that almost became planets at the start of the Solar System. Finding more of them could give us important clues to events that occurred some 4.6 billion years ago, said Dr. Katherine Joy from Manchester University. “We can't access the iron core of the Earth, but iron meteorites provide us with a really nice guide to what the inside of our own planet is like and gives us an indication of how many planets there may have been in the early Solar System,” she told BBC News.

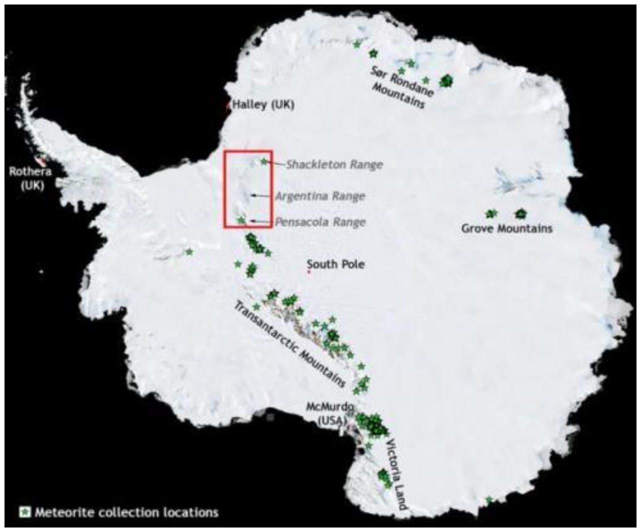
Ten times fewer of these iron lumps are recovered on the White Continent compared with other parts of the globe. The British scientists think they know the reason for this discrepancy. They have developed a mathematical model that suggests the chunks of metal are all still out there, waiting to be picked up; they just happen to be buried a few centimetres below the surface.

Technologies normally employed in landmine detection are being adapted to make a wide sensor. This apparatus will be dragged by skidoos across the ice to find the hidden space material. A prototype system should be ready for testing at the UK's Halley research station in the Antarctic summer season of 2018/19. Assuming this goes well, a team will then deploy to a deep-field site a year later to begin the iron hunt in earnest.

Landmine detection technology is being adapted to track down the meteorites. Credit: University of Manchester

The Manchester-led project is funded by the Leverhulme Trust with logistic support from the British Antarctic Survey (BAS). Any meteorites that are located will be brought back to the UK to be curated and studied. It is hoped the search will prove so successful that expeditions will become an annual event.

Of the more-than-35,000 meteorites catalogued in collections, something like two-thirds have been retrieved from the White Continent. Not only does the colour contrast make for easier prospecting, but hunters also get a helping hand from the way the ice sheet moves. Meteorites that crash in Antarctica's high interior are buried and transported towards the coast, ultimately to be dumped in the ocean. But if this conveyor happens to run into a barrier on the way - such as a range of mountains - the ice will be forced upwards and scoured by winds to reveal its cargo. Meteorite hunters on the continent concentrate their searches in these special “stranding zones”. What they notice, however, is that a mere 0.5% of discoveries are iron meteorites. Based on global statistics, this number should be more like 5.5%.

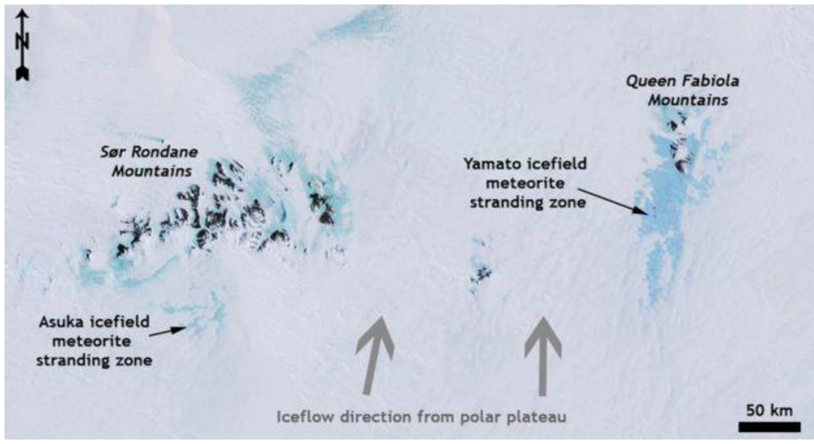


Meteorite hunters concentrate their searches in "stranding zones". Credit:USGS/DOI/Meteoritical Society

Dr. Geoff Evatt s a mathematician (U. of Manchester) specialising in glacial systems. His work (http://www.bbc.com/news/science-environment-35587680) suggests the properties of iron-rich meteorites mean they struggle to break the surface at stranding zones in the same way as stony meteorites. "As they get nearer to the surface, the iron meteorites see the sun and absorb heat energy, and that allows them to melt back down," he explained. "Iron has high thermal conductivity; it transfers heat from its top side to its underside where it can melt the ice below and essentially sink back down. That doesn't happen with the stony-type meteorites because although they absorb the energy, they can't transfer it as efficiently to their undersides. We think there must be a great mass of missing iron meteorites just under 30cm below the surface." If the team's apparatus can identify the right places, it should be fairly straightforward to dig out the meteorites.

Professor Tony Peyton works in Manchester's School of Electrical and Electronic Engineering. He is looking to incorporate fairly standard landmine detectors into a 10m-wide rig that can be pulled across the ice to sense the sunken treasure. "The issue is not so much signal to noise that we would have in our more extreme and demanding applications; the issue for us is really the ergonomics and practicality of engineering a system that can cover the area that we want and also cope with the environmental factors - the temperature range and the vibration."

The team has yet to make the decision on where precisely to conduct its search. Logistics demand it be within range of Halley and the expertise of BAS. This means the chosen site is likely to be somewhere along the Shackleton, Argentina or Pensacola ranges. These territories have largely been ignored by meteorite hunters to date. But from satellite images, it is clear they have extensive areas of dense, blue ice - the kind of ice that has been forced upwards and brushed clean of snow by Antarctica's relentless winds. Dr. Joy plans a reconnaissance to the region in the same season that the detection rig is put through its paces at Halley.



Blue ice: Relentless winds descend off Antarctica's high interior and clear the ice of snow. Credit: USGS

NASA has just announced the Psyche space mission https://sese.asu.edu/research/psyche which will visit an iron asteroid. "That's going to a body made of exactly the type of material we hope to be collecting in Antarctica," she said. "Understanding the differences and similarities between what Psyche samples in-situ and what we see in meteorites in Antarctica is going to be critical to unlocking some of the secrets of the earliest days of the Solar System."

Artist's concept of the Psyche spacecraft, which will conduct a direct exploration of an asteroid thought to be a stripped planetary core. Image credit: SSL/ASU/P. Rubin/NASA/JPL-Caltech

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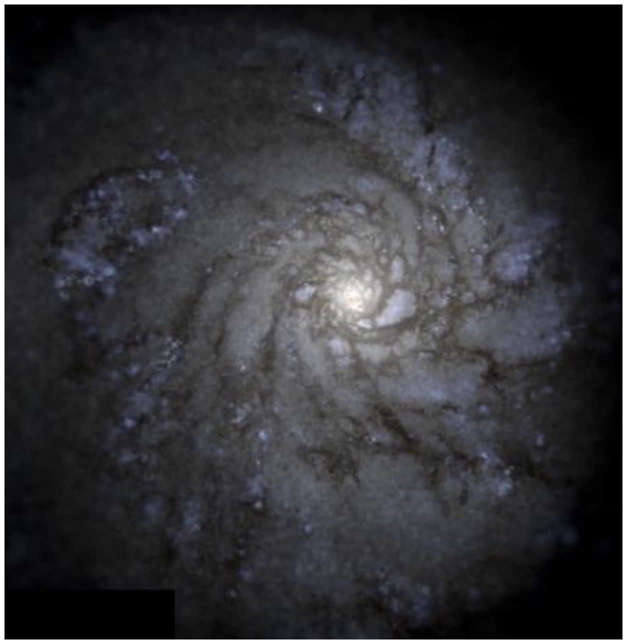
http://www.caltech.edu/news/recreating-our-galaxy-supercomputer-51995

Recreating Our Galaxy in a Supercomputer

by Whitney Calvin

Astronomers have created the most detailed computer simulation to date of our Milky Way galaxy's formation, from its inception billions of years ago as a loose assemblage of matter to its present-day state as a massive, spiral disk of stars.



Simulated view of our Milky Way galaxy, seen from a nearly face-on angle. This image was created by simulating the formation of our galaxy using a supercomputer, which, in this case, consisted of 2,000 computers linked together.
Credit: Hopkins Research Group/Caltech

The simulation solves a decades-old mystery surrounding the tiny galaxies that swarm around the outside of our much larger Milky Way. Previous simulations predicted that thousands of these satellite, or dwarf, galaxies should exist. However, only about 30 of the small galaxies have ever been observed. Astronomers have been tinkering with the simulations, trying to understand this “missing satellites” problem to no avail.

Now, with the new simulation—which used a network of thousands of computers running in parallel for 700,000 central processing unit (CPU) hours—Caltech astronomers have created a galaxy that looks like the one we live in today, with the correct, smaller number of dwarf galaxies.

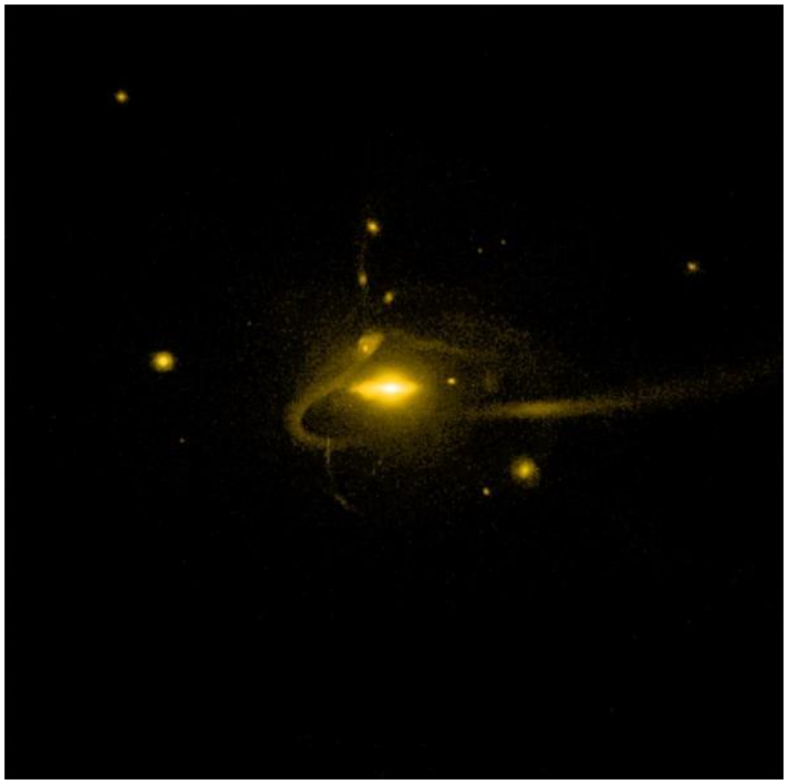
“That was the aha moment, when I saw that the simulation can finally produce a population of dwarf galaxies like the ones we observe around the Milky Way,” says Andrew Wetzel, postdoctoral fellow at Caltech and Carnegie Observatories in Pasadena, and lead author of a paper about the new research, published August 20 in *Astrophysical Journal Letters*.

One of the main updates to the new simulation relates to how supernovae, explosions of massive stars, affect their surrounding environments. In particular, the simulation incorporated detailed formulas that describe the dramatic effects that winds from these explosions can have on star-forming material and dwarf galaxies. These winds, which reach speeds up to thousands of kilometers per second, “can blow gas and stars out of a small galaxy,” says Wetzel.

Indeed, the new simulation showed the winds can blow apart young dwarf galaxies, preventing them from reaching maturity. Previous simulations that were producing thousands of dwarf galaxies weren't taking the full effects of supernovae into account.

“We had thought before that perhaps our understanding of dark matter was incorrect in these simulations, but these new results show we don't have to tinker with dark matter,” says Wetzel. “When we more precisely model supernovae, we get the right answer.”

Astronomers simulate our galaxy to understand how the Milky Way, and our solar system within it, came to be. To do this, the researchers tell a computer what our universe was like in the early cosmos. They write complex codes for the basic laws of physics and describe the ingredients of the universe, including everyday matter like hydrogen gas as well as dark matter, which, while invisible, exerts gravitational tugs on other matter. The computers then go to work, playing out all the possible interactions between particles, gas, and stars over billions of years.



In a new simulation of the formation of our Milky Way galaxy, astronomers were able to, for the first time, correctly predict the number of dwarf galaxies observed today. Dwarf galaxies are small galaxies that swarm around the outside of the Milky Way. Prior simulations found thousands of them—far more than the 30 or so observed so far. This image from the new simulation shows our galaxy with the correct number of dwarf galaxies. The streak is a tidal tail from a torn-apart dwarf galaxy.
Credit: Hopkins Research Group/Caltech

“In a galaxy, you have 100 billion stars, all pulling on each other, not to mention other components we don't see like dark matter,” says Caltech's Phil Hopkins, associate professor of theoretical astrophysics and principal scientist for the new research. “To simulate this, we give a supercomputer equations describing those interactions and then let it crank through those equations repeatedly and see what comes out at the end.”

The researchers are not done simulating our Milky Way. They plan to use even more computing time, up to 20 million CPU hours, in their next rounds. This should lead to predictions about the very faintest and smallest of dwarf galaxies yet to be discovered. Not a lot of these faint galaxies are expected to exist, but the more advanced simulations should be able to predict how many are left to find.

The study, titled “Reconciling Dwarf Galaxies with ΛCDM Cosmology: Simulating A Realistic Population of Satellite Around a Milky Way-Mass Galaxy”
http://authors.library.caltech.edu/70179/
was funded by Caltech, a Sloan Research Fellowship, the National Science Foundation, NASA, an Einstein Postdoctoral Fellowship, the Space Telescope Science Institute, UC San Diego, and the Simons Foundation. Other coauthors on the study are: Ji-Hoon Kim of Stanford University, Claude-André Faucher-Giguére of Northwestern University, Dušan Kereš of UC San Diego, and Eliot Quataert of UC Berkeley.

Recreating the galaxy simulations, interviews with Caltech researchers Phil Hopkins and Andrew Wetzel, and additional readings can be found here:

https://mediaassets.caltech.edu/gform

https://mediaassets.caltech.edu/gform#interviews

https://carnegiescience.edu/news/reconciling-dwarf-galaxies-dark-matter

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THE CONVERSATION

https://theconversation.com/its-our-solar-system-in-miniature-but-could-trappist-1-host-another-earth-73482

It's our Solar System in miniature, but could TRAPPIST-1 host another Earth?

By Elizabeth Takser, Japan Aerospace Exploration Agency

Scientists have discovered seven Earth-sized planets, so tightly packed around a dim star that a year there lasts less than two weeks. The number of planets and the radiation levels they receive from their star, TRAPPIST-1, make these worlds a miniature analogue of our own Solar System.

The excitement surrounding TRAPPIST-1 was so great that the discovery was announced with an article in *Nature*[1] accompanied by a NASA news conference. In the last two decades, nearly 3,500 planets[2] have been found orbiting stars beyond our Sun, but most don't make headlines.

How likely are we really to find a blue marble like our Earth among these new worlds?

Earth 2.0?

We still know little about these planets with certainty, but initial clues look enticing.

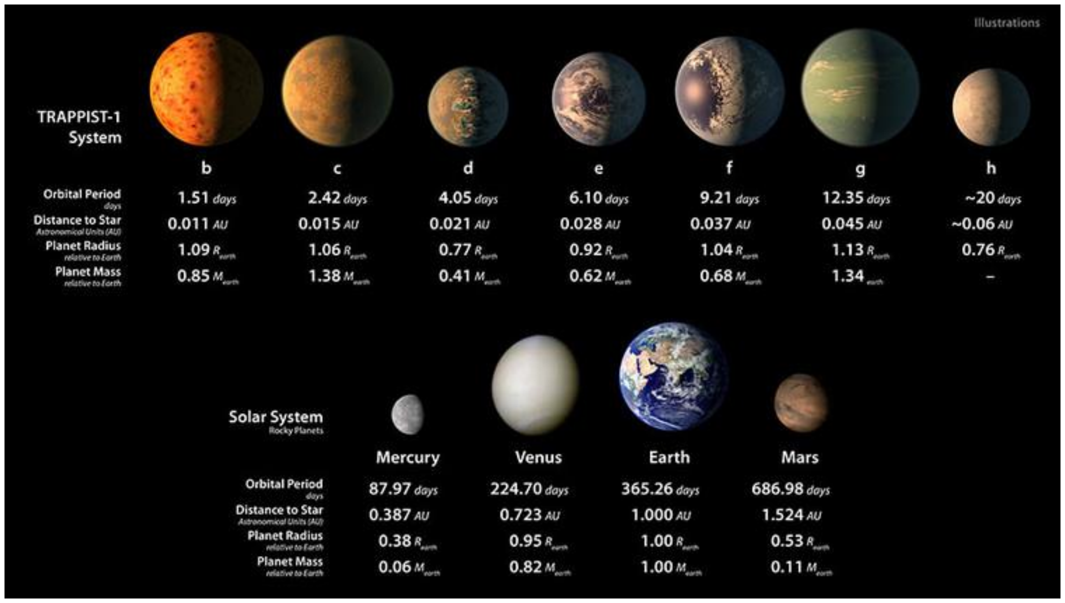
All seven worlds complete an orbit in between 1.5 and 13 days. So closely are they huddled that a person standing on one planet might see the neighbouring worlds in the sky even larger than our Moon. The short years place the planets closer to their star than any planet sits to the Sun. Happily, they avoid being baked by TRAPPIST-1 because it is incredibly dim.

TRAPPIST-1 is a small ultracool dwarf star[3] with a luminosity roughly 1/1000th that of the Sun. Comparing the two at Wednesday's news conference, lead author of the Nature paper, Michaël Gillon, said that if the Sun were scaled to the size of a basketball, TRAPPIST-1 would be a puny golf ball. The resulting paltry amount of heat means that three of the

Artist impression of the Trappist-1 System. Credit: ESO/M. Kornmesser/spaceengine.org

seven TRAPPIST-1 planets actually receive similar amounts of radiation as Venus, Earth and Mars.

This alternative Solar System does look like a compact version of our own, but does TRAPPIST-1 include an Earth 2.0?



Artists impression of the seven TRAPPIST-1 worlds, compared to our solar system's terrestrial planets. Credit: NASA/JPL-Caltech

1. http://www.nature.com/nature/journal/v542/n7642/full/nature21360.html\
2. http://exoplanetarchive.ipac.caltech.edu
3. http://www.eso.org/public/news/eso1706/

Here's the good news first.

The seven siblings are all Earth-sized, with radii between three quarters and one times that of our home planet and masses that range from roughly 50% to 150% of Earth's (the mass of the outermost world remains uncertain). Because all are smaller than 1.6 times Earth's radius[4] the seven TRAPPIST-1 planets are likely to be rocky worlds, not gaseous Neptunes. TRAPPIST-1d, e and f are within the star's temperate region — aka the "Goldilocks zone" where it's not too hot and not too cold — where an Earth-like planet could support liquid water on its surface.

The orbits of the six inner planets are nearly resonant, meaning that in the time it takes for the innermost planet to orbit the star eight times, its outer siblings make five, three and two orbits.

Such resonant chains are expected around stars where the planets have moved from where they originally formed. This migration occurs when the planets are still young and embedded in the star's gaseous planet-forming disc. As the gravity of the young planet and the gas disc pull on one another, the planet's orbit can change, usually moving towards the star.

If multiple planets are in the system, their gravity also pulls on one another. This nudges the planets into resonant orbits as they migrate through the gas disc. The result is a string of resonant planets close to the star, just like that seen encircling TRAPPIST-1.

Being born far from the star offers a couple of potential advantages. Dim stars like TRAPPIST-1 are irritable when young, emitting flares and high radiation that may sterilise the surface of nearby planets. If the TRAPPIST-1 system did indeed form further away and migrate inwards, its worlds may have avoided getting fried.

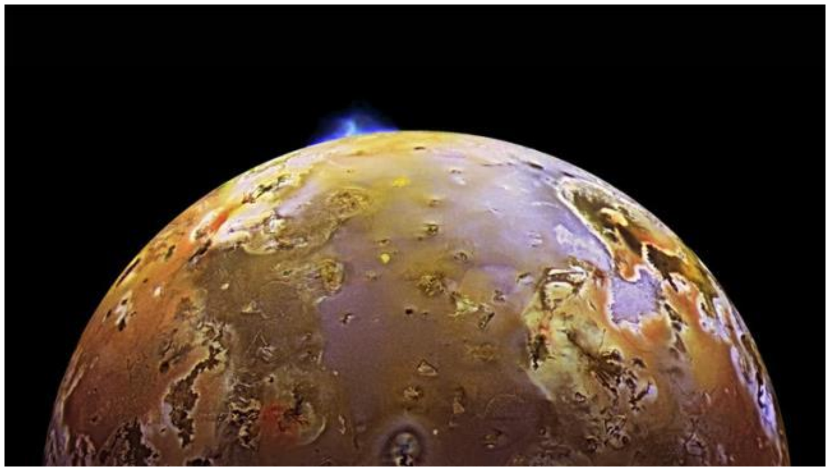
Originating where temperatures are colder would also mean the planets formed with a large fraction of ice. As the planets migrate inwards, this ice could melt into an ocean. This notion is supported by the estimated densities of the planets, which are low enough to suggest volatile-rich compositions, like water or a thick atmosphere.

Not an Earth?

Since our search for extraterrestrial life focuses on the presence of water[5], melted icy worlds seem ideal. But this may actually bode ill for habitability. While 71% of the Earth's surface is covered by seas, water makes up less than 0.1% of our planet's mass. A planet with a high fraction of water may become a water world[6]; all ocean and no exposed land.

Deep water could also mean there's a thick layer of ice on the ocean floor. With the planet's rocky core separated from both air and sea, no carbon-silicate cycle[7] could form – a process that acts as a thermostat to adjust the level of warming carbon dioxide in the air on Earth.

If the TRAPPIST-1 planets can't compensate for different levels of radiation from their star, the temperate zone for the planet shrinks to a thin strip. Any little variation, from small ellipticities in the planet's orbit to variations in the stellar brightness, could turn the world into a snowball or baked desert.



Jupiter's moon Io, is in resonance with moons Europa and Ganymede, and its tidal heating powers its volcanoes. Credit: NASA/JPL/University of Arizona

4. http://adsabs.harvard.edu/abs/2015ApJ...801...41R
5. https://www.nasa.gov/vision/earth/everydaylife/jamestown-water-fs.html
6. http://adsabs.harvard.edu/abs/2015MNRAS.452.3752K
7. https://www.skepticalscience.com/weathering.html

Even if the oceans were sufficiently shallow to avoid this fate, an icy composition might produce a very strange atmosphere. On the early Earth, air was spewed out in volcanic plumes. If a TRAPPIST-1 planet's interior is more akin to a giant comet than to a silicate-rich Earth, the air expelled risks being rich in the greenhouse gases of ammonia and methane[8]. Both trap heat at the planet's surface, meaning the best location for liquid water might actually be in a region cooler than the "Goldilocks zone".

Finally, the TRAPPIST-1 system's orbits are problematic. Situated so close to the star, the planets are likely in tidal lock – with one face permanently turned towards the star – resulting in perpetual day on one side and everlasting night on the other. Not only would this be weird to experience, the associated extremes of temperatures could also evaporate all water and collapse the atmosphere[9] if the planet's winds are unable to redistribute heat.

Also, even a small ellipticity in the planets' seemingly circular orbits could power a second kind of warmth, called tidal heating, making the planets into Venus-like hothouses. Slight elongations in the planet's path around its star would cause the pull from the star's gravity to strengthen and weaken during its year, flexing the planet like a stress ball and generating tidal heat[10].

This process occurs on three of Jupiter's largest moons whose mildly elliptical paths are caused by resonant orbits similar to the TRAPPIST-1 worlds. In Europa and Ganymede, the flexing heat allows subsurface liquid oceans to exist. But Jupiter's innermost moon, Io, is the most volcanic place in our Solar System. If the TRAPPIST-1 planets' orbits are similarly bent, they could turn out to be sweltering.

8. http://adsabs.harvard.edu/abs/2015AsBio..15...57L
9. http://adsabs.harvard.edu/abs/1997Icar..129..450J
10. http://solarsystem.nasa.gov/europa/tidemovie.cfm
11. http://www.nature.com/nature/journal/v533/n7602/full/nature17448.html
12. http://www.planetary.org/explore/space-topics/exoplanets/transit-photometry.html
13. https://jwst.nasa.gov/origins.html

The view from here

So how will we ever know what the TRAPPIST-1 planets are really like? To investigate the possible scenarios, we need to take a look at the atmosphere of the TRAPPIST-1 siblings.

TRAPPIST-1 was named for the Belgian 60cm TRAnsiting Planets and Planetesimal Small Telescope in Chile that detected the star's first three planets last year[11] (it also happens to be the name of a type of Belgian beer). As the name suggests, both the original three worlds and four new planetary siblings were discovered using the transit technique[12]; the tiny dip in starlight as the planets passed between the star and the Earth.

Transiting makes the planets excellent candidates for the next generation of telescopes[13] with their ability to identify molecules in the planet's air as starlight passes through the gas. The next five years may therefore give us the first real look at a rocky planet with a very different history to anything in our Solar System. Thomas Zurbuchen, associate administer of the Science Mission Directorate at NASA, declared the discovery of TRAPPIST-1 as, "A leap forward to answering 'are we alone?'".

But the real treasure of TRAPPIST-1 is not the possibility that the planets may be just like the one we call home; it's the exciting thought that we might be looking at something entirely new.

About the Author

Elizabeth Tasker is an astrophysicist at the Japanese Aerospace Exploration Agency (JAXA) in Japan. Her research looks at the formation of planets and stars in simulations of galaxies like our own Milky Way. Elizabeth's popular science book, 'The Planet Factory', will be published by Bloomsbury in Autumn 2017. She also keeps her own personal blog as testimony to exactly how confusing life can sometimes get in Japan. You can find Elizabeth on twitter and Google+.
https://theconversation.com/profiles/elizabeth-tasker-102945

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https://www.sciencenews.org/sponsored/remembering-vera-rubin-trailblazer-telescope-and-beyond

Remembering Vera Rubin, a trailblazer at the telescope and beyond

by Ashley Yaeger, ScienceNews

When we stare up at the night sky, we see shimmering stars, fuzzy galaxies and faint clouds of gas and dust. It is what we cannot see, however, that will forever remind us of astronomer Vera Rubin. Rubin is best known for confirming the existence of dark matter and, along the way, serving as an advocate for women in science and an inspiration to those who wanted to become scientists. She died December 25, 2016. She was 88.

"I hope the day comes when women and minorities in science are so common that Vera's efforts to break down barriers will be hard to appreciate," says Deidre Hunter, an astronomer at the Lowell Observatory in Flagstaff, Ariz. Hunter worked closely with Rubin, often going with her to telescopes around the world to study the stars. Hunter says she hopes Rubin will ultimately be remembered for her scientific achievements, which revolutionized our understanding of the universe. Rubin's passion for astronomy and her humanity should not be forgotten, either, Hunter says.

Rubin respected everyone she worked with, whether astronomers, writers or students, old or young, famous or not. She encouraged everyone to believe they had something to contribute and sought every opportunity to share her passion for science as often as she could, including working with Society for Science & the Public. Rubin served on the Society's Board of Trustees from 2002 to 2008, providing guidance on how the Society could inform, educate and inspire — all actions she strove to achieve in her own life.

"Vera Rubin was truly inspirational," says Neta Bahcall, an astrophysicist at Princeton University. "She was passionate about science, science education, women in science, promoting science literacy, teaching young people. She was amazing."

Vera Rubin (1975) using a "measuring engine" to measure galaxy rotation. Credit: Carnegie Institution of Washington. (For more about this photo, go to http://people.virginia.edu/~dmw8f/astr5630/Topic01/t1_rubin.html.)

Rubin was born Vera Cooper on July 23, 1928, in Philadelphia. At age 10, she moved with her family to Washington, D.C. There, she stared out her bedroom window (she said you could still see the stars from the city in the 1930s and 1940s) and traced the paths of stars along with the trails of meteors that flashed across the night sky. She said she knew then that she wanted to become an astronomer. Little did she know that at about the same time, the idea of dark matter was being discussed, very skeptically, in the astronomy community. A few years later, Rubin chose to attend Vassar College in New York, in part because the institution had offered her a scholarship and because she had read that Maria Mitchell, the first American woman to become a professional astronomer, had worked there.

After graduating from Vassar, Vera married Robert Rubin and attended Cornell University, where she studied with physics giants Richard Feynman and Hans Bethe. She also explored the motions of galaxies, and in 1950, rocked the astronomy community with a bold result: The universe appeared to spin around a central axis. Rubin's argument and analysis were met with intense skepticism and ultimately didn't stand the test of time. But the experience taught her to be dogged in her determination to unravel the universe's deepest secrets.

Rubin turned her attention to stars in the 1960s. She wanted to know how fast they circled the center of their galaxy. As she started to measure the speeds of stars farther and farther from a galaxy's center, she saw something unexpected: Stars farther out circled the galactic center at speeds similar to stars closer in. That would be like Pluto circling the sun at the same velocity as Mercury. If that happened, the solar system would be spinning so fast it would fly apart. So should the galaxies. But they didn't. Mysterious matter was keeping them together. Rubin calculated that to stay together, a galaxy had to have at least six times as much of this unknown dark matter than ordinary matter. Her work confirmed that dark matter did, in fact, exist.

Decades later, scientists still aren't sure what dark matter is. The most prominent theories say it is a particle, which has led physicists to build elaborate experiments to detect it. So far, they have been unsuccessful. But these failures never discouraged Rubin. To her, Bahcall says, it just meant that we should keep searching.

Vera Rubin at the Lowell Observatory in 1965. Rubin and her colleague Kent Ford used Lowell's Perkins Telescope (and another telescope at Kitt Peak National Observatory) to make the first direct observation of dark matter. (Image from Carnegie Institution of Washington). Additonal information can be found here: http://azdailysun.com/news/opinion/columnists/view-from-mars-hill-vera-rubin-broke-new-ground-in/article_f2639329-39d9-5f8c-8805-31cab3fe1c13.html