MROI
MONTHLY INQUIRER

OCTOBER 2020

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Do all of this and more by joining the Friends of the MRO. Go to our website to find out more:
http://www.mro.nmt.edu/support-mro/

Virtual Star Parties Coming Soon!

The MROI is pleased to announce Virtual Star Parties coming soon! Keep an eye out on our website and across all of our social media platforms to you don't miss out on the fun!

This page : Moon by Colleen Gino and Dylan Etscorn

Front Cover image: Moon taken by Colleen Gino

Back Cover image: Solar transit of the International Space Station taken by Colleen Gino and Dylan Etscorn

Stay up to date with all of MROI's monthly newsletters at http://www.mro.nmt.edu/news/newsletter/.
Click the links below to access new content being uploaded across all our platforms!

Be sure to check out the MRO's AstroDaily! A daily blog where you can find information on happenings at the MROI, current events in the world of astronomy, tips and tricks on viewing the night sky, and much much more! Content is being added every day at http://astrodaily.mro.nmt.edu/!

The Celts, the Cross-Quarter Day, and Candy

By Shelbi Etscorn

Witch Head Nebula taken by Colleen Gino and Dylan Etscorn

If you're a reader of the MRO's blog AstroDaily (and if you aren't you should be!) you may have read my recent article on what exactly an equinox is. A very brief summary: an equinox is the time of year when the sun's path is directly above the Earth's celestial equator causing there to be an equal length of night and day everywhere in the world. A solstice is either the longest day of the year or the shortest day of the year depending on if it is the summer or winter solstice.

The two equinoxes and two solstices split the Earth's revolutions around the sun into four parts, so they are aptly called Quarter Days. Usually they occur on March 20th, June 20th, September 22nd, and December 21st. Most people are familiar with these dates. But have you heard of Cross-Quarter Days?

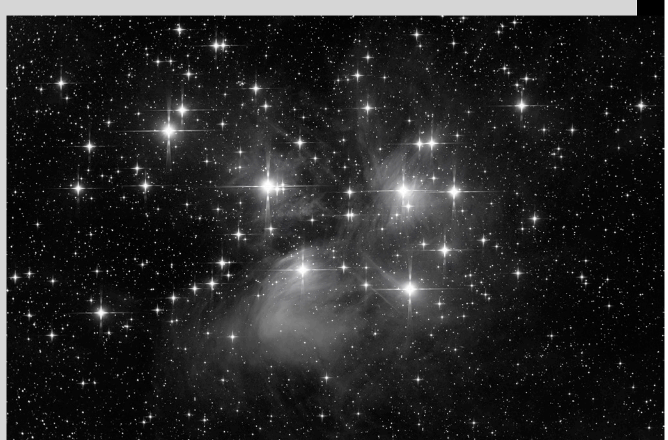
These are the days that fall in between the four Quarter Days. Even if you can't think of them right now, you probably are very familiar with these days: they are February 2nd, May 1st, August 1st, and October 31st. More commonly they are known as Groundhog Day, May Day, Lammas and Halloween. In keeping with the season, today I'll be telling you a little bit more about Halloween.

More than likely, Halloween originated from Samhain, a Celtic harvest festival. It was viewed as the transition from the light to the dark as the last hints of summer faded away and winter's cold began creeping in. It was on this day that the gateway between the world of the living and the world of the dead was at its very thinnest, giving the dead a single night to return. Fires were burned to help ward off evil spirits and food and offerings were left out for the souls of loved ones. These traditions morphed into leaving out jack-o'-lanterns and giving candy to trick-or-treaters.

Samhain also happens to be the day when he Pleiades reaches its highest point in the sky at midnight. The Celts, being excellent astronomers, noticed this coincidence and began associating the asterism with mourning and sorrow. The seven stars were also believed to be the guiding lights that led the Earth from the dark to the light.

The Pleiades aren't the only spooky thing you can look for in the sky this time of year though! Halloween happens to fall on a full Moon this year, which itself is a bit of a spooky treat; unfortunately, it may mean other celestial objects with spooky names might be a little hard to see on that particular night. The Skull Nebula, Ghost Nebula, and the Witch Head Nebula rank among some of the scariest sounding celestial objects seen around Samhain.

So while you're dressing up or enjoying your candy this year, take a look up at the stars and see if you see any ghosts or witches. And don't forget the connection between so much of our daily life and the world of astronomy.



Pleiades taken by Colleen Gino and Dylan Etcorn

Instrumentation Station:

Precision Surfaces of Mirrors

M. J. Creech-Eakman, MROI Project Scientist

Instrumentation Station:
Precision Surfaces of Mirrors
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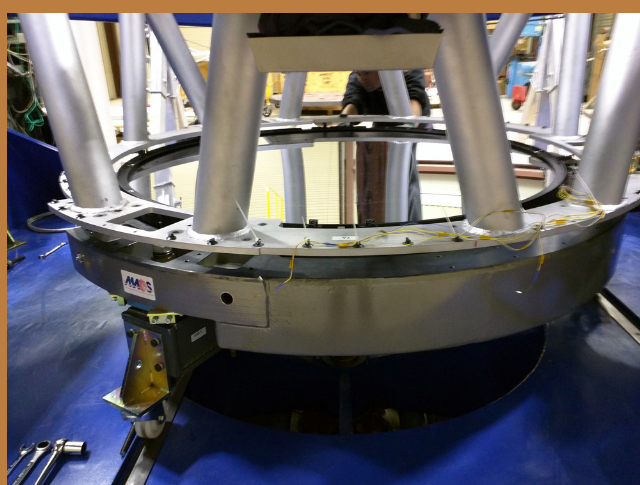
A few months ago I presented a "light paper" analogy to discuss how the interferometer captures the light from far away stars and recombines it across many telescopes in order to make a high-resolution image. Making this piece of "light paper" flat (which is tracked by looking at the phase of the light waves for those of you who remember your college physics class) and recombining it is tricky business and depends on lots of things in the interferometric telescope. These include the detailed shapes of the optics, how quickly we collect and sense the light waves, and the coatings on the optics or types of glasses uses for lenses, just to mention a few. Today's science note focuses on the shape of the optics themselves.

If you were lucky enough to have a perfectly flat wavefront coming down from the stars to your telescope, it would be very important not to destroy that perfect wavefront by your optics having imperfect shapes (imagine "funhouse" mirrors at a carnival). Unfortunately, it is not easy to create optics which have surfaces that are perfect to a level that is smaller than the wavelength of the light being observed. For instance, if you are observing infrared light at 1 micrometer*, or micron in our parlance as astronomers, you would want the optics that the light is interacting with to be perfectly flat (not wavy or bumpy) at a much smaller geometric size than the light's wavelength. We refer to this type of measurement as a surface roughness – not only can it distort the light wave, but it can also scatter light out of the beam path, reducing the overall reflectivity of your optical system. Often the "flatness" of a flat mirror will be quoted in terms of the light wavelength (λ) you are using to make your observation. For reference, the flatness of your typical bathroom mirror might be 5 or 10λ, while optics used with cameras or backyard telescopes are often $\lambda/4$ to $\lambda/10$. For work at professional observatories, and with interferometers and lasers, you often want flatness that is better than $\lambda/10$, and can sometimes go all the way to $\lambda/100$. Incidentally, this is another reason it is easier to work at longer wavelengths, like infrared and radio, where the physical surface roughness you need is easier to attain.



The 1.4m primary mirror of an MROI telescope.

Most optics we use in the interferometer are not strictly flat however; they have some curvature to their surface. This curvature is there so that we can focus the beams on a sensor to study the characteristics of the light, or sometimes to make the beams smaller so that we can move them around and combine them together more easily in the beam combining room at the observatory. If you make the curvature wrong on your optics, you can mess up your images (like what happened in the early days with the Hubble telescope), and then you have to do more work to correct it to make a useful image. Today, we measure the surface of curved optics against a precision reference object to make sure that we have made them correctly. For the large primary mirrors of MROI (1.4 meters or about 4.5 feet in diameter) we use a computer generated hologram recorded on a precision glass plate as the reference. This allows us to track how well the surface curvature is made and to ensure that all the mirrors for all the telescopes are identical to one another. Can you guess how we measure the mirror surface against the hologram? That's right! We use laser interferometry to measure the mirror and compare it to the hologram! There are only a few dozen places in the world today that make precision mirrors the size of the ones needed for MROI – ours are being polished at a company called Arizona Optical Systems. Most of the rest of our optics at MROI are purchased off-the-shelf and are $\lambda/10$ at optical wavelengths – so at least $\lambda/20$ in the infrared where we actually do a lot of our work. And now you know how precision optics are used and measured!

** For reference, "baby fine" human hair is about 50 microns thick, so you could fit fifty 1-micron light waves across the diameter of one "baby fine" human hair.*

Staff Starlight

Now that school is back in swing, we can finally restart our monthly "Student Starlight" section! However, before we get back to telling you about all of our wonderful students working at the MROI, we first would like nothing more than to introduce you to Tech's new physics professor, Dr. Ryan Norris! Dr. Norris comes to us from Atlanta, Georgia where he spent the last eight years studying and working. In his own words: "I did my graduate work using optical interferometry to image the surface of stars like red super giants. Interferometers like the MROI and the CHARA array – which is the one I used – can resolve surface features, so you can reconstruct the image and see bright spots actually on the surface of these stars. That's what I do. I image these stars to see whether the models that we have fit what we observe."

In order to image these stars, Dr. Norris used the CHARA Array.

"That's how I got into interferometry. I came to Georgia State for grad school and I just saw what people were working on and I thought this idea that you could achieve this really high resolution was really cool and I just thought this is their specialty, so if I'm going to be here I may as well take advantage of the fact that this is the University to be at for this kind of work."

As far as his thoughts on moving from a fully functioning interferometer to one still being constructed, Dr. Norris says,

"It's pretty exciting. That was what attracted me to do this job, the fact that I could be a part of something even as it was beginning to happen so there's this idea to make a big difference and affect the direction it takes and to just – be there from the beginning. It's exciting. Hearing the stories from the people who worked on CHARA from the very beginning was always like – ah it'd be cool to be able to be a part of all that. And in my dissertation my last chapter was about, if you wanted to image a star like Betelgeuse, what would you use? And my example was the MROI because they're set up to do that. They're a unique facility. So it was neat to have that continuity from what I was doing in school to here."

Dr. Norris, We're so excited to have you on the team here at MROI and in the classroom inspiring the future generations who will continue on the work we are starting here!

Dr. Ryan Norris

New Mexico Tech
Physics Professor

Spargo's Sky Report

October Skies

MARS ATTACKS! All Sci-Fi references aside, the red planet will be a scant 38,547,383 miles from Earth on October 6th. In recent times, it has been closer to Earth only in 2003 and 2018. You can celebrate "Opposition" from the Sun on the 13th, when Mars will be 38,959,973 miles from Earth. What makes this year's appearance special is that Mars will be well north of its sky position in 2018. During this month, its peak magnitude will be -2.6, briefly outshining Jupiter. It will be ideally placed for viewing surface features. So, break out your telescopes and go for it! Mars will not be this close to us again until 2035.

Jupiter and Saturn will continue to dominate the early evening sky. The magnitudes of both planets fade slightly by the end of the month. Both are still well placed for telescopic observations of moons and rings. Both planets reach eastern quadrature late this month which means they cast shadows to the east. This will enhance viewing of eclipses of Jupiter's moons and shadows from Saturn's rings.

Early-morning sky watchers will be rewarded as brilliant Venus still rises at least 3 hours before the Sun. Shining at magnitude -4.1, its visible phase increases from 72 to 81 percent of its cloudy atmosphere. Tiny Mercury will not be visible to us this month.

The Moon will be full on the 1st, last quarter on the 10th, new on the 16th, first quarter on the 23rd, and full again on the 31st. So, for Halloween, we'll have a "Blue Moon" which is two full Moons in one month. It also happens that the full Moon on the 1st will be the "Harvest Moon." The Harvest Moon is the full Moon nearest to the equinox which was September 22nd.

Looking east on the mornings of October 13 and 14, about an hour before sunrise, the waning crescent Moon will visit brilliant Venus. Looking south-southwest on the night of the 22nd, the nearly first quarter Moon can be found just below and about halfway between Jupiter and Saturn. Looking east on the 29th, one hour after sunset, the nearly full Moon will be just below the red planet Mars.

Due to the closure of New Mexico Tech because of COVID-19 virus concerns, there WILL NOT be a first Saturday of the month star party at the Etscorn Campus Observatory.

Stay safe and Clear Skies!

Jon Spargo
New Mexico Tech Astronomy Club
October 2020

FUN AND GAMES

Another word scramble for you all! Unscramble all the words listed here for your chance to win an MROI prize! Hint: All the words can be found in this newslettter! Send your answers along with your name and address to info@mroi.nmt.edu with the subject Word Scramble. Good luck!

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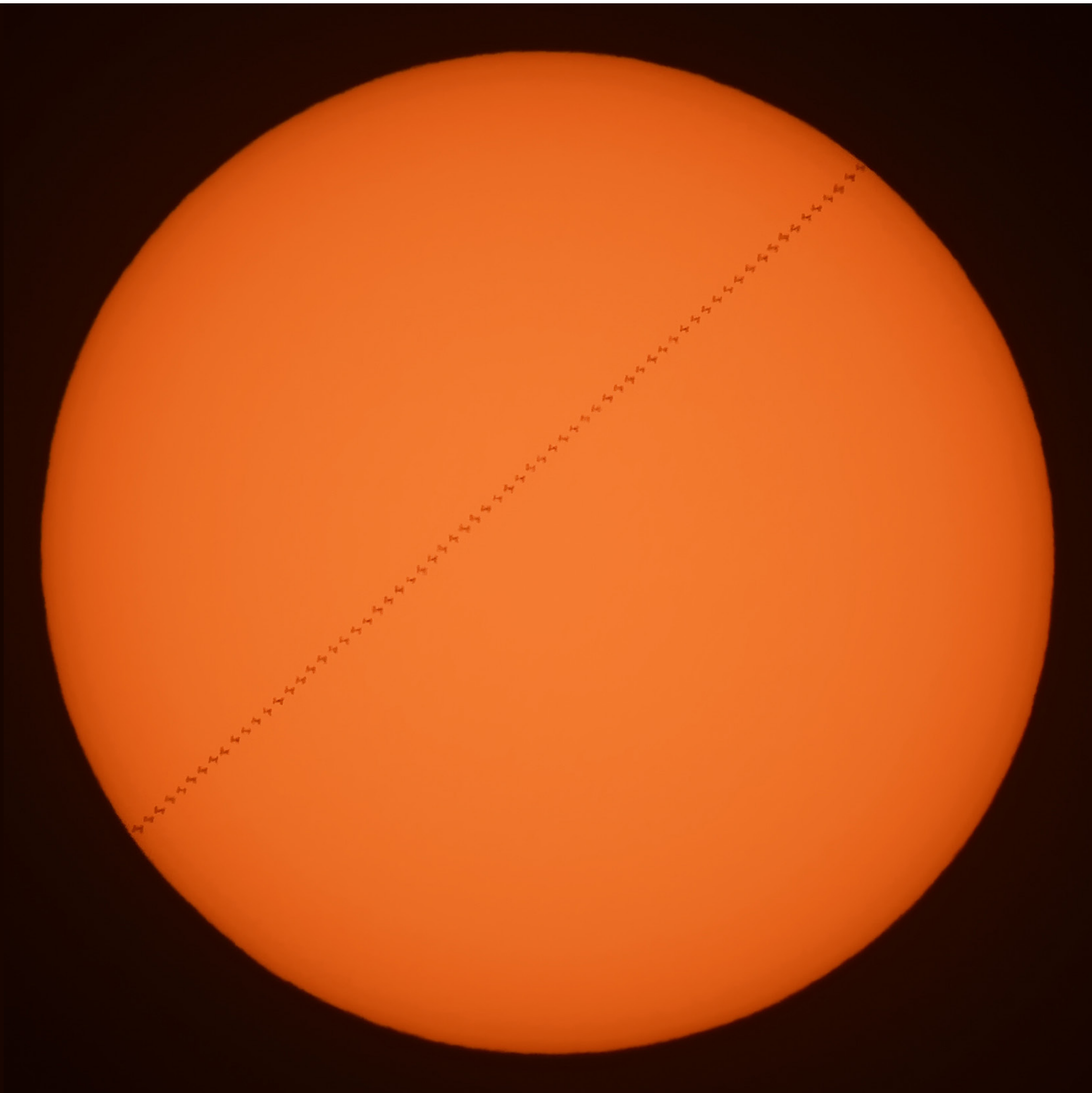

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