AOH OBSERVER

Spring 2019

The Newsletter of the Astronomers of Humboldt

Table of Contents

The Observer Staff

Grace Wheeler: Editor

Ken Yanosko: Proofreader

Don Wheeler: Proofreader

Susie Christian: Cartoonist

Space Writers and Outreach Volunteers Needed, and a New Ambassador

For the Spring issue of the Observer, we are pleased to present original content from members: a travel article by Ken Yanosko, a review of the Golden State Star Party by Kathy Blume, and original artwork from Susie Christian.

One of the goals of the AOH Observer is to to be a community newsletter, in other words, a place where our members write about topics that interest them or submit photos that they are proud to display. The articles don't have to be lengthy and can be on a wide range of topics such as night sky observations; visits to museums, observatories, and astronomy festivals; reviews of movies, books, equipment. We welcome articles on telescopes, astrophotography, and DIY equipment projects (why spend $28 on a solar finder when you can build one for $4). Most appreciated would be features written about current NASA space missions as these can count towards a Night Sky Network outreach event. Submissions can be sent to grace@astrohum.org.

Spring is usually the start of our outreach season. Last year the AOH either sponsored or participated in community events such as "Yuri's Night," "Get Out and Play," and "HSU Natural History Museum Astronomy Day." We did visits to schools and day camps, plus we worked with youth groups such as the 4-H and Cub Scouts. In the summer of 2018, we partnered with the Humboldt Redwood State Park to do a series of monthly star parties—something we hope to do again in 2019. We thank the many volunteers who donated their time in bringing astronomy to our community. If you are interested in becoming a volunteer, we could use your help. If you are new to outreach or uncomfortable about presenting by yourself, you will always be paired with a more experienced volunteer. The AOH is a member of the Night Sky Network (NSN), and we use many of their toolkits. There are training videos and written instructions that come with most of the activities. NSN programs that we have used include telescope viewing (day and evening), scaled model of the solar system, gravity well, cratering lab (messy but loads of fun), and "meteorites and meteorwrongs." Help is also needed in developing new activities, constructing props, and transporting and setting up events. Members who have done outreach will tell you that it is both fun and satisfying, and a great way to give back to your community.

I have saved the best news for last. Congratulations to AOH member Becky Chambers who has been appointed to be a NASA Solar System Ambassador for our region. This is quite an achievement. Becky is an accomplished writer and published author of science fiction (The Wayfarer Series). With the AOH, Becky is a 2019 member of the Board of Directors, outreach volunteer, Night Sky Network coordinator, and grant writer extraordinaire. In her role as Solar System Ambassador, Becky will be sharing the latest science and discoveries of NASA's missions through a variety of community events. The AOH is looking forward to working with Becky in her role as an Ambassador. Becky can be contacted at Becky@astrohum.org.

The 2019 AOH Potluck

The AOH Annual Potluck was held in February at the Humboldt Area Foundation. There were 37 attendees, which included long-time members, new members, and guests. The speaker was Jon Pedicino, Professor of Astronomy at the College of the Redwoods. The title of his talk was “Are We Alone in the Universe.” Dr. Pedicino gave a fascinating review of the search for exoplanets (especially ones with the potential for habitability), and the possibility of life in our own solar system. Other activities included (1) handing out certificates of appreciation and NSN Pins to our volunteers, (2) raffle for door prizes (everyone who participated was a winner), (3) presentation of a certificate and gift to Jon Pedicino, and (4) recognition of Mark Mueller for his service as president in 2018. There was an abundance of good food and good companionship. Thank you to Brent Howatt and Ken Yanosko (raffle master) who shared the hosting duties, and to Catrina Howatt who served as “front of the house”, and kept us organized. The Potluck committee was Grace Wheeler, Ken Yanosko, Mark Wilson, Brent Howatt, and Catrina Howatt. We are grateful to the following members who also helped with the setup and cleanup of the Emmerson Room: Greg and Becky Deja, Dan and Sherry Eaton, Russ and Jacky Owsley, Becky Chambers, Bea Asmundardottir, Jeff and Lisa Schmitt, and Don Wheeler. Stay tuned for 2020!

Below is a photo montage from the Potluck. Photo credits: Don Wheeler, and John Carlton Thomas.

Meet and Greet before dinner.

Calling the Potluck to order.

Ken with the raffle jar. Joey and Mary looking very happy, and Mark W.

President Brent Howatt giving the opening remarks.

Catrina and Brent inspect the door prizes.

Post-dinner conversation.

Sherry Eaton and the Thomas Family.

Honoring Past President Mark Mueller.

Presenting the certificate of appreciation to Dr. Pedicino.

Golden State Star Party

By Kathy Blume

Location: Frosty Acres Ranch, Adin, California
Dates: June 29-July 3, 2019 (4 nights)
Pre-registration is recommended as this event is limited to 400 people (registration is currently open).
Information: http://goldenstatestarparty.org

Eva and I recently attended the Golden State Star Party in Adin, CA. In a quick summary, the stars shone brightly, the company was great, we learned a lot, and the array of equipment brought by the campers was most impressive especially the 32” (!) Dob. There were also a number of 24”ers, large SCT’s (our 8” was on the puny side), and many astroimagers with an array of equipment.

There were several clubs as well as one or two school groups. Our talks with fellow campers were definite highlights. A highlight for us was talking with Conrad Jung, Staff Astronomer at Chabot Space & Science Center, one morning. He spent at least an hour answering our questions about astroimaging. We’re sure he would have spent more time with us had we not felt that our neurons were overloaded.

Arriving on Wednesday afternoon, we were greeted by 90+ temps that pretty much continued for the duration. It did cool down at night, so sleeping was good. We learned that everyone else had vast quantities of Aluminet (google it!) to shade their vehicles and sitting areas. It really works! High winds were promised but did not make an appearance. Vast views were advertised and these were much in evidence. The site is a quite large ranch field, mostly flat but dented with evidence of springtime cow feet (not so much the other cow evidence). Among the amenities are a large tent for evening star talks, BBQ dinners, and informal gatherings. Also, there were many well-placed and extremely clean Porta Potties and hand-washing stations, and a 6-stall (rooms actually) shower truck. Very civilized!

The July 11-15 dates were before the fires, so transparency was very good. We saw many, many stars, clusters, and nebulae Wednesday and Thursday nights. Unfortunately, clouds were forecast for Friday and Saturday, and even more unfortunately, the weatherperson was correct. We waited until Friday p.m., saw that we would see very little that night, checked our ability to withstand two more days of 90-95 degree heat, and decided to leave early.

We can highly recommend GSSP. It is very well run, attended by friendly folks without exception, and a very nice dark sky site.

Editor’s note: Pictures of the 2018 GSSP can be found here.

“Group of astronomers looking at M13 - in a big DOB. Saturday night GSSP 2015” GSSP Facebook.

“Sunset right before a rainy night” (July 18, 2015) GSSP Facebook.

Telescopes of all kinds abound at the annual Golden State Star Party at the Frosty Acres Ranch in Adin. Photo by Jake Hibbitts, Lassen County TImes.

Galileo in Florence by Ken Yanosko

In February Susan and I had the good fortune to visit Florence, Italy, perhaps the capital of art and artifacts from the Italian renaissance. Of course we saw works of Florentine artists Michelangelo, Donatelli, Botticelli, Brunelleschi, and others, but my favorite visit was to the Museo Gallileo. It commemorates and displays not only the works of Galileo Galilei himself, but also houses an extensive collection of scientific apparatus. Here are some of my photos.

Me and G. He died in 1642; I was born 300 years later.

A collection of early telescopes; the top two are the only extant scopes that are known to have been used by Galileo himself.

A collection of later, larger telescopes, including refractors and reflectors.

A Ptolemaic armillary sphere, showing the Earth at the center of the Universe, and the paths of the stars and planets surrounding it. Galileo, disbelieved at first, eventually put this model to rest.

Church authorities eventually recognized that Galileo's heliocentric model was correct; they allowed his body to be reburied in a place of honor in Santa Croce, a church a few blocks away from the Museum.

Last laugh? When his body was moved, Galileo's right hand fell off (or was removed). His upraised middle finger is now prominently displayed under glass in the Museum.

This article is distributed by NASA Night Sky Network.
The Night Sky Network program supports astronomy clubs across the USA dedicated to astronomy outreach. Visit nightsky.jpl.nasa.org to find local clubs, events, and more!

Mars the Wanderer

By David Prosper

April's skies find Mars traveling between star clusters after sunset, and a great gathering of planets just before sunrise.

Mars shows stargazers exactly what the term "planet" originally meant with its rapid movement across the evening sky this month. The ancient Greeks used the term *planete,* meaning *wanderer*, to label the bright star-like objects that travelled between the constellations of the zodiac year after year.

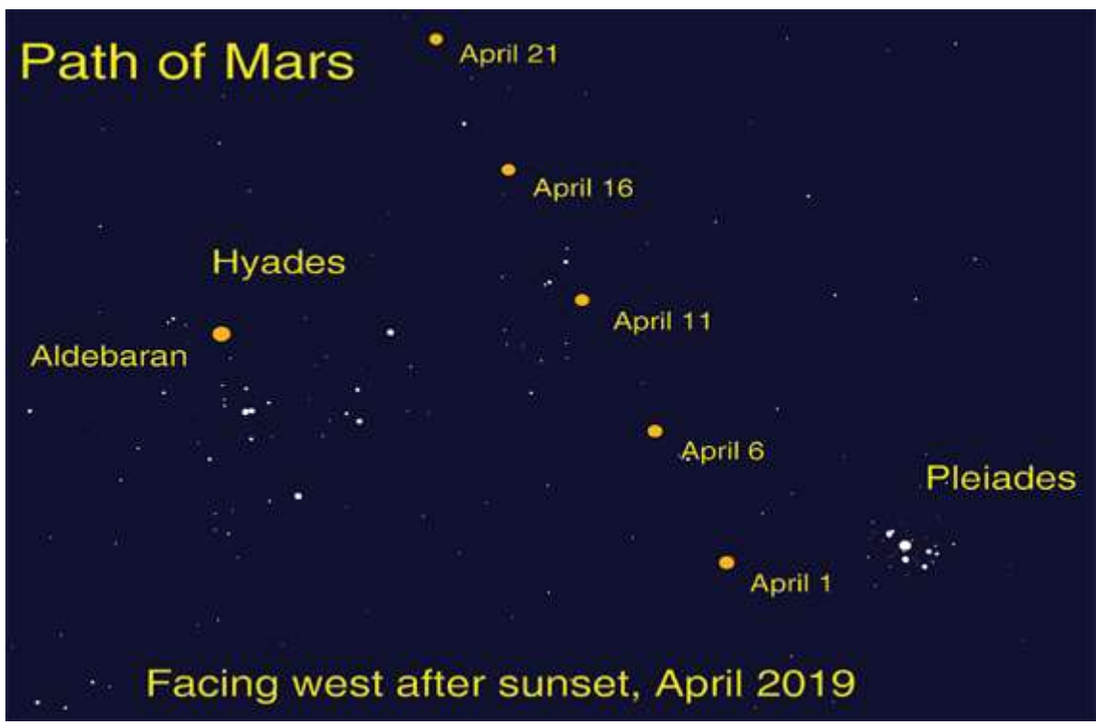
You can watch Mars as it wanders through the sky throughout April, visible in the west for several hours after sunset. Mars travels past two of the most famous star clusters in our night sky: the **Pleiades** and **Hyades**. Look for the red planet next to the tiny but bright Pleiades on April 1st. By the second week in April, it has moved eastward in Taurus towards the larger V-shaped Hyades. Red Mars appears to the right of the slightly brighter red-orange star **Aldebaran** on April 11th. We see only the brightest stars in these clusters with our unaided eyes; how many additional stars can you observe through binoculars?

Open clusters are made up of young stars born from the same "star nursery" of gas and dust. These two open clusters are roughly similar in size. The Pleiades appears much smaller as it is 444 light years away, roughly 3 times the distance of the Hyades, at 151 light years distant. Aldebaran is in the same line of sight as the Hyades, but is actually not a member of the cluster; it actually shines just 65 light years away! By comparison, Mars is practically next door to us, this month just a mere 18 light minutes from Earth – that's about almost 200 million miles. Think of the difference between how long it takes the light to travel from these bodies: 18 minutes vs. 65 years!

The rest of the bright planets rise before dawn, in a loose lineup starting from just above the eastern horizon to high above the south: **Mercury**, **Venus**, **Saturn**, and **Jupiter**. Watch this month as the apparent gap widens considerably between the gas giants and terrestrial planets. Mercury hugs the horizon all month, with Venus racing down morning after morning to join its dimmer inner solar system companion right before sunrise. In contrast, the giants Jupiter and Saturn move away from the horizon and rise earlier all month long, with Jupiter rising before midnight by the end of April.

The **Lyrids** meteor shower peaks on April 22nd, but sadly all but the brightest meteors will be washed out by the light of a bright gibbous Moon.

You can catch up on all of NASA's current and future missions at nasa.gov.



Caption: The path of Mars between the Pleiades and Hyades in April.
Image created with assistance from Stellarium.

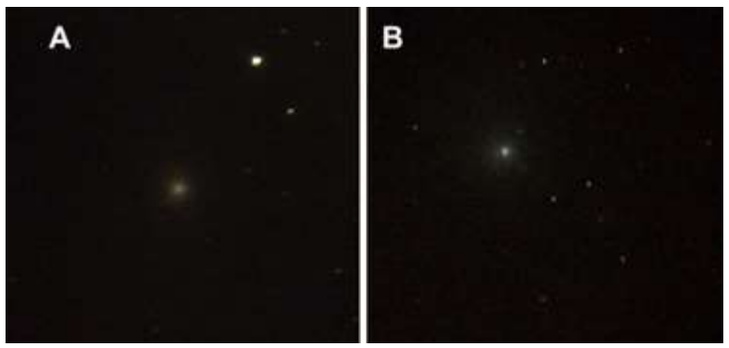
The AOH Messier Marathons

By Grace Wheeler

The Messier Marathon is an annual event typically held between mid-March to early April around the time of the equinox. In the marathon, observers attempt to view the maximum number of Messier objects that can be seen for their given latitude (there are 110 Messier objects). The dates that the AOH and most astronomy clubs follows is set by messier.seds.org and takes into account the new moon. Because of the inclement weather in our area, we usually try to schedule a couple of Friday and Saturday dates to maximize our chances of having a marathon. The marathon was popularized in the 1970s, and most likely the event was invented independently by several astronomers and groups. The comet hunter Don Machholz is often credited with originating the Messier Marathon in 1979. A history of how the Messier Marathon was started, along with resources for organizing and preparing for the event can be found here at www.messier.seds.org.

Viewing Messier Objects

New members often have questions about the Messier designation of deep sky objects. Charles Messier (1730-1817), a French astronomer, was interested in identifying comets but noted that there were many diffuse objects in the night sky that could be mistaken for comets (Messier had poorer quality optics at the time of his observations). From 1758 to 1782, Messier and his associate Pierre Mechain cataloged over 100 objects according to their position in the sky. Unlike comets that move across the sky over the course of several nights, Messier Objects are stationary. The catalog that we use today contains 110 objects; these later additions were made by other astronomers using notes from Messier and Mechain. The Messier catalog is significant in that it was the first reliable database for finding deep sky objects such as galaxies, nebulae, and star clusters in the night sky.



Which of these images is the comet and which the Messier object? Bonus if you can identify the Messier object. (The answer is at the end of this article).

We usually observe Messier objects according to the seasons when the Messier objects and their associated constellation are placed optimally in the sky. For example, the constellation Orion and its Messier objects M42, M43, and M78 are visible from late fall to early spring, but their best viewing is during the winter when these are located high in the sky and visible during most of the night. Similarly, observing the Messier galaxies of Leo, Virgo, and Coma Berenices is best done during the springtime when these constellations are well placed in the night sky. A list of the Messier objects, the constellations in which these are found, and the optimal viewing season can be found on Fred Espenak's Astropixel webpage.

This brings us back to the Messier Marathon. During a narrow window of time around the spring equinox, it is possible to view the majority of the Messier Objects during one entire night. The goal here is quantity over quality as some of the Messier objects will be close to the horizon, and viewed under twilight conditions, i.e. shortly after sunset or before sunrise. In theory, all 110 Messier objects are viewable worldwide between latitudes 20 degrees south to 55 degrees north. The optimal latitude for the Messier Marathon is at 25 degrees north. The sequence for searching for Messier objects can be found here on the messier.seds.org website. Based on experience of AOH marathoners (discussed in the next section), the maximum number of Messier objects that can be viewed from Kneeland is 109; M30 is usually lost in the haze of sunrise.

AOH Messier Marathon: the 1990s

Recently, as I was digging through some of the past AOH newsletters of the 1990s (members can access these on the "members only" site at www.astrohum.org.), I came across several articles written about the AOH Messier Marathon. Based on what I could glean from the articles, the first AOH Messier Marathon was held in 1980. The marathons of this era were, when good weather prevailed, all night affairs. Members camped at the Kneeland Airport, and occasionally one of the members would bring a camper so that members could get out the cold, or prepare a hot drink. There were pre-Messier Marathon activities held in February or March in which members learned star hopping strategies for finding Messier objects. In those days this was done in an inflatable planetarium that was housed at the College of the Redwoods. At least two newsletter articles mention a phone number that members could call and listen to a pre-recorded message with an update on the status of the marathon. This was before the Kneeland webcam; the AOH website and Facebook page were several years in the future. In conversations that I have had with long-time AOH members, star hopping was the only legitimate method for hunting down Messier objects (Lenore Freeman's *A Starhoppers Guide* gets mentioned a lot). Members worked solo or in groups. As for the record for most Messier objects found during a marathon, Bob Zigler and Karen Becjeck wrote in the March 1994 newsletter: "*I do not believe that it is possible to get all 110 objects from our latitude, but 109 should be possible. Our club record is 108 for individuals, held by two persons. As a group, our record is 109 in one night."* Our AOH treasurer, Bob Zigler is one of the holders of the star hopping record, and to his knowledge, the record still stands. The April 1994 newsletter mentions a new record of 109 set by three members. However, these members used digital setting circles and as then-President Rey Kleinsasser wrote: "*as for the three who got 109, well, you guessed it! No star maps, no star hopping, no binoculars only a digital readout. Tsk Tsk!"* The first use of a "goto" computerized telescope at a Messier Marathon was reported in the April 1995 AOH newsletter (see next page). Larry Etter, the owner of the computerized telescope, "won" the Messier Marathon that year with 107 objects.

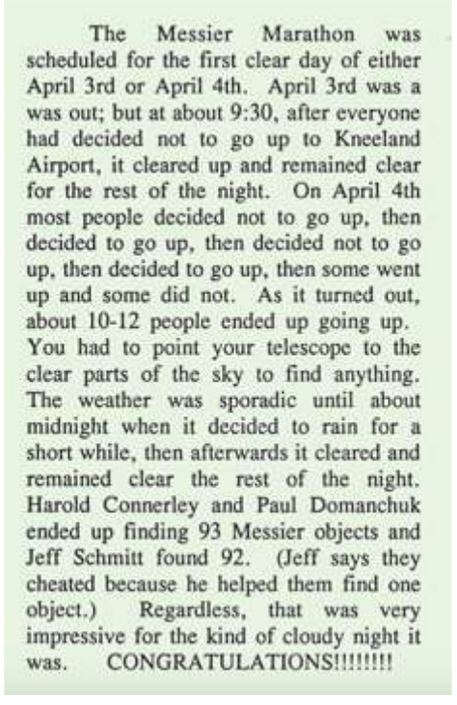
There are several humorous articles written about the Messier Marathons contained in the old newsletters (look for February, March, April, and May issues). The two entries posted below are particularly funny. I hope that some of the "long-timers" in the club will read this article and feel inspired to write about the Messier Marathons of the 1980s. I suspect there are some interesting tales from the time.

LAST MEETING: MESSIER MARATHON 1995: About 5 people showed up at the 15th Annual Humboldt Messier Marathon. That's right! 15th Annual! On further checking we realized that we have been doing the Messier Marathon since 1980. Those participating in this years marathon included Ray Kliensasser, Jon Hafstrom, Larry Etter, Mike Foster, and Richard Gillen. Ray arrived about 8:30 with the fog, which did not clear until about midnight. Jon left early, depressed about the fog, while Richard the Die-Hard Star Hopped about 75 Messier Objects and hundreds of NGC Objects. Mike lost some interest in the fog, but Star Hopped through the Virgo cluster twice, once before and once after a group of students from C/R came to see some heavenly bodies. They went on to see many NGC objects including The Cats Eye Nebula and Omega Centauri. Larry was the hands down winner with 107 objects. It needs to be noted, however that Larry was using a Computer aided telescope, and was able to find objects in the fog, catalog the Virgo cluster, view objects around hillsides, and generally wreak havoc on the other observers! This is a new kind of computer aided telescope harassment, and needs to be curtailed. Watch yourself Larry! Actually, Larry missed three objects, M-74 & M-77 were lost in light & haze, and M-30 was above the horizon, but behind the weather sock hill. Congratulations Larry!

NEXT MEETING: ASTRONOMY DAY: Our next meeting is the 13th Annual Astronomy Day

1

April 1994



The Messier Marathon was scheduled for the first clear day of either April 3rd or April 4th. April 3rd was a was out; but at about 9:30, after everyone had decided not to go up to Kneeland Airport, it cleared up and remained clear for the rest of the night. On April 4th most people decided not to go up, then decided to go up, then decided not to go up, then decided to go up, then some went up and some did not. As it turned out, about 10-12 people ended up going up. You had to point your telescope to the clear parts of the sky to find anything. The weather was sporadic until about midnight when it decided to rain for a short while, then afterwards it cleared and remained clear the rest of the night. Harold Connerley and Paul Domanchuk ended up finding 93 Messier objects and Jeff Schmitt found 92. (Jeff says they cheated because he helped them find one object.) Regardless, that was very impressive for the kind of cloudy night it was. CONGRATULATIONS!!!!!!!!

April 1995

AOH Marathons of Recent Years

Since joining the club in the fall of 2012, I have participated in only two Messier Marathons out the six that were scheduled (2019 is still pending). This has not been from lack of trying, but due to overcast conditions that canceled four of those events. My first marathon was in March 2013, which at the time, was during the drought. We had a dry spring season that year which was atypical for Humboldt. The night of the marathon was clear and balmy, and we stayed late into the night. There were seven of us: Russ, Ken, Mark M., Greg, Dan, Don, and me. Don and I used our goto telescope and quickly worked our way down the list, albeit haphazardly. There was some good-natured teasing about us "cheating", but that didn't stop a few of the members from asking us to slew to certain Messier objects so that they could confirm their finds. It was a "half-marathon" and most of us left after chipping away at the Virgo Cluster. The 2016 Marathon was held Friday, April 1st. We ended early when the fog came in at around 11 p.m. Ken in his club report states that we left at midnight…and if we were out that late, then good for us! There were only four members who attended that year: Ken, Mark Wilson, Don, and myself.

The last attempt at a Messier Marathon was on April 1, 2017. It didn't get reported as a club activity, and it certainly didn't make it into the newsletter – until now. Although the Kneeland webcam showed it was foggy, Mark Mueller, Lou Lutticken, Don, and I still went up in hopes that the clouds would have dissipated by the time of our arrival.

No such luck, and we were met by thick fog on the runway. Not wanting to give up too soon, we decided to stay. While we were waiting, Mark helped set up a Telrad finder on Lou's Newtonian. Fortunately, the moon was visible through the cloud deck, and they were able to use the moon to align the Telrad and the telescope. At least something productive came of the trip. After an hour we gave up but perhaps had we stayed until midnight (like some of the club members had done in the 1990s), it might have cleared.

Lou and Mark Mueller setting up the Telrad finder on Lou's Newtonian. We got good views of the "Cloud Nebula".

As of this writing, we had to cancel the March 9-10, 2019 dates because of overcast, rain, and possible snow showers. Our next chance of having a marathon is on March 29 or 30. My fingers are crossed for clear skies. For many in our club, this will be their first Messier Marathon. In addition to the star hoppers, there will probably be a few members using computerized goto telescopes. Whether you are using star charts, digital setting circles, or a computer, the goal of the marathon is to have fun and challenge yourself. An added bonus is enjoying the camaraderie of your fellow marathoners. Even if you don't own a telescope, there will be plenty of members willing to share. If we are lucky, we will have a late night for our 39th annual Messier Marathon. See you all there!

Resources for the Marathon

http://www.messier.seds.org/xtra/marathon/mm-tips.html
http://www.custerobservatory.org/docs/messier2.pdf
http://astrohum.org/tumol.pdf
https://freestarcharts.com/messier
http://www.everythingintheuniv.com/_eiu/new_books.htm#starhopper
http://astrohum.org/newsletters/newsletter_2016_a.pdf

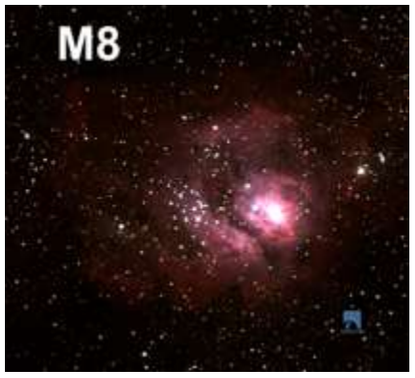
Answer: Panel A is M87, an elliptical galaxy in Virgo. Panel B is Comet C/2015 V2 (Johnson). The comet is greenish so that should have been a hint. Both were imaged in the spring of 2017 through a 6 inch SCT (Pentax Q7, ASA 800, 30s exposure).

The Messier Catalog: A Diversity of Deep Sky Objects

(The text for this article is adapted from Celestial Treasure Hunt, and the images are courtesy of Slooh)

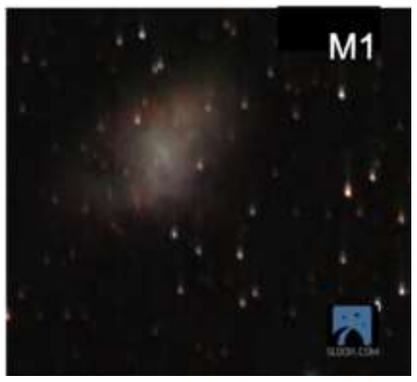
Star Nurseries: Clouds of gas and dust where new stars are born. Examples: ***M42 (Orion Nebula) in Orion and M8 (Lagoon) in Sagittarius.***

Distance: 1344 ly



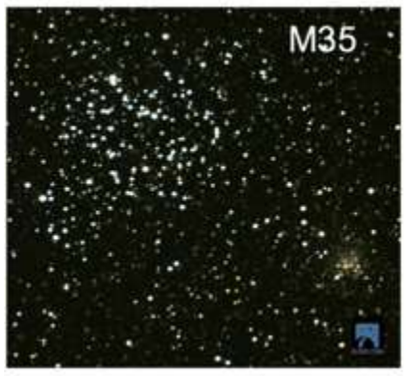
Distance: 4000 ly

Supernova Remnant: The ghostly remains from a massive star that has collapsed and undergone a supernova explosion. The explosion flings gas and dust into space and eventually creates star nurseries. Example: ***M1 (Crab Nebula) in Taurus*.**

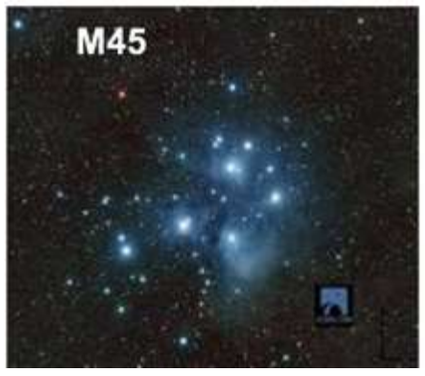


Distance: 6523 ly

Open clusters: young stars that are formed from the same cloud of gas. As the stars age, the gas and dust is blown away. The stars are found grouped together in open clusters. Eventually they will take off on their own. Examples: ***M35 in Gemini and M45 (Pleiades) in Taurus.***

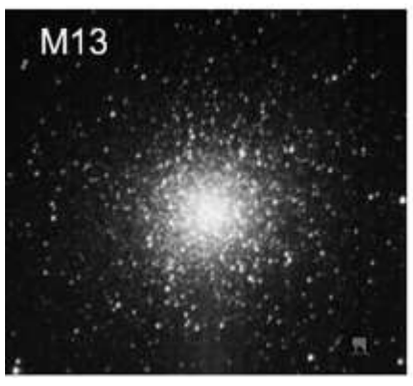


Distance: 2800 ly

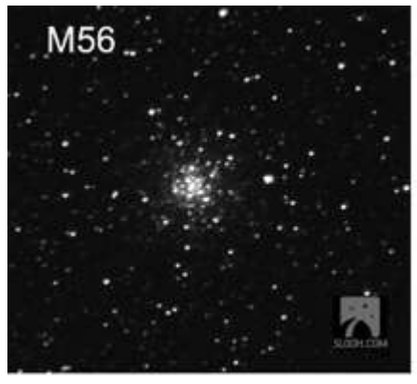


Distance: 444 ly

Globular clusters: dense collections of ancient stars. Formed from giant molecular clouds of gas near the beginning of the universe. Examples: **M13 (Great Hercules Cluster) in Hercules and M56 in Lyra.**



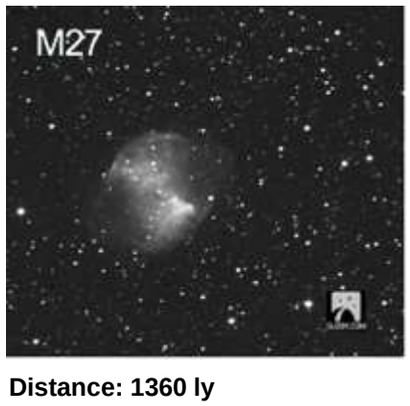
Distance: 22180 ly



Distance: 32900 ly

Planetary Nebula: an expanding, glowing envelope of ionized gas ejected from red giant stars at the end of their life. At the center of the nebula lies a dwarf star. This will be fate of our own Sun. Examples: ***M57 (Ring) in Lyra and M27 (Dumbbell Nebula) in Vulpecula.***

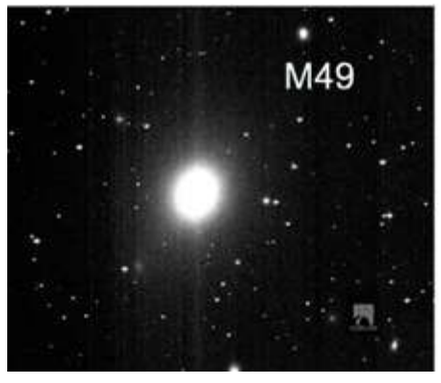
Distance: 2283 ly



Distance: 1360 ly

Galaxies: Systems of gravitationally bound stars and their solar systems, gas and dust, and dark matter. The most distant objects that we can see. Examples: **Spiral galaxy M31 in Andromeda, and elliptical galaxy M49 in Virgo**.

Distance: 2.5 million ly



Distance: 56 million ly

Farewell, Opportunity: rover dies, but its hugely successful Mars mission is helping us design the next one.

Andrew Coates, Professor of Physics, Deputy Director (Solar System) at the Mullard Space Science Laboratory, UCL

THE CONVERSATION
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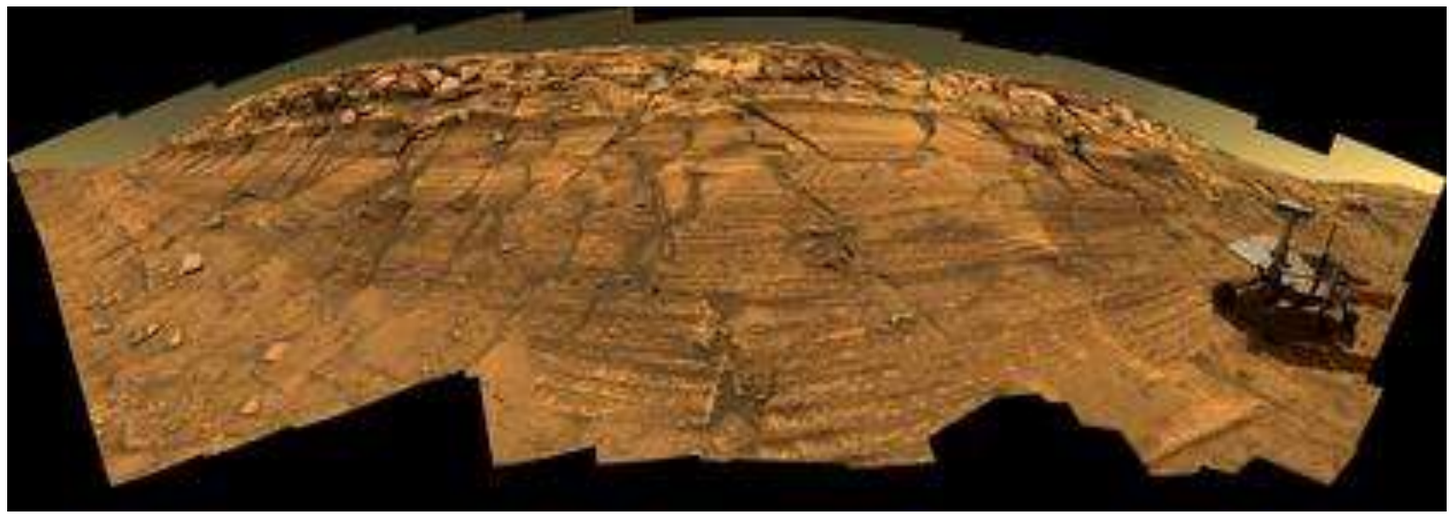
https://theconversation.com/farewell-opportunity-rover-dies-but-its-hugely-successful-mars-mission-is-helping-us-design-the-next-one-111862



Opportunity on 'Burns Cliff' (Simulated). NASA/JPL

NASA's Opportunity rover on Mars has been officially pronounced dead. Its amazingly successful mission lasted nearly 15 years, well beyond its initial three-month goal. Opportunity provided the first proof that water once existed on Mars and shaped its surface, a crucial piece of knowledge informing both current and future missions.

Opportunity landed on the red planet on January 25, 2004, and was last heard from on June 10, 2018, when a huge dust storm reduced light levels there significantly. This prevented the rover from using its solar panels to charge its batteries. The solar panels had already started to degrade due to the longer than expected mission, and the low light levels and the build up of dust may have caused its ultimate demise.

The rover has driven over 45km on the Martian surface despite being designed to travel for just 1km – an interplanetary record. Lasting almost 60 times its expected lifetime, it is an incredible achievement for space exploration. The mission is therefore helping scientists design new rover missions including NASA's Mars 2020 rover and the ExoMars 2020 rover that I work on, recently named "Rosalind Franklin" after the DNA pioneer.

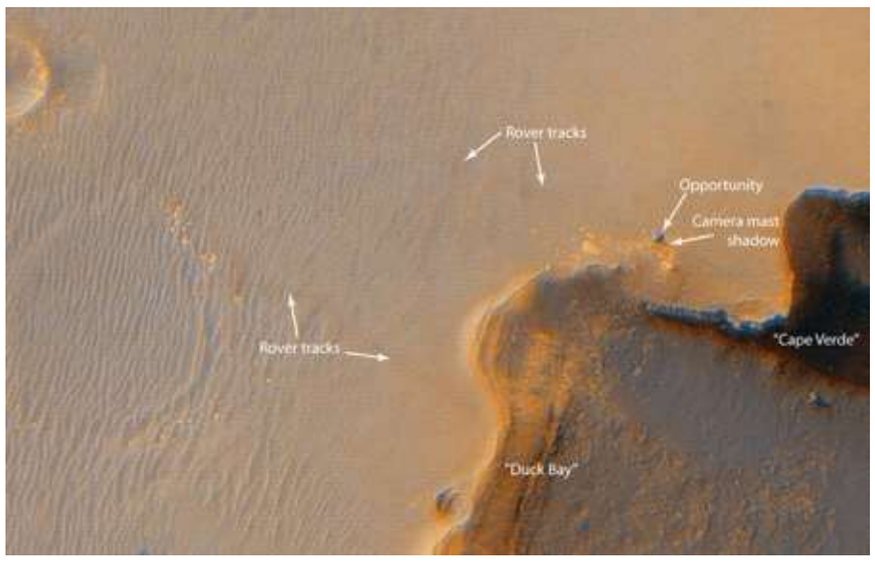
Stunning science

The science from the Mars exploration rovers Spirit and Opportunity has been simply groundbreaking. For Opportunity, it started with landing by chance in a 22-metre wide crater called "Eagle" on an otherwise mainly flat plain – a space exploration "hole in one". Immediately after landing, it spotted a layered rocky outcrop, similar to sedimentary rocks on Earth but never before seen on Mars. And because it was mobile, it could actually examine the rock composition directly after leaving the landing platform.

By illuminating the rocks with radioactive sources, the rover discovered the expected iron (effectively rust) that makes Mars' surface reddish brown, along with other metals such as nickel and zinc. But it also found more volatile elements like bromine, chlorine and sulphur, which indicated that these rocks may have reacted with ancient water. Most excitingly, it detected the mineral "jarosite", which is often seen in the outflow of acidic water from mining sites on Earth. This provided direct evidence that acidic water had been involved in the formation of Mars' rocks 3.8-4 billion years ago.

The rover then moved out of the Eagle crater onto the flat, surrounding plain. In the first weeks, it discovered “blueberries” – millimetre-sized spheres of the mineral hematite. Although this could have formed due to volcanism or meteor impacts, analysis revealed that it most likely formed in water.

Opportunity later visited the spectacular Victoria crater, which is 750 metres in diameter and some 70 metres deep, with dunes on the crater floor. Remarkably, the rover and its tracks were imaged from orbit by NASA’s Mars Reconnaissance Orbiter near the crater rim. There was more hematite here, too, showing that this may have formed underground in water, before being brought to the surface when the crater formed via an impact.



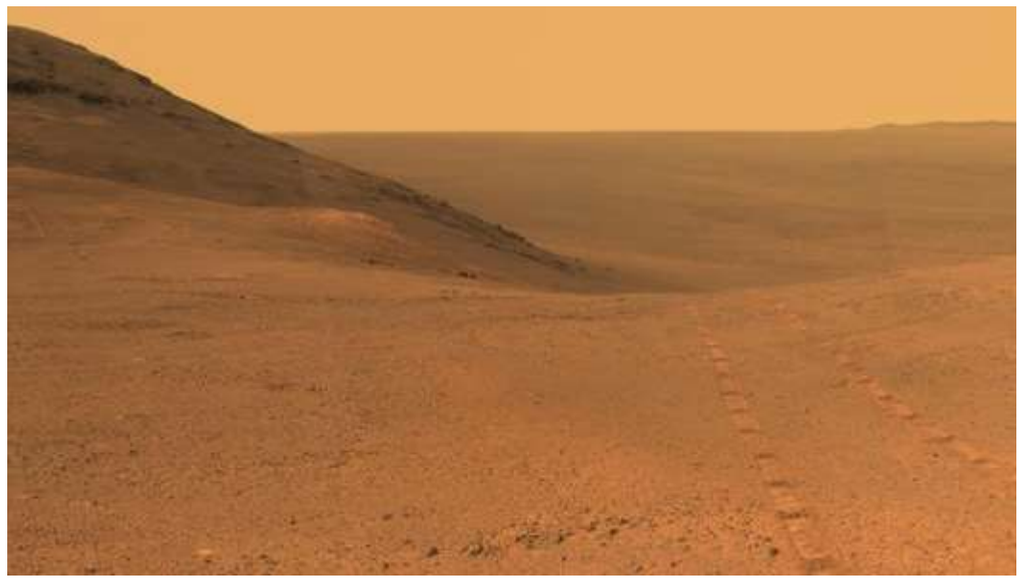
Opportunity at Victoria Crater spotted from orbit.
NASA/JPL/University of Arizona

Its next destination was the Endeavour crater, which is 22km in diameter and 300 metres deep. Here it also made a major discovery – there were clays near the crater rim, which would have required fresh, abundant and non-acidic water for their formation. This was the first indication that Mars was actually habitable 3.8-4 billion years ago, containing drinkable as well as acidic water.

These main science results are key to our scientific exploration of Mars today. The question of habitability is being pursued further by the NASA Curiosity mission, which has already found evidence of a large, ancient lake on early Mars that contained organic matter by drilling into the mudstones that remain.

Digging deeper

Thanks to Opportunity, upcoming missions will look closer at the spots were ancient water flowed. NASA’s Mars 2020 rover will gather samples from Jezero crater, a location where orbiters have detected signs of an ancient river delta. These samples may be returned to Earth by a future international mission. Analysis in labs on Earth may ultimately answer the question of whether there is or ever was life on Mars, if we haven’t already.



Opportunity outside Endeavour crater.
NASA/JPL-Caltech/Cornell/Arizona State Univ.

Meanwhile, our Rosalind Franklin rover, a collaboration between the European Space Agency and Russia, is due for launch in 2020. It will land in March, 2021, at Oxia Planum, an elevated plain. Here, there are also signs of prolonged exposure to ancient water, clays and a river outflow channel.

Rosalind the rover will pick up where Opportunity and Curiosity left off by examining a key, unexplored dimension on Mars – depth. We will drill down to two metres below the surface of Mars for the first time, much further than Curiosity’s five centimetres. This is enough to take us far enough below the harsh surface environment of Mars – with cold temperatures, a thin carbon dioxide atmosphere and high levels of harmful radiation – to see if anything lives there.

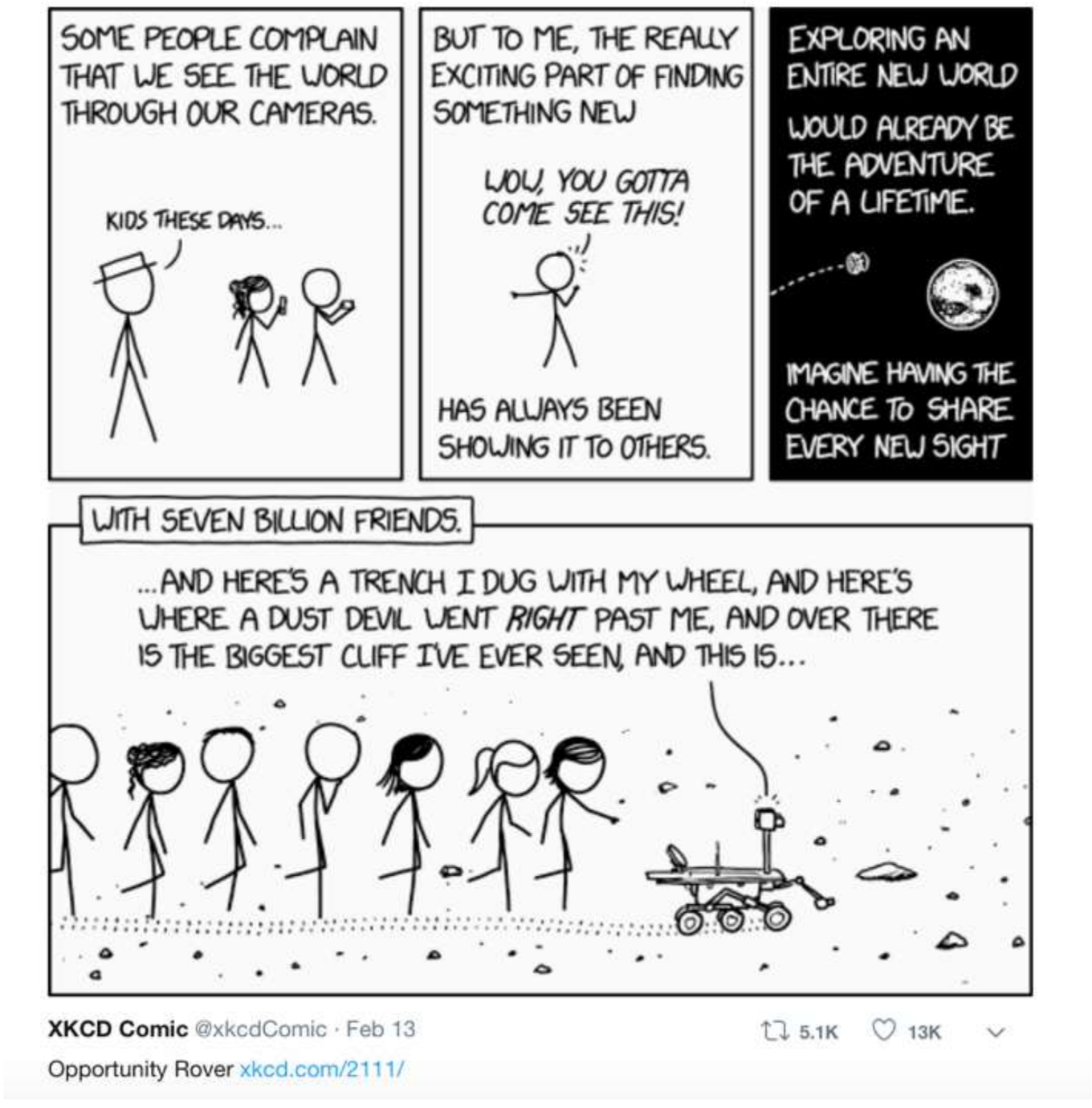
We will decide where to drill using a number of instruments, including the PanCam instrument which I lead. Samples will be vaporised and put into a drawer for analysis by three instruments which will look for markers of life – such as complex carbonates.

One of the key aspects of Opportunity's success was the teamwork between its science and engineering teams. This is definitely something that will be implemented on upcoming rovers. Many members of the Mars 2020 team, and some on the ExoMars team, have direct experience from Opportunity which will be invaluable as we learn how to operate our rovers on the planet.

Another interesting legacy of Opportunity is that we we don't have to worry too much about Martian dust, except during exceptional global storms. Opportunity showed that that during the rest of the time, accumulating dust blows away naturally in the wind – helped by the movement of the rover over the ground causing vibration. It was a surprise that Opportunity lasted so long, and it certainly blazed a trail for us.

Rosalind Franklin has the best chance of any currently planned mission for detecting biomarkers and even perhaps evidence for past or present life on Mars. But we are building on the shoulders of giants, like the Opportunity Rover. #ThanksOppy indeed!

#ThanksOppy



The Iridium Flare Era is About to End

By David Dickenson Universe Today

Republished from Universe Today

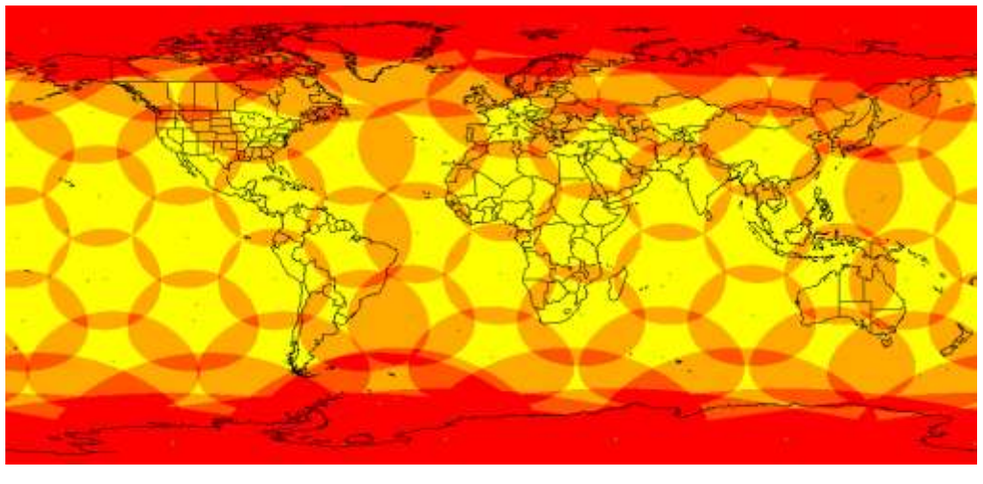
https://www.universetoday.com/141741/the-iridium-flare-era-is-about-to-end/

You never forget your first one. I remember reading about a curious new set of flaring satellites, known as Iridiums. This was waaaaay back in the late 1990s, when we still occasionally read things in something called magazines, which involved pressing ink into plant-flesh to convey information.

Fast-forward to 2019, and the age of the predictable Iridium flare may be coming to an end. Already, scrolling through Heavens-Above reveals very few Iridium flares for the coming months, and these familiar nighttime flashes may become a thing of the past come the end of the decade in 2020.

The current spate of Iridium reentries have been coming nearly daily now. Looking at the Aerospace Cooperation's reentry page shows Iridiums SV32, SV59, SV91 and SV14 have all reentered the Earth's atmosphere in March 2019 alone, and Iridium-60 is due to reenter this weekend.

Launched in batches from 1997 to 2002, the constellation of 66 Iridium satellites plus 32 on-orbit spares and 4 dummy test masses was conceived by Motorola, and placed in low Earth orbit. At the time, the company envisioned that the constellation would pioneer the growth of personal satellite phone technology. In the end, however, the rise of cheap mobile phone towers worldwide at the turn of the millennium meant that satphone tech never really got past niche applications, such as emergency rescue and use by expeditions travelling to remote locations. Motorola's Iridium company declared bankruptcy in 1999, and a group of private investors bought the constellation of satellites. Later, the control was taken up by Iridium Communications. The dream of accessible mobile communication worldwide may still come to pass, as OneWeb carried out its first successful launch in early 2019.



Caption: Image of gif file showing worldwide coverage for the Iridium Satellites.
https://commons.wikimedia.org/wiki/File:Iridium_Coverage_Animation.gif

These satellites came with a perk for amateur satellite spotters: three large, refrigerator-sized reflective panels that could flare up to magnitude -8 when the Sun caught them just right. These sorts of specular flares are predictable, and soon, websites and later apps included these predictions. And heck, it was just plain fun at star parties to say "watch this patch of the sky, right about… now!" as a dependable Iridium flare appeared, right on time.

The Iridiums also made the news in 2009, when Iridium-33 collided with the defunct Kosmos-2251 satellite over Siberia. This was the first major collision between two satellites in orbit, and represented one of the largest debris-producing events in orbit in recent years.

The Rise of Iridium NEXT

The beginning of the end started in 2017, when Iridium Communications began launching its next generation of satellites, known as IridiumNEXT. Unfortunately, despite some early rumors on the SeeSat-L satellite tracking message board, the newer generation of IridiumNEXT satellites aren't flare producers.

What's the current status of the older constellation? Well, there are currently six dependable flare producers remaining as of March 15th: SVs -45, -54, -58, -61, -64, and -97. There are 25 more satellites that the company lost control of over the years that are currently defunct… unfortunately, flares from what remains of those are spurious, and aren't predictable.

The original tweet can be found here

We cited 2019 as perhaps the last year that dependable Iridium flares will occur in our new book, *The Universe Today's Ultimate Guide to Viewing the Cosmos*. Iridium CEO boss Matt Desch also mentioned to us that "we have approval for up to 10 (original) satellites with lower fuel levels to take up to 25 years for reentry… so last (Iridium flare) in 2043?" He also noted, though, that most of the remaining satellites will start tumbling after 2019.

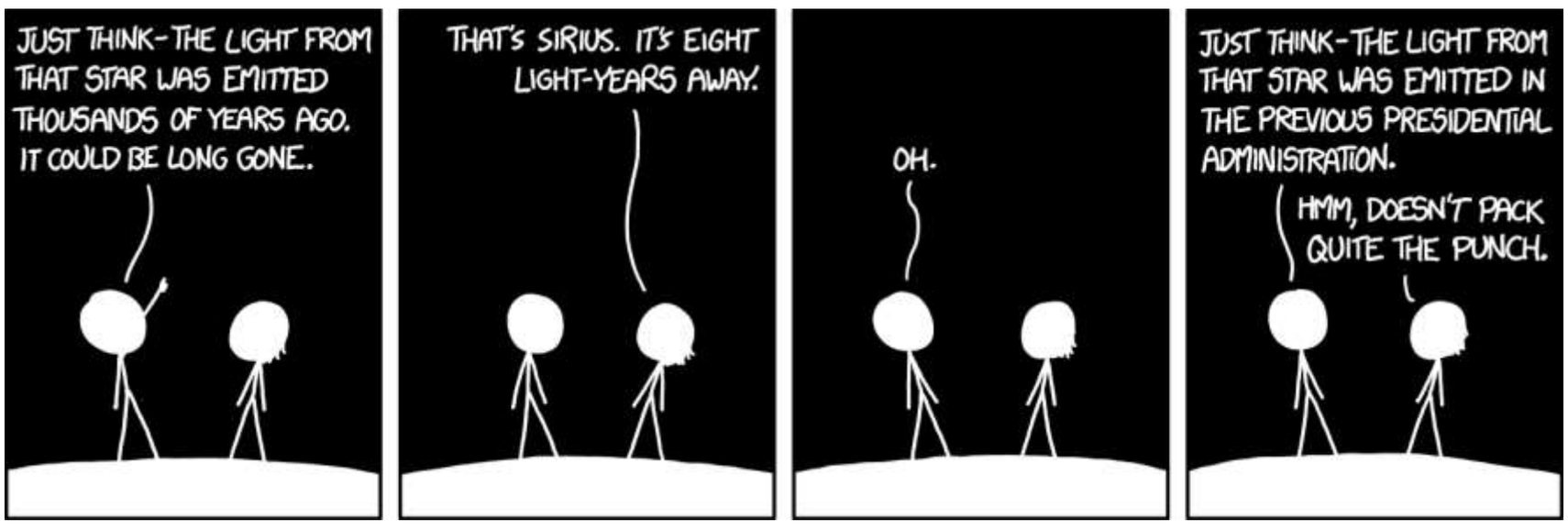
Turns out, it's hard to place a good, dedicated reflector in space. We've always thought it's kind of ironic that some of the brightest and most dependable flaring satellites, such as the Iridiums, were never actually designed to do so. We've followed the latest spate of artistic reflector sats to include Mayak, Humanity Star, and Orbital Reflector… all of which turned out to be underwhelming, at best.

There are numerous platforms for tracking Iridiums across ye ole web, but observer beware… many of them are now actually tracking 'ghost sats,' as they're not taking them out of the catalog as they reenter. Heavens-Above is a great tried and true resource, and it's updated as the fleet of Iridium satellites diminishes over time.

Dedicated observers are chronicling the final days of the Iridium flares using the #flarewell hashtag on Twitter and the Catch the Iridium Project, which is urging viewers to see the final dependable flares, and just hit 1,000 images. Dedicated observer Ira Mollay also mentioned to us that are also two historical missing in action Iridiums, (SV 48 and SV 79) which failed shortly after launch in 2000 and 2001, which worth sleuthing out in archival images. Who will capture the last Iridium flare? It's strange to think that this fascinating era of satellite-spotting may soon be coming to an end.

Our own very modest Iridium flare capture.

Ancient Stars https://xkcd.com/1342/



Goodbye Kepler, hello TESS: Passing the baton in the search for distant planets

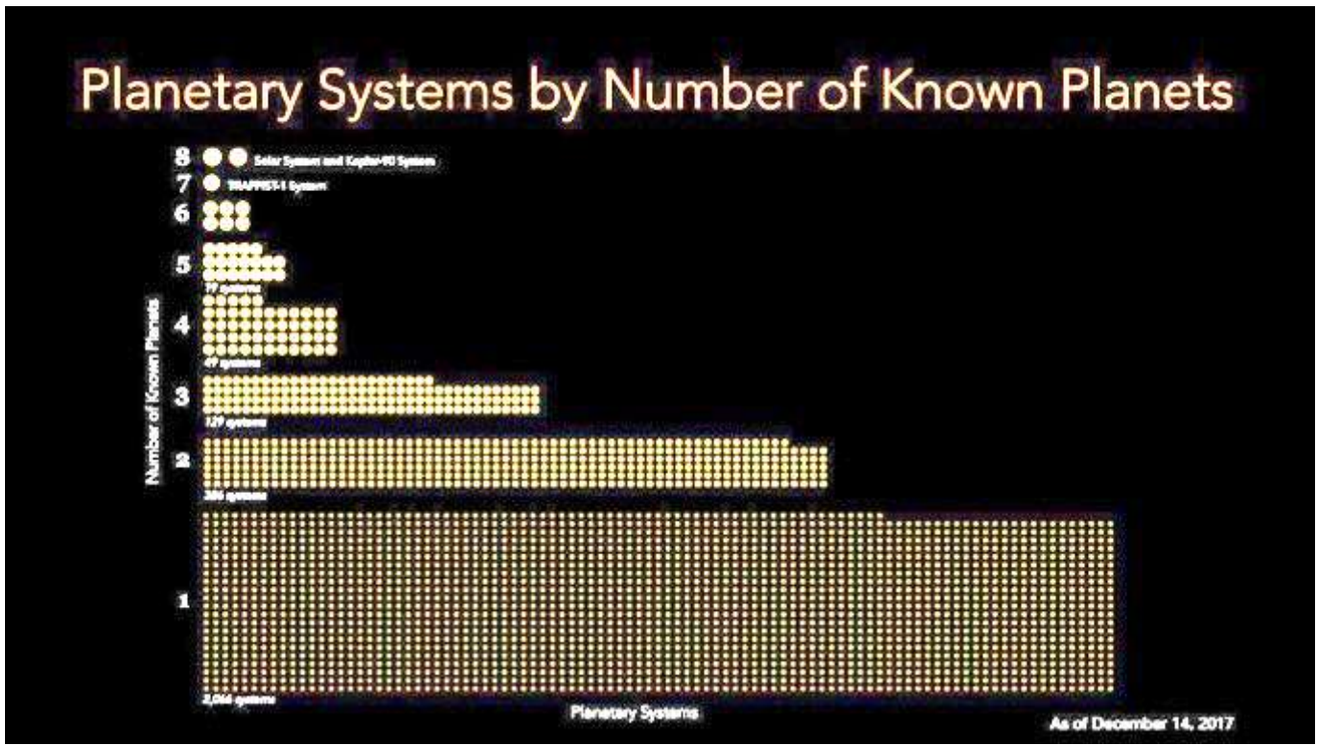
by **Jason Steffen** Assistant Professor of Physics and Astronomy, University of Nevada, Las Vegas

THE CONVERSATION
Academic rigor, journalistic flair

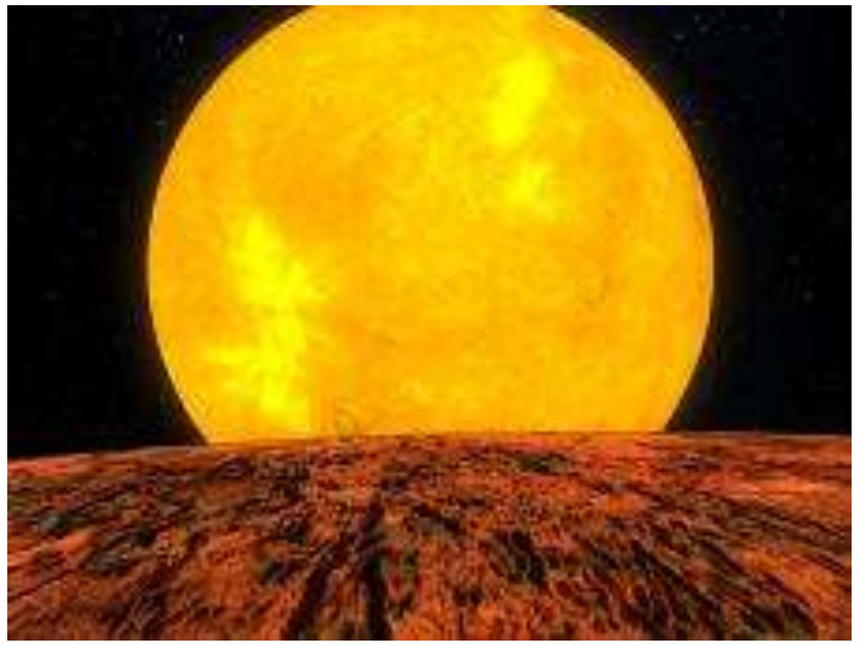
https://theconversation.com/goodbye-kepler-hello-tess-passing-the-baton-in-the-search-for-distant-planets-93688

For centuries, human beings have wondered about the possibility of other Earths orbiting distant stars. Perhaps some of these alien worlds would harbor strange forms of life or have unique and telling histories or futures. But it was only in 1995 that astronomers spotted the first planets orbiting sunlike stars outside of our solar system.

In the last decade, in particular, the number of planets known to orbit distant stars grew from under 100 to well over 2,000, with another 2,000 likely planets awaiting confirmation. Most of these new discoveries are due to a single endeavor — NASA's Kepler mission.



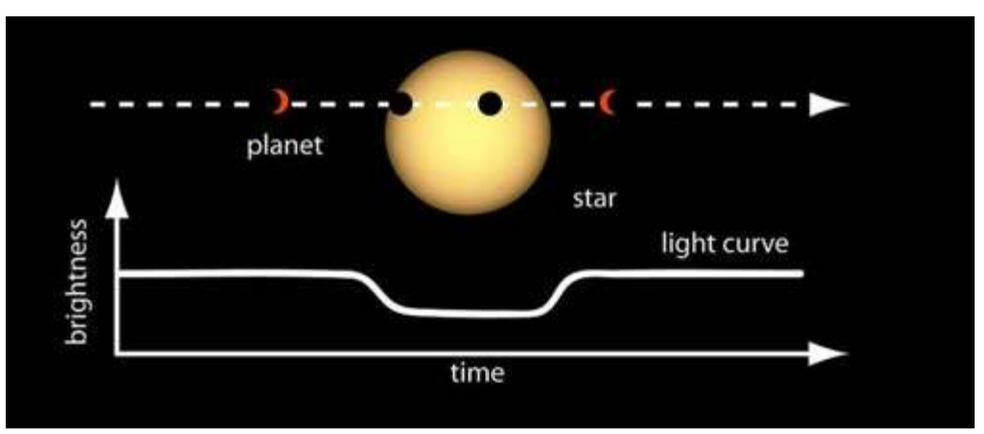
Number of confirmed exoplanets continues to grow. NASA/Ames Research Center/Wendy Stenzel and The University of Texas at Austin/Andrew Vanderburg, CC BY



Imagined view from Kepler-10b, a planet that orbits one of the 150,000 stars that the Kepler spacecraft is monitoring. NASA/Kepler Mission/Dana Berry, CC BY

Kepler is a spacecraft housing a 1-meter telescope that illuminates a 95 megapixel digital camera the size of a cookie sheet. The instrument detected tiny variations in the brightness of 150,000 distant stars, looking for the telltale sign of a planet blocking a portion of the starlight as it transits across the telescope's line of sight. It's so sensitive that it could detect a fly buzzing around a single streetlight in Chicago from an orbit above the Earth. It can see stars shake and vibrate; it can see starspots and flares; and, in favorable situations, it can see planets as small as the moon.

Kepler's thousands of discoveries revolutionized our understanding of planets and planetary systems. Now, however, the spacecraft has run out of its hydrazine fuel and officially entered retirement. Luckily for planet hunters, NASA's TESS mission launched in April and will take over the exoplanet search.



Scientists can determine the size or radius of a planet by measuring the depth of the dip in brightness and knowing the size of the star. https://www.nasa.gov/mission_pages/kepler/, CC BY

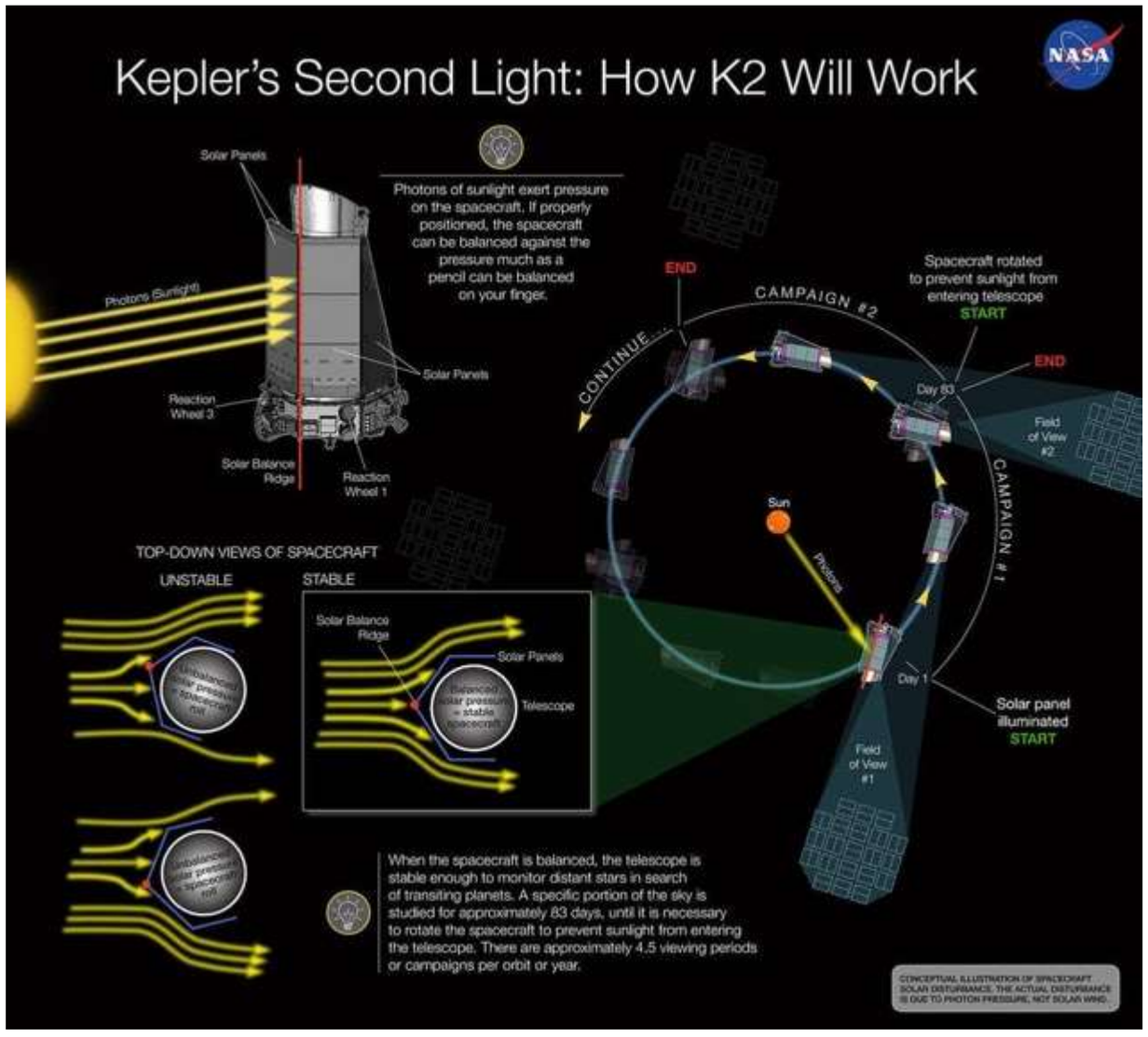
Kepler's history

The Kepler mission was conceived in the early 1980s by NASA scientist Bill Borucki, with later help from David Koch. At the time, there were no known planets outside of the solar system. Kepler was eventually assembled in the 2000s and launched in March of 2009. I joined the Kepler Science Team in 2008 (as a wide-eyed rookie), eventually co-chairing the group studying the motions of the planets with Jack Lissauer.

Originally, the mission was planned to last for three and a half years with possible extensions for as long as the fuel, or the camera, or the spacecraft lasted. As time passed, portions of the camera began to fail but the mission has persisted. However, in 2013 when two of its four stabilizing gyros (technically "reaction wheels") stopped, the original Kepler mission effectively ended.

Prepping the Kepler spacecraft pre-launch in 2009. NASA/Tim Jacobs, CC BY

Even then, with some ingenuity, NASA was able to use reflected light from the Sun to help steer the spacecraft. The mission was rechristened as K2 and continued finding planets for another half decade. Now, with the fuel gauge near empty, the business of planet hunting is winding down and the spacecraft will be left adrift in the solar system. The final catalog of planet candidates from the original mission was completed late last year and the last observations of K2 are wrapping up.



NASA scientists figured out how to use solar pressure to stabilize Kepler. NASA Ames/W Stenzel, CC BY

Kepler's science

Squeezing what knowledge we can from those data will continue for years to come, but what we've seen thus far has amazed scientists across the globe.

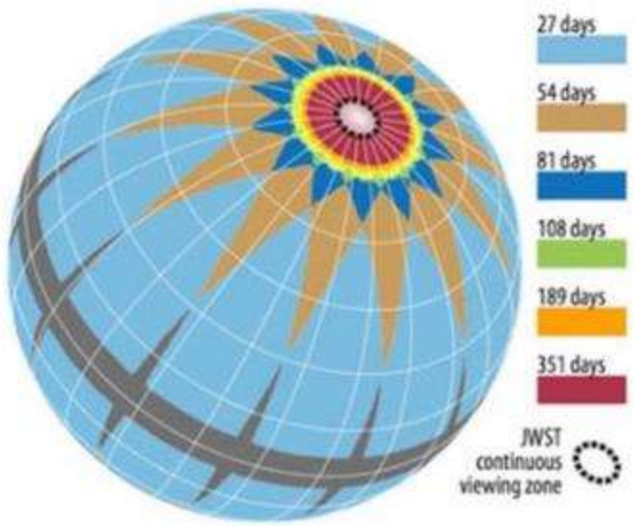
We have seen some planets that orbit their host stars in only a few hours and are so hot that the surface rock vaporizes and trails behind the planet like a comet tail. Other systems have planets so close together that if you were to stand on the surface of one, the second planet would appear larger than 10 full moons. One system is so packed with planets that eight of them are closer to their star than the Earth is to the Sun. Many have planets, and sometimes multiple planets, orbiting within the habitable zone of their host star, where liquid water may exist on their surfaces.

As with any mission, the Kepler package came with trade-offs. It needed to stare at a single part of the sky, blinking every 30 minutes, for four straight years. In order to study enough stars to make its measurements, the stars had to be quite distant – just as when you stand in the middle of a forest, there are more trees farther from you than right next to you. Distant stars are dim, and their planets are hard to study. Indeed, one challenge for astronomers who want to study the properties of Kepler planets is that Kepler itself is often the best instrument to use. High quality data from ground-based telescopes requires long observations on the largest telescopes – precious resources that limit the number of planets that can be observed.

We now know that there are at least as many planets in the galaxy as there are stars, and many of those planets are quite unlike what we have here in the solar system. Learning the characteristics and personalities of the wide variety of planets requires that astronomers investigate the ones orbiting brighter and closer stars where more instruments and more telescopes can be brought to bear.

Enter TESS

Once launched, TESS will identify exoplanets orbiting the brightest stars just outside our solar system. NASA's Goddard Space Flight Center, CC BY



Duration of TESS' observations on the celestial sphere, taking into account the overlap between sectors. NASA, CC BY

NASA's Transiting Exoplanet Survey Satellite mission, led by MIT's George Ricker, is searching for planets using the same detection technique that Kepler used. TESS' orbit, rather than being around the Sun, has a close relationship with the Moon: TESS orbits the Earth twice for each lunar orbit. TESS' observing pattern, rather than staring at a single part of the sky, will scan nearly the entire sky with overlapping fields of view (much like the petals on a flower).

Given what we learned from Kepler, astronomers expect TESS to find thousands more planetary systems. By surveying the whole sky, we will find systems that orbit stars 10 times closer and 100 times brighter than those found by Kepler – opening up new possibilities for measuring planet masses and densities, studying their atmospheres, characterizing their host stars, and establishing the full nature of the systems in which the planets reside. This information, in turn, will tell us more about our own planet's history, how life may have started, what fates we avoided and what other paths we could have followed. The quest to find our place in the universe continues as Kepler finishes its leg of the journey and TESS takes the baton.

Heavenly Bodies by Susie Christian

Child Moon

The child's wonder
At the old moon
Comes back nightly.
She points her finger
To the far silent yellow thing
Shining through the branches
Filtering on the leaves a golden sand,
Crying with her little tongue, "See the moon!"
And in her bed fading to sleep
With babblings of the moon on her little mouth.

-Carl Sandburg