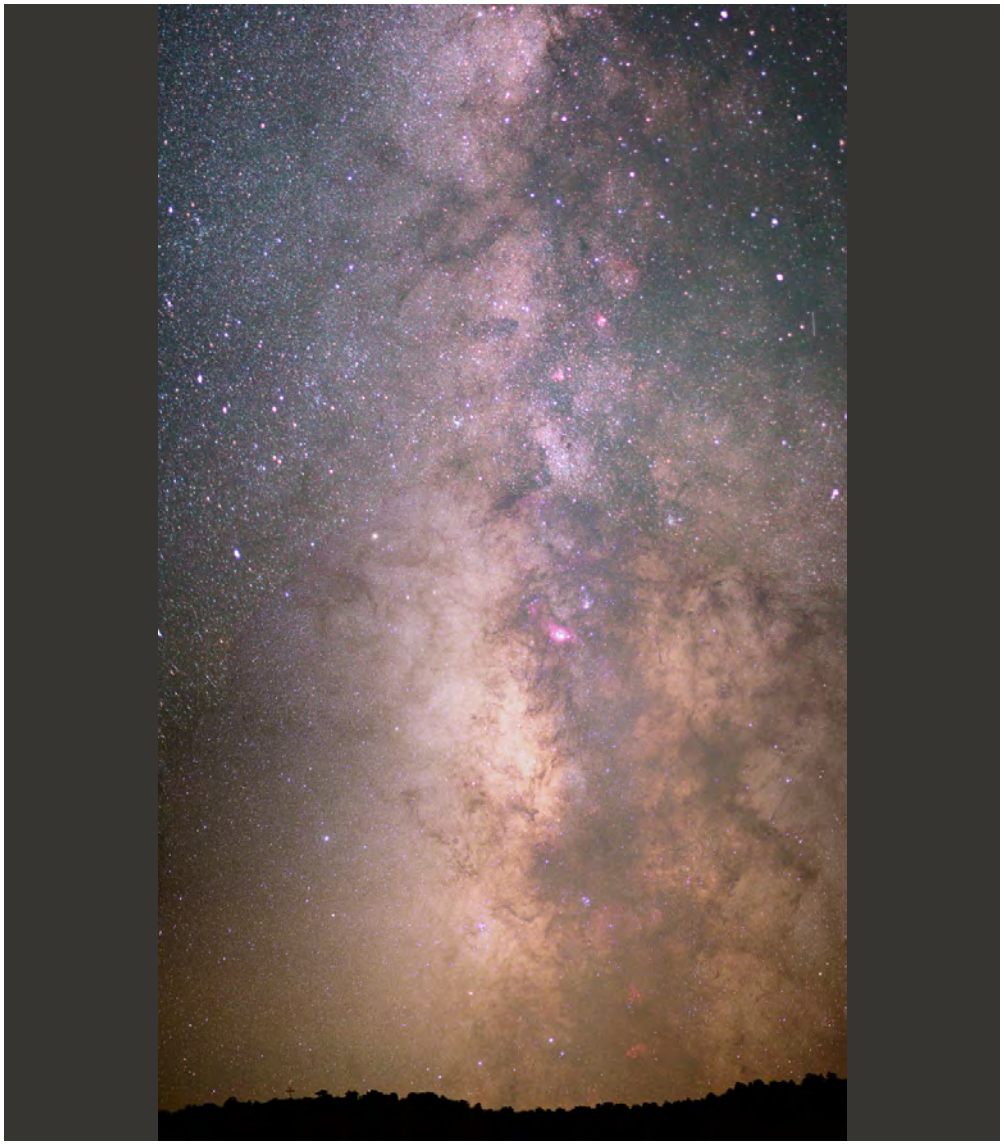
REFLECTIONS / REFRACTIONS

University Lowbrow Astronomers Monthly Newsletter

November 2021, Vol 45, Issue 11

Inside this issue:



MILKY WAY, Okie-Tex Star Party (OTSP)

BY ADRIAN BRADLEY

The Cat's Paw Nebula, NGC 6334 - something we don't normally get to see at our latitude - is at the bottom of the image before the top of the mesa. The image was made from four shots of the Milky Way using an f/2.8 lens at 35mm. ■

(More photos from the OTSP, pages 5-8 & 12)

GENERAL RELATIVITY - PART 1

BY DAVE SNYDER

In previous articles, I've discussed different aspects of gravity, but I've never gone into depth into the subject of general relativity, Einstein's theory of gravity.

General relativity is a difficult subject, but if you don't worry about the mathematical details and take your time with the concepts it is possible to understand much of what's going on.

Before I go into general relativity proper, I will explain why Einstein felt a new theory of gravity was necessary.

Newtonian Physics

Newton's physics is based on three laws of motion. In particular, the first law is as follows: The natural state of all objects is to be at rest or moving at a constant direction and speed. Deviation from this natural motion only occurs when the object is acted on by a force.

I'll use the example of Earth orbiting the Sun, but other examples are possible.

The natural motion of Earth is a straight line with constant speed. But the Sun exerts a force on Earth, and as a result, Earth moves in an elliptical orbit around the Sun.

Newtonian physics was very successful in predicting the motions of objects such as Earth, but one problem surfaced early on. How can the Sun exert a force on Earth if the two objects are separated by 93 million miles? This is known as "action at a distance." Newton was aware of the question but had no answer.

About one hundred years after Newton, Pierre-Simon Laplace proposed an alternative to Newton's equations. Suppose the Sun creates a gravitational field, a sort of fluid that fills all space. This field is stronger near the Sun and becomes weaker as the distance from the Sun increases. Then assume that Earth as it moves through the gravitational field experiences a force pushing it toward the stronger field and away from the weaker field. Laplace created an equation expressing this idea, and while it differed from Newton's equations, it produced exactly the same results.

In Newton's formulation, gravity acts instantaneously no matter what the distance. In Laplace's formulation, gravity acts very quickly: billions of times faster than the speed of light. If the speed of gravity was any slower, planetary orbits such as that of Earth would decay. No such decaying orbits have been observed.

Laplace's formulation can avoid the "action at a distance" problem, since the Sun doesn't act directly on Earth, rather it acts on the gravitational field. This can work if we assume the Sun acts on the center of the gravitational field first (namely its own center of mass), and that influence spreads outward.

Einstein and special relativity

Special relativity differs from Newtonian physics when objects are moving very fast, at which point strange things happen to time and space. But that isn't the most relevant feature.

Let's consider the three dimensions of space and the one dimension of time are really components of a single entity called "space-time."

Special relativity demands that all material objects must move through space-time. It is not possible for an object to be completely motionless. Remember this is motion through space-time. Most objects move through time even if they do not move through space, going from past to future at the speed of one second per second.

The total motion through space-time will in general be split between motion through space and motion through time. The faster you go through space, the slower you go through time and vice versa. At the extremes, an object can have zero velocity through space, and move through time at one second per second. Move faster through space, and you will move through time slower than one second per second. Conversely an object can move at most at the speed of light through space, if it moves at the speed of light, it doesn't move through time at all.

Note that small velocities through time are equivalent to large velocities through space. In addition, special relativity posits that mass and energy are different aspects of the same thing.

General Relativity - Part 1 continues, pg 3

General Relativity - Part 1 continued...

Energy comes in different forms, but for purposes of this article, only one form of energy is relevant, namely kinetic energy. If an object is at rest its kinetic energy is zero, but as the velocity increases, the kinetic energy increases as the square of velocity.[1, 2, 3, 4, 5]

Gravity

After publishing the two papers that describe what is now known as special relativity, Einstein started thinking about gravity. Einstein argued that Newtonian gravity is not compatible with special relativity. Newtonian physics predicts gravity acts instantly even over vast distances. But special relativity predicts that the action of gravity cannot occur faster than the speed of light. Einstein needed to construct a new theory of gravity.

A key insight came to Einstein when he saw a window washer on a nearby building. He pondered what would happen if the window washer fell.

To understand Einstein's insight, first assume this person doesn't get hurt. Now focus on what is going on while the person is falling. Newton would say the person was undergoing an acceleration downward of 1g. Einstein knew this but realized there was another way of looking at it. While falling a person is effectively weightless.

There are two types of acceleration: coordinate acceleration and proper acceleration.

Coordinate acceleration is a quantity computed by recording the velocity of an object over time. The change in velocity with respect to time is the coordinate acceleration. When acceleration is mentioned in Newtonian physics, it is almost always coordinate acceleration.

Proper acceleration is different. Imagine being in a car. The car is initially parked and motionless. The car accelerates until a constant high speed is reached. After a while, the brakes are applied, and the car comes to a stop. Over some of that time you will feel a force either forward or backward. At other times you feel no force. However, you aren't feeling a force, you feel acceleration. Specifically, proper acceleration.

This sensation of acceleration is subjective, and it is better to have a more precise way of measuring it. An accelerometer is a device to measure proper acceleration and is more precise than the "feeling" just described. Suitably miniaturized, accelerometers can be found in some modern electronics such as cell phones. We can thus define proper acceleration as the value an accelerometer displays.

Away from gravitational fields, coordinate acceleration and proper acceleration have the same values. Within a gravitation field, they have different values.

- In the case of the falling window washer, he/she has zero proper acceleration, but a coordinate acceleration of 1G downward.
- In the case of an object in orbit around Earth, it has zero proper acceleration, and a coordinate acceleration toward Earth's center (the exact value is dependent on the type of orbit).
- A person standing motionless on a sidewalk has a proper acceleration of 1G upward and zero coordinate acceleration. [6, 7]

At this point, we don't have a complete theory of gravity. Einstein needed to develop his Equivalence principle, include non-Euclidean geometry and a concept known as tensors to build such a theory. It would take about 8 years.[8]

I will go over that in a subsequent article. ■

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General Relativity - Part 1 Bibliography & Notes continues, pg. 4

General Relativity - Part 1 Bibliography & Notes, continued...

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Notes

1 Henri Poincaré produced a theory similar to Einstein's in many respects and did so a few years before Einstein, however the general consensus is Einstein deserves credit for the best formulation.
2 Hendrik Lorentz produced a set of equations that are identical to the key equations in Einstein's theory and did so a year before Einstein published his 1905 papers. However, Lorentz hadn't gone beyond the equations to produce a workable theory.
3 Einstein had a number of discussions with Michele Besso, and these discussions were important in the development of special relativity.
4 There has been much debate over the role Einstein's first wife, Mileva Marić, played in her husband's work (if any). This much is known: Marić was smart, knowledgeable about physics, but never became a professional physicist. Marić and Einstein frequently discussed physics, but the details of these discussions were never recorded. Marić claimed, in a letter she wrote to a friend, that she helped Einstein with some of his important results, but again details were not recorded. After Einstein had an affair with his first cousin, Elsa Löwenthal (born Elsa Einstein), he decided he wanted a divorce from Marić so he could marry Elsa. As part of a potential divorce agreement, Einstein promised to give Marić all the money from the Nobel Prize (assuming he would eventually win a Nobel Prize). Some might use this to conclude Einstein believed Marić deserved some credit for the results that bear his name, but I don't think it is valid to make that conclusion given those facts. There are no known statements from Einstein that Marić ever contributed anything to his work (but then again with a few key exceptions, there are no statements from Einstein that anyone else contributed to his work). My personal belief is Marić probably made contributions, but we probably will never have any proof one way or the other.
5 Space-time was not Einstein's invention. Rather it came from Einstein's former math professor, Hermann Minkowski. Minkowski read Einstein's paper on special relativity. Minkowski thought Einstein wasn't a very good student but was impressed with special relativity and realized that it could be reformulated in a geometrical way. This formulation is what we now call space-time. Einstein initially was dismissive of the idea. Einstein no doubt knew what Minkowski thought of him, and it is likely that colored Einstein's thinking about Minkowski's work. But Minkowski suddenly and unexpectantly died, and Einstein then started looking at the idea of space-time with fresh eyes. This geometric interpretation would become an important component of general relativity.
6 For those of you familiar with calculus, coordinate acceleration is simply the first derivative of velocity or the second derivative of position.
7 Under normal conditions proper acceleration is simply the coordinate acceleration minus the acceleration due to gravity. However, this is not necessarily true in extreme conditions such as those found close to a black hole. Note: the acceleration due to gravity is computed from Newton's equations. Near Earth's surface, this latter acceleration is 1G. but in general will be higher or lower in other locations.
8 There are claims that other individuals, most notably Marcel Grossman and David Hilbert, deserve some credit for the development of general relativity. I will explore this more in subsequent articles. ■

ASTROPHOTOGRAPHY TIP OF THE MONTH

If you're driving across the country to a star party, don't forget to double-check and make sure you have *all* your gear. And if you **do** forget a critical piece, find Adrian Bradley. (See Doug Bock's article for details, p. 5.)

Fortunately, Adrian has more than one way to enjoy a star party. See his photos, pages 1, 8, 12.

(Photo of Adrian at the OTSP by Jan Fohey)

OKIE-TEXAS STAR PARTY

BY DOUG BOCK

This month I traveled to the Okie-Tex Star Party for the first time. It worked out to be a wonderful trip. There were about 12 of us from Michigan that traveled there through many different routes, and at different times. I picked up Roger Tanner from his house near Adrian on the way out of Michigan. Bob and Gabe Halsall met up with us in Missouri at the end of the first day of travel. The next day we headed for Black Mesa State Park, Oklahoma, just 10 miles from the star party itself -- just the night before its start.

The next morning we headed over to find a spot to set up near the Lowbrow astronomers camp. It was cloudy the first day, October 1, so we weren't in any big hurry to set up for that night.

The next day I set up my system and when I came to put the counterweight shaft on the EQ head, I couldn't find it. I spent a lot of time looking for it, and finally concluded I must have left it at home. I called my wife to check the observatory. She went out and reported she didn't see it anywhere. After searching for another 15 minutes, I called her back and asked that she check a black case I had in the corner, plus the 6" SCT case, which was a complete longshot since I never put the G11 stuff in there. She checked and didn't find anything again until she picked up a foam square sitting on the table, and the shaft was under it. I had pulled the shaft off the mount, set it on the table, then later while putting other things in the truck, covered the shaft with the foam piece. Thus, I missed it entirely when I did my final walkthrough to make sure I had everything.
I was pretty disappointed since I wasn't going to be able to do any imaging for the entire week, except for my tripod and widefield camera setup for time-lapse.

Fortuitously, Adrian Bradley came over to chat and I mentioned I wasn't going to be doing any imaging this week, and he asked why. After explaining, he asked what mount I use. He stated he had the same mount here and I could use his counterweight shaft if need be. Adrian saved the week for me. Thank you, Adrian.

Okie-Texas continues, p.6

The NE corner of the field was populated by the University Lowbrow Astronomers, which I'm also a member of.

Roger Tanner brought his 10" f/3.9 astrograph on an iOptron CEM70g, and I had my 4" refractor on my Losmandy G11. We were both doing imaging all week.

I also did some time-lapse for video, plus this star trail, using my Canon T3i and 10mm lens.

Okie-Texas continued...

The event was well attended by about 400 people. The meals were good and the maintenance of the outdoor facilities was excellent, with cleaning crews each day. There were many large dobs and imaging systems set up all over the observing field. Many had windbreaks to keep the wind at bay, which only really happened one of the nights. The skies were excellent each night, with our galaxy visible from horizon to horizon. Bortle 1 skies are really worth the trip.

Roger and I had set up across the "road" a bit with our scopes and trailer. Bob and Gabe were just a bit away as well. Once it got dark enough to check polar alignment each night, I set up Sequence Generator Pro, with the object list for the night, including exposure time, number of exposures, and time to start and stop the sequence.

This automation is the same as when I use this setup in the observatory at home, so I was confident it would work. I had my laptop in the trailer just so I could check up on the progress, via remote desktop to the telescope computer. This allowed me to get more sleep than the rest of the folks. ☺

Another object I hadn't ever imaged due to its size is the Pleiades (M45). With this refractor I can get most of it.

Here are the other objects from that week. The Eastern Veil Nebula, The Iris Nebula, the Helix Nebula and the Triangulum Galaxy.

It was a great trip. We started for home on the 8th, a day in front of the coming storms, and arrived home on the 10th. ■

One result I like the most is this one with the Horsehead and Flame Nebula.

This was 41 x 5 minute sub frames, with the William Optics 105mm APO refractor and the ZWO asi2600MC PRO camera at gain 100, and temp 0C.

More photos from Doug Bock, p. 12

OUR OKIE-TEX 2021 HIGHLIGHTS

BY DON FOHEY

Okie-Tex was quite an adventure for Jan and me this year. We met up with Wendy and Robert Wade the night before at Black Mesa State Park and worked out our strategy to occupy the NE corner of the field: We were to wake at 5:30 a.m. and break camp so that we could be in line at the field by 6:30 a.m. for the 7:30 a.m. field opening at sunrise. We arrived and were 5th and 6th in line. Robert and I donned headlamps and walked the field to survey our intended location. About 7 a.m., other arrivals drove past all of us in line and started driving onto the field, so we all started our engines and the land rush was on. We drove to the corner and Robert swung his rig into position and directed us into the NE corner, which turned out to be wonderful. Thank you, Robert. Wendy set out cones and flags to reserve space for Jim/Adrian and Nathan Murphy who were arriving about 7:30 a.m. Doug Bock put his camper just across from us. Camp Lowbrow was established!

We had attended Okie-Tex in 2009 and Jan consider being locked in a trailer at night with only a red light to be cruel and usual punishment. This year, with the help of Nathan, we were able to cover the windows of our A-liner pop-up camper with blankets and black-out cloth so that lights could be used in the camper without showing any light on the field. Jan and Wendy managed to read and visit in the camper while the guys observed.

The days were hot sitting under shade with T-shirts, shorts, and sandals. Tarantulas walked thru camp. They were hunted by Tarantula Hawks (a big scary wasp that preys on tarantulas). The nights were cold, requiring thermal underwear, a fleece sweater, a down jacket, hat, and gloves. The scenery around us of desert and mesas made for a surreal location.

Tarantula walking through camp.
(Photo by Don Fohey)

Left to right: Adrian Bradley, Nathan Murphy, Jim Forrester, Wendy Wade, and Robert Wade
(Photo by Jan Fohey)

The first observing night was Saturday, my 14" Big Blue Dob was a pleasure, and my tracking system worked well. I was pleased. I had prepared an observing list and was able to visit about 1/2 of the objects on it, but I chose not to take the extra time to log objects. Things dewed up, unusual for Okie-Tex, so at about 3 a.m. I decided to close down. My mirror cover was all wet from dew. I turned it sideways to put it thru the truss shroud --and dropped it on the mirror. The mirror rang like a bell; I was sickened. The morning revealed a 3" mar across the mirror. I am sad every time I look at the mirror, but lots of mirrors have mars and the telescopes work just fine.

Sunday, Monday, and Tuesday nights were wonderful. I finished my observing list on Sunday. I created some new lists and logged 15 objects on Monday and 18 on Tuesday. Nathan was a big help, sharing views, identifying star fields, and finding comets. I was disappointed that I was unable to discern the Horsehead Nebula. The skies were good, but I think there was a small amount of lingering smoke from the westward forest fires. Wednesday we enjoyed a day trip with our group to the Capulin Volcano and Carlton State Park to see the dinosaur tracks. Wednesday night was windy and limited our viewing. We left on Thursday to continue our trip to Big Bend National Park. Okie-Tex is a truly unique experience. ■

PHOTOS from the OTSP, by ADRIAN BRADLEY

"This was my first trip to a Bortle 1 sky and I'm actually able to say that the nightscape images I got here still don't do justice to how things looked to the naked eye. I wish for everyone to see the Milky Way that visible."

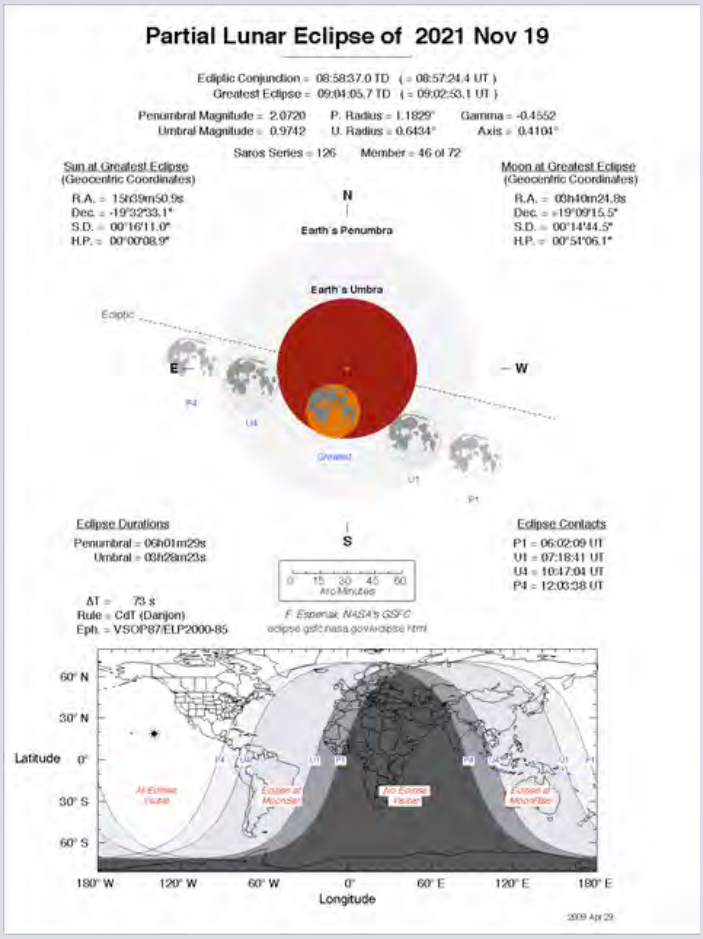
THE LUNAR ECLIPSE OF NOVEMBER 19, 2021

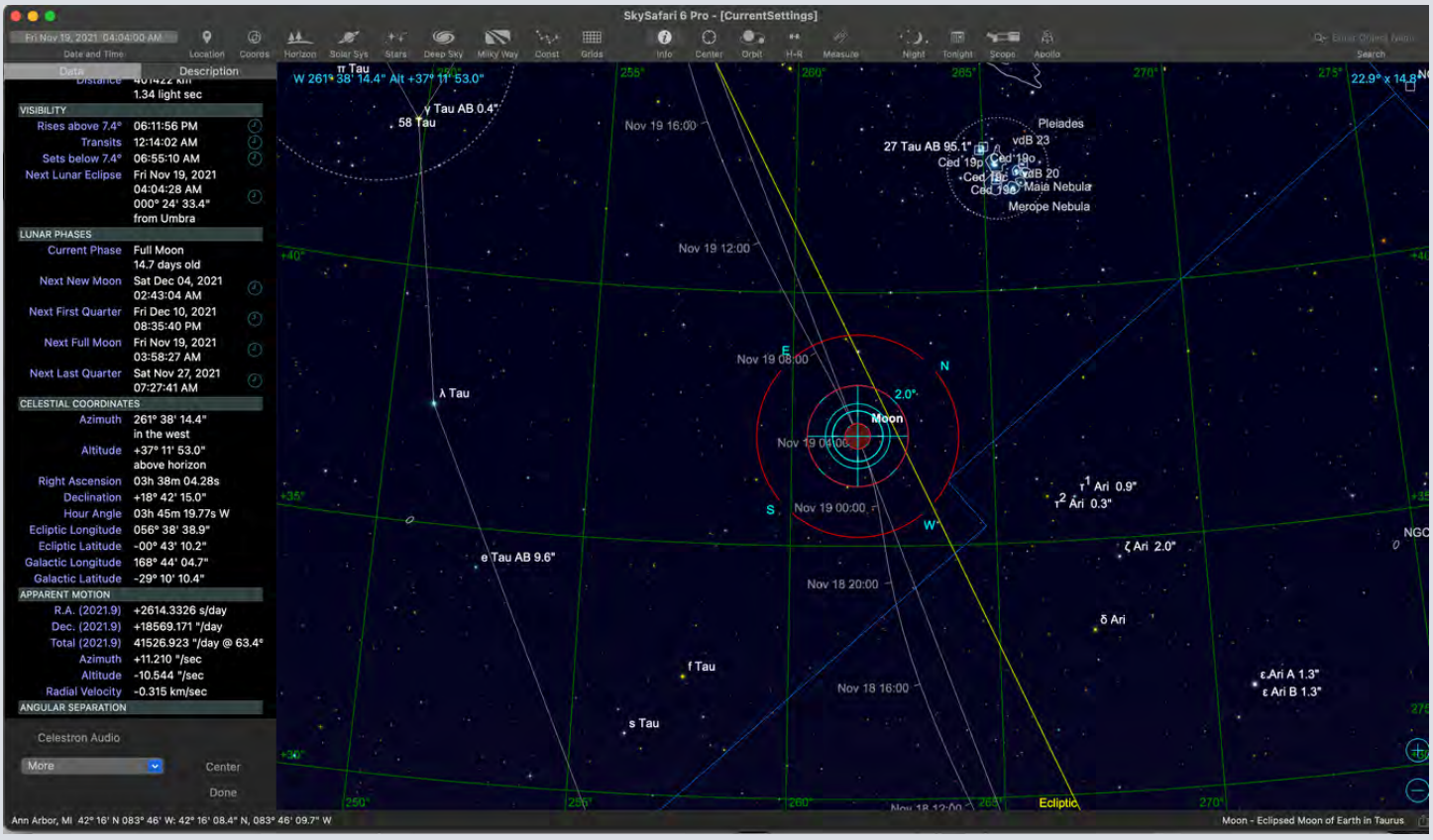
by JIM FORRESTER

Early risers (or those very late to bed), will be treated to an almost total eclipse of the moon in the wee hours of Friday, November 19. 97% of the Lunar disc begins slipping into the umbra of the Earth's shadow at 02:18 and reaches greatest eclipse just past 04:00 EST. At this time the Moon will be just south of due west, about 37 degrees above the horizon. This 3% sliver, though, will likely be bright enough to overwhelm the eye to the typical red color the moon reflects during totality. But the best way to find out is to be outside to see it.

Lunar eclipses, unlike their solar counterparts, can be safely observed unfiltered with any instrument, including the naked eye. Remember, though, the moon will be full and very bright at almost any magnification. You'll be much happier if a filter is between your eye and the image of the moon. As the moon slips further into the umbra, though, removing the filter may give you a better view. The sky throughout should be spectacular, with the Pleiades just 6 degrees to the northwest.

Don't want to be up so early in the morning? Next May 15/16, the full moon will be at total eclipse for 1 hour, 25 minutes bracketing midnight. ■





THE GREAT AURORA THAT ... WASN'T

by DOUG SCOBEL

Despite all the media hype, predictions of a great aurora the night of October 30-31 never quite materialized, even north of the 45th parallel. Between midnight and 1:00 p.m., there was an amorphous glow barely seen with the unaided eye. The camera helped bring it out; keep in mind that colors in this image are exaggerated compared to what was seen visually. Lake Michigan is on the horizon bottom left. →

Boring Borealis

After 1:00 p.m., I captured Gemini and Orion rising in the east, sure signs of the coming winter. Also seen here are Auriga and Taurus, center left and right, respectively, and Perseus at top. ↘

Winter Knocking at the Door

Both Images were taken north of Northport, MI, near the tip of the Leelanau peninsula.

I used a Canon EOS 5D Mark IV DSLR with a Canon 24-70mm lens set to 24mm. 15 seconds at f/4, ISO 5000. Raw images processed in Adobe Photoshop Elements 2020. ■

UPCOMING MEETING SPEAKER SCHEDULE

NOVEMBER 19: Dr. Fred Adams, U-M. Topic: ***TBA***

DECEMBER 17: Don Fohey, Lowbrow member. Topic: ***The New Horizon Mission to Pluto***

JANUARY 21, 2022: Dan Durda, Southwest Research Institute, Boulder, CO. Topic: ***The Southwest Research Institute's Suborbital Research Initiative: First Flights with Virgin Galactic and Blue Origin***

FEBRUARY 18: Professor Claude Pruneau, WSU Physics Dept. Topic: ***What the LHC mini-bangs tell us about the Big Bang***

MARCH 18: Tentative Professor Michael Meyer, U-M Astronomy. Topic: ***The NASA/ESA/CSA James Webb Space Telescope: Discovery Space***

APRIL 15: Adrian Bradley, Lowbrow VP. Topic: ***The Dark Skies of Michigan***

Lowbrow General Meeting
G115 Angell Hall, UM Central Campus
Zoom: https://umich.zoom.us/j/96335537161
October 15, 2021 7:30 pm

Come to Order: 7:35pm

Speaker: Dr. Keren Sharon, UM Assoc Professor of Astronomy - Gravitational Lensing

Officer Reports:

- Dave Jorgenson - Not Present - VP
  - Nothing new to report. Request to Arthur Bosman hasn't been answered yet.
- Joy Poling - Not Present - VP
  - updated the Calendar to reflect our In-Person meeting status.
- Doug Scobel - Remote - Treasurer
  - 170 memberships (new record), 12 Covid considerations.
  - $11,557.51 in the treasury. $692.00 of that is money collected for RASC items.
  - Collecting money for RASC cal/handbooks - ordering the weekend of October 16-17. Shipping them to VP Liz Calhoun for live distribution.
  - TCF Bank to Huntington transfer went well. Huntington works better.
  - Doug is now working at Enerdyne near Traverse City.
- Adrian Bradley - VP
  - Okie-Tex was great
- Amy Cantu - Newsletter
  - Nothing new
- Liz Calhoun - Unable to attend
  - Has possession of the Peach Mountain keys
  - Working with Doug Scobel on distributing RASC materials when they arrive
- Jack Brisbin - Observatory Director
  - Graffiti cleanup
  - Grounds maintenance, clearing brush
  - Testing electronics
  - Red Rubylith - 2019 pricing! $1
- Jeff Kopmanis - Communications
  - Attendance
    - Online: 22
    - In-person: 11
  - GLAAC Update
    - Nominations for 2022 Officers are open at this time until January 13 election meeting
    - November is a "bye" month for GLAAC meetings
    - Tentative Date for AATB 2022: September 16-17, 2022
    - AATB Viewership
      - Friday: 673, Saturday: 478

Brian Ottum	313	164 (rain)
Ford	153	176
Doug Bock (NCO)	37	35

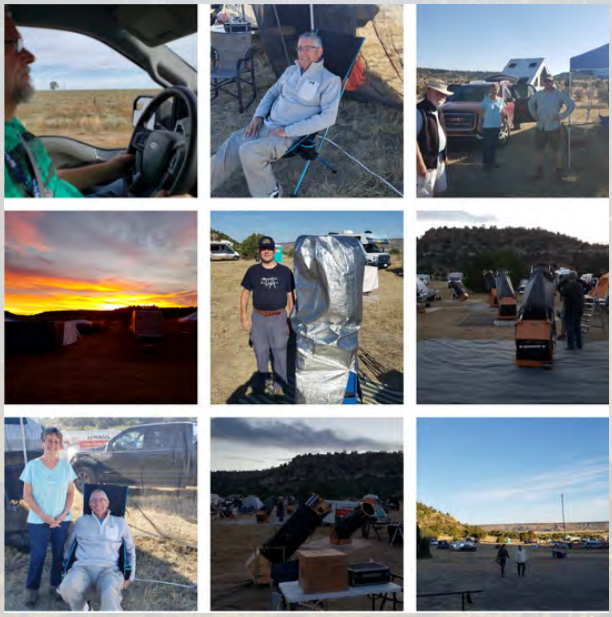
- Overview: Due to changing Covid conditions, it was difficult to make an in-person/virtual decision until August, which had an impact on the effectiveness of our marketing and communications.

- Charlie Nielson - President
  - In-Person meeting has worked well so far
  - Westland Library - in March
- Krishna Rao - Webmaster
  - Looking into CMS (WordPress or Drupal)
- Jim Forrester - Past Officer (Peach Mtn authorized key holder)
  - Prospective Open House Dates - document set to Membership on 10/14/21

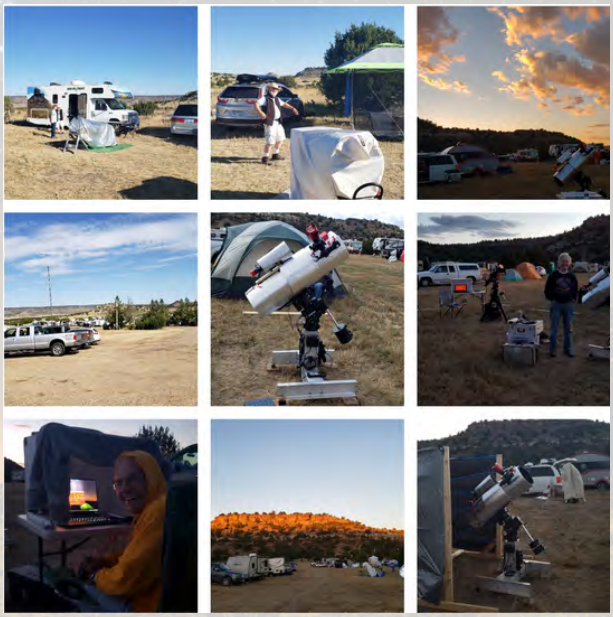
Meeting Adjourned: 9:29pm Motion: Jack Brisbin, 2nd: Adrian Bradley

Next Meeting: November 19, 2021. Speaker: Prof. Fred Adams, UofM Physics - Topic TBA

More Photos from the OTSP. Above panorama, by Adrian Bradley



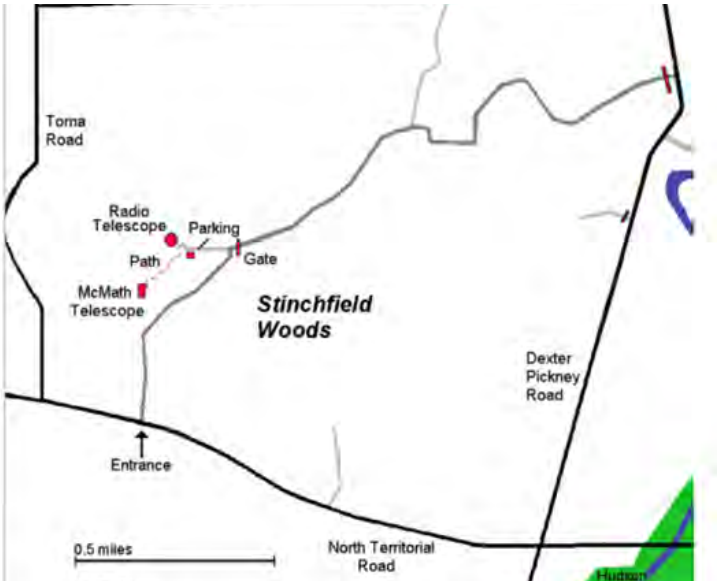
Photos left and right, by Doug Bock



PLACES & TIMES

Monthly meetings of the University Lowbrow Astronomers are held the third Friday of each month at 7:30 p.m. The location is usually Angell Hall, ground floor, Room G115. Angell Hall is located on State Street on the University of Michigan Central Campus between North University and South University Streets. The building entrance nearest Room G115 is the east-facing door at the south end of Angell Hall.

Peach Mountain Observatory is the home of the University of Michigan's 25-meter radio telescope and McMath 24" telescope, which is maintained and operated by the Lowbrows. The entrance is addressed at 10280 North Territorial Road, Dexter MI, which is 1.1 miles west of Dexter-Pinckney Rd. A maize and blue sign marks the gate. Follow the gravel road to the top of the hill to a parking area south of the radiotelescope, then walk about 100 yards along the path west of the fence to reach the McMath Observatory.



PUBLIC OPEN HOUSE / STAR PARTIES

Public Open Houses / Star Parties are generally held on the Saturdays before and after the New Moon at the Peach Mt. Observatory but are usually canceled if the forecast is for clouds or temperatures below 10 degrees F. For the most up-to-date info on the Open House / Star Party status call: (734) 975-3248 after 4 pm. Many members bring their telescope to share with the public and visitors are welcome to do the same. Mosquitoes can be numerous, so be prepared with bug repellent. Evenings can be cold so dress accordingly.

MEMBERSHIP

Annual dues are $30 for individuals and families, or $20 for full time tudents and seniors age 55+. If you live outside of Michigan's Lower Peninsula then dues are just $5.00. Membership lets you access our monthly newsletter online and use the 24" McMath telescope (after some training). You can have the newsletter mailed to you with an additional $18 annual fee to cover printing and postage. Dues can be paid by Venmo, PayPal, or by mailing a check. For details about joining the Lowbrows, contact the club treasurer at: lowbrowdoug@gmail.com

Lowbrow members can obtain a discount on these magazine subscriptions:

Sky & Telescope - $32.95/year
or $65.90/2 years
Astronomy - $34.00/year, $60.00/2 years
or $83.00/3 years

Newsletter Contributions:
Members and non-members are encouraged to write about any astronomy-related topic. Contact the Newsletter Editor: Amy Cantu cantu.amy@gmail.com to discuss format. Announcements, article, and images are due by the 1st day of the month as publication is the 7th.

Telephone Numbers:

President:	Charlie Nielsen (734) 747-6585
Vice President:	Adrian Bradley (313) 354-5346
	Joy Poling
	Liz Calhoun
	Dave Jorgensen
Treasurer:	Doug Scobel (734) 277-7908
Observatory Director:	Jack Brisbin
Newsletter Editor:	Amy Cantu
Key-holders:	Jim Forrester
	Jack Brisbin
	Charlie Nielsen
Webmaster:	Krishna Rao
Online Coordinator	Jeff Kopmanis

A NOTE ON KEYS: The Club currently has three keys to the Observatory and the North Territorial Road gate to Peach Mountain. University policy limits possession of keys to those whom they are issued. If you desire access to the property at an unscheduled time, contact one of the key-holders. Lowbrow policy is to provide as much member access as possible.

Lowbrow's Home Page
http://www.umich.edu/~lowbrows/

Email to all members
Lowbrow-members@umich.edu

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STAMP