Ann Arbor, Michigan

REFLECTIONS / REFRACTIONS

University Lowbrow Astronomers

July 2006

Volume 30 Issue 7

Hale-Bopp

(because sometimes you just need a good comet picture)

HALE—BOPP PICTURE

Image data: Date: 3/11/97 Time 4:20 a.m. (11:20 UT) Place: Longmont, CO (35 miles North of Denver) From the deck of my daughter's home.

Sky direction: Northeast

Camera: Pentax Spotmatic 35mm SLR with Vivitar 35mm lens with 2x Teleplus Extender.

Exposure: 90 seconds @ f.2.8, Fuji color ASA 200 film.

The red and white line is a plane from near-by Vance Brand airport. Brand is an astronaut from Longmont who learned to fly at the airport.

Photo copyright: William B. Stegath, 7 Heatheridge, Ann Arbor, MI 48104

July Meeting location change

Friday, July 21—At Sherzer Hall Room 402

Joe Bernstein talks about Neutron Star Debris

(see page 10 for directions)

Inside this issue:

Important Club Info

- July 21 — University Lowbrow Astronomers' monthly meeting 7:30pm at EMU's Sherzer Hall
- July 22 — Public Open House at Peach Mt. Observatory starts at dusk (come on out & help us feed the bugs)
- July 29 — Public Open House at Peach Mt. Observatory starts at dusk (come on out & help us feed the bugs)
- August 18 – University Lowbrow Astronomers' monthly meeting 7:30pm at Room 130, Dennison Hall UofM
- August 19 - Public Open House at Peach Mt. Observatory starts at dusk (come on out & help us feed the bugs)

Nandini & Sameer's Story

By Nandini Hanagud

Here's the story of our telescope:

Our interest in astronomy till date has only extended to reading Carl Sagan's "Cosmos" and for a while having the SETI – software/screensaver on our PC. But about a week ago or so, we were walking around window-shopping in the mall and we just happened to step into the discovery store.

They had telescopes right there at the front of the store. We had always assumed that telescopes were more expensive than they really are. Sameer and me both kind of looked at each other, and said, "Wow, can you imagine what we might be able to see through this". So we went back home, did a bit of research, picked up "Astronomy for dummies", to get their take on how to pick a scope. From what we understood it would be easier to use one with an equatorial mount rather than the one with an azimuth one. So we decided on an EQ, and of all the models there this one seemed appropriate for beginners, which is what we are. So here we are with 114 inch, f/8.8 Meade.

On our second attempt at using the scope at home after we bought it, we found Jupiter and four of its moons and thought we were probably seeing some light shine off something, it seemed to too good to be true, only it was true, isn't that fabulous?!

(I met Nandini and Sameer at an Open House at the end of May, they set up next to me on Peach Mt. I tried to give them a few helpful hints on set-up and practicing alignment in daylight at home; They were back at the next open house, lets see how they did; Editor)

I wrote a few paragraphs about the double-double. I'm trying to maintain a blog of all that I observe etc. so I have all my notes in one place and this is going to be a part of my blog but I trimmed it a bit and thought I'd send it along to you, just in case you think you'd like to add this to the newsletter. Please let me know if you see anything that is factually incorrect. Please feel free to edit it as needed. Thanks again for showing us how to use our telescope correctly I'm very proud of our little scope now I got to see a double-double with it :-)... Anyway here's the article...

I saw a Double – Double last night:

Just below Vega, in the summer sky, towards the top left corner of a parallelogram shaped pattern of stars, is a binary star system made up of two pairs of binary stars. This is the Epsilon Lyrae – A double - double. It lies at a distance of 160 light years from Earth. So what I saw last evening was an image that was a hundred and sixty years old.

In a binary star system, two stars are gravitationally bound. There are two binary star systems in Epsilon Lyrae - Epsilon 1 and Epsilon 2. I could see the binary systems Epsilon 1 and Epsilon 2 through my scope. Epsilon 1, to the left of my view (Newtonian telescopic view) should have appeared split across horizontally and Epsilon 2 should have appeared split vertically across to reveal each star in this quadruple star system.

These are 5th magnitude stars. A 1st magnitude star is a 100 times brighter than a 6th magnitude star. Magnitude measures relative brightness. The brighter a star appears, the lower the number. Jupiter[3] was probably about –2.4 in magnitude last evening. Last night was fairly hazy and the Epsilon system looked like a single faint point of light to my un-aided eye..

In a binary star system, two stars revolve around their common center of mass. The center of mass is proportionately closer to the heavier star. The heavier star moves in a smaller but slower orbit. Now, Epsilon 1 has an orbital period of about 1200 years and Epsilon 2 has an orbital period of 585 years, and Epsilon 1 and Epsilon 2 also revolve around their common center of mass and their orbital period is estimated be hundred thousands to a million years[2]. A really slow cosmic dance!

References:

1. Stephen P Maran (2005) *Astronomy for Dummies*. 2nd Ed. Wiley Publishing Inc

2. Bruce McCure . *Epsilon Lyrae – The Double Double.* <http://www.idialstars.com/el.htm>

3. Amateur Astronomers Association of New York. *This Month's Sky* < http://www.aaa.org/aaawhatsup.htm>

CLIMBING THE IMAGING MOUNTAIN – First Installment

By Brian Ottum

I became hooked on astronomy when I was 12 years old. Someone pointed out Jupiter to me, and a couple months later I saw a lunar eclipse. Soon the UPS truck brought the obligatory 60mm Japanese refractor. Amazingly, its poor quality did not extinguish my passion for the hobby. When I was 16 I raked leaves, shoveled driveways, painted and did other jobs to earn enough for an orange Celestron 8. About that same time, I started doing photography for my high school yearbook. So it was obvious that I'd attach my camera to the telescope and take some of those amazing pictures I saw in magazines. Hah! Not so fast. My initial results were blurry, streaky, and unsatisfying.

So I concentrated on observing for the next couple decades. Like many others, I simply love showing others the Heavens through my scope. I'd guess that I've been fortunate to show objects to about 3,000 people. This still remains my #1 love. However, I've periodically been drawn back into astrophotography. And usually with poor results.

The highlights (and lowlights) of my early astrophotography career are:

- taking slides of the 1979 total solar eclipse in North Dakota and creating a slide show set to music for my high school science class - my 15 minutes of fame
- taking pictures and video and assembling a presentation of the 1991 total solar eclipse from Baja Mexico
- having my video camera inexplicably quit two minutes before 1997 totality on a cruise ship off the coast of Montserrat
- surprisingly good shots of Comets Hale-Bopp and Hyakutake in the 1990's
- rushing through two rolls of film during the amazing northern lights display of November 2001 from a silent cornfield in northern Michigan

Each time I'd have a positive astrophography experience, I'd dive a bit deeper. But soon I'd hit a roadblock. There was something I did know how to do, or I lacked the proper equipment. So I stayed on the visual side of things.

During the 1990's I started to see the impressive work being done by amateur CCD imagers. But when I looked into it, I saw that they were not only spending tens of thousands of dollars on equipment, but also hundreds of hours preparing and doing post-processing. Yuck.

However, I was also seeing worsening light pollution around my house. Using my backyard observatory for visual observing was becoming less fun. The last straw was the addition of new obnoxious lights at the prison a couple miles south of my house. Dark skies are rather distant, and I could not abandon my family for long periods of time.

The solution to my dilemma came when Canon introduced its affordable digital SLR, the 10D. I saw that I could use it for both daytime AND nighttime photography, so I bought it in 2004. The sensor allowed me to "subtract out" light pollution from the Prison Glow Observatory.

Over the past two years, I've come to realize that astrophography/astroimaging is simultaneously gratifying and frustrating. For me, the benefits are huge but the investments in time & money are not trivial. I see that there is no learning curve. It is more like climbing a huge mountain. There are many techniques, tips and tricks to learn. Unfortunately, there is no one repository of information. I have started climbing the mountain using the various tools:

- screwing up and learning from my mistakes
- reading Wodaski's The New CCD Astronomy book
- gathering scattered bits of insight from dozens of web sites and user groups
- taking to experts like Carl Burton and Rick Krejci

I'm only partway up the mountain. I can see how far I've come, but I'm daunted by the distance above me.

Over the next couple newsletters, I will lay out my take on astrophotography:

- a 'fishbone diagram' summarizing the myriad causes of a bad picture
- the current state of astroimaging equipment and my recommendations should you be foolish enough to also start climbing this mountain
- my 'lazy astrophotographer' method of taking great pictures without a lot of fuss and bother

This edition closes with an offer. I'm happy to haul people up this mountain quickly by passing on what I've learned. Call me or email me.

Brian Ottum (734) 429-3559 ottum@comcast.net

Gravity Part 3: Space Travel

by Dave Snyder

In part two of this article, I started a discussion of Newton's Theory of Gravity. I explained how, over the years, astronomers and mathematicians developed methods for predicting motions of the planets, comets and other celestial bodies.

But that isn't the whole story.

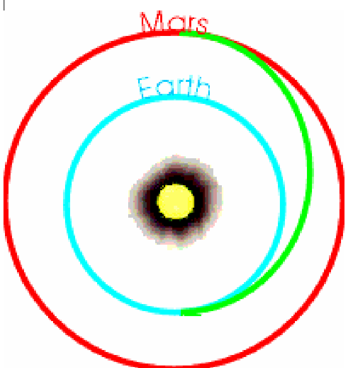
Over the past 50 years we've sent numerous spacecraft to the moon and planets. If we want spacecraft to reach their destination, careful planning is needed. The techniques described in part two are helpful when planning space missions, but not sufficient.

Going from A to B

Generally space missions go from point A to point B using a limited amount of fuel. In the past most space missions have used Kepler orbits and/or escape trajectories as much as possible. Kepler orbits were described in part two, they are ellipses - staying in such an orbit requires no fuel. An escape trajectory is a parabola or hyperbola that also requires no fuel. In other words we "coast" as much as possible.

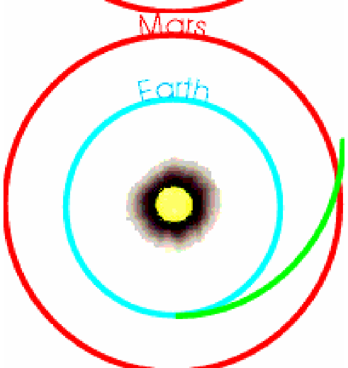
But we cannot coast the entire mission; one or more transfers will be needed, and transfers require fuel.

A common transfer is from a Kepler orbit to a larger/smaller Kepler orbit. There are three ways this is done.



1. Hohmann Transfer Orbits.

Suppose we are in the orbit "Earth" and we want to be in the orbit "Mars." We can transfer using what is called a Hohmann orbit (this is a Kepler orbit tangent to the two other orbits - it need not be Mars, it works for most other planets as well). In many cases this is the least expensive way to transfer. However, it has some disadvantages: it is slow and can only be used during specific launch windows, for an Earth-Mars transfer, these windows occur once every two years. For an Earth-Jupiter transfer, the windows occur every 13 months.

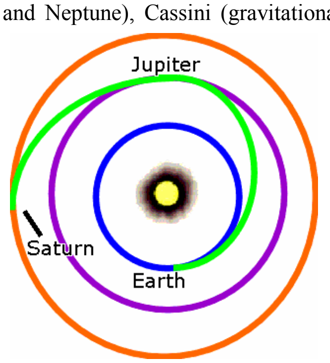


2. Modified Hohmann Orbits.

Alternatively we can replace the Hohmann transfer orbit with an orbit that intersects the destination orbit. This is called a modified Hohmann orbit. It is faster than a Hohmann orbit, but requires more fuel.

3. Gravitational Assist.

If the spacecraft flies by a planet, the planet will push the spacecraft into a different trajectory. This might either speed the spacecraft up or slow it down (depending the precise circumstances). This is known as gravitational assist (the diagram shows a possible flight from Earth to Saturn using a gravitational assist from Jupiter). This can be faster and/or may use less fuel than is possible with other techniques. Gravitational assist was first used by Mariner 10 (gravitational assists from Venus and Mercury). It has been used several times since including Voyager (gravitational assists from Jupiter, Saturn, Uranus and Neptune), Cassini (gravitational assists from Venus, Earth and Jupiter) and Messenger (six gravitational assists from Earth, Venus and Mercury).



If you wish to send the spacecraft out of the solar system, an escape trajectory is needed (as mentioned above, a parabola or hyperbola). Transferring to an escape trajectory takes a lot of fuel (though fuel consumption can be reduced by careful use of gravitational assists).

Using the techniques described so far allow us to flyby a planet. However it is often useful to enter orbit (for observation of the planet and/or to place a lander on the surface). This is often done in two steps.

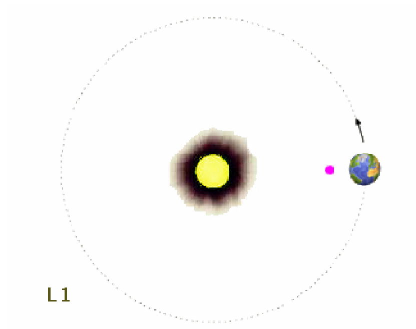
1. An orbital insertion burn can be used to go into orbit, however this typically results in an eccentric orbit around the planet.
2. The eccentric orbit can be "circularized" with a rocket burn or, if the planet has an atmosphere, with aero-braking (requires less fuel, but is usually slower than a rocket burn).

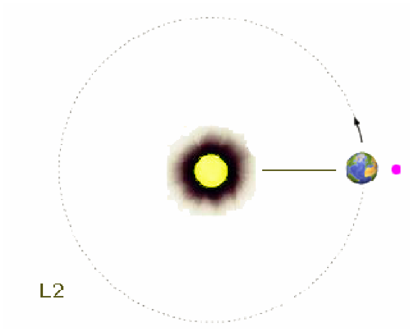
Other orbital manipulations are sometimes used, such as changing the inclination (but I wont go into more detail).

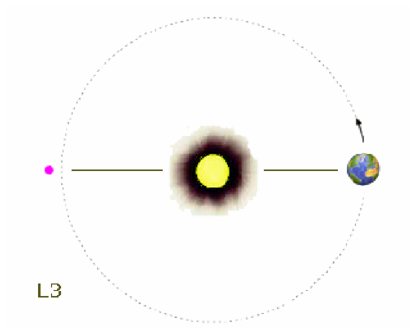
Staying Put

So far I've talked about going from A to B. Sometimes once we get to a destination, we want to keep stationary. Assuming we can't just land on a surface, keeping stationary without using large amounts of fuel is tricky, but there is a way to do it involving Lagrangian points. These are five configurations called L1, L2, L3, L4 and L5.

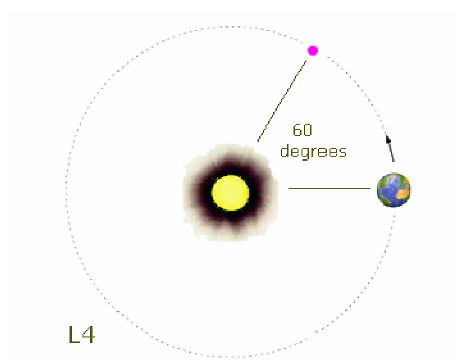
I will be talking about three objects: the Sun, the Earth and a spacecraft (however it doesn't have to be the Sun and the Earth). You will recall the orbit of the Earth around the Sun is very close to a perfect circle. Now suppose we place a spacecraft so it lies along a line between the Earth and the Sun. If the distances are just right, you get Lagrangian points L1, L2 and L3 (see the diagrams).

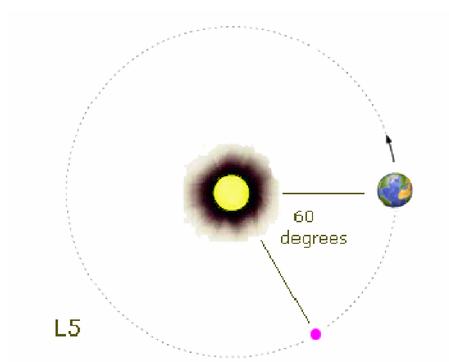






Or you can place the satellite in the same orbit but exactly 60 degrees ahead of the Earth (see diagram L4). Or 60 degrees behind the Earth (diagram L5).





L4 and L5 are stable, once a satellite is at or close to L4, it will tend to stay at or close to L4. The same is true of L5. Thus it possible to park a satellite at either L4 and L5 and it will stay there without expenditure of fuel.

L1, L2 and L3 are metastable. Once a satellite is at or close to L1, it will slowly drift away from L1; the same is true of L2 and L3. Even so this can be a reasonable method for parking a satellite, while the satellite will tend to drift away, this can be controlled with reasonable bursts of fuel.

SOHO (a satellite that observes the sun) uses L1. WMAP (another satellite) uses L2. Other uses of L1 and/or L2 are likely. Since L3 is hidden behind the Sun, it is currently unused and is likely to remain unused. There have been discussions involving space stations at either L4 or L5, however this has not happen yet.

The third object must be much smaller than the other two, but it doesn't have to be an artificial satellite. It can be an asteroid. If you look at the L4 and L5 points of the Sun and Jupiter, you will find a group of asteroids known as the Apollos. At some point in the past asteroids wandered into these regions, once there they never left. There are also examples involving the moons of Saturn.

The Interplanetary Superhighway

It gets more interesting. If a spacecraft starts near a L1, L2 or L3 point, it is possible to transfer to the "interplanetary superhighway." This is a set of "tubes" or pathways that allow travel within the solar system with very little fuel.

This technique was first used in 1991. That's when the first Japanese mission to Moon ran into trouble. Because of a malfunction, soon after launch the spacecraft lost most of the fuel needed to get to the Moon. Using this new approach it was possible to use the existing fuel supply to get to the Moon (however it took three months to do so - compared to a few days using traditional techniques).

I do not have the space to explain the superhighway in any detail, but I will summarize a few main points.

- Trajectories using the superhighway generally require very little fuel, however they take longer than traditional trajectories.
- They are harder to calculate than traditional trajectories. They are constantly changing and require a mathematical technique known as "chaos." However software has been developed that can calculate these trajectories. You might think chaos is something to be avoided, however we've learned that appropriate use of chaos can help in a variety of engineering tasks including controlling spacecraft.

This can be more than just saving a little fuel, it might allow a single mission to visit a variety of destinations in a way that would be impractical with traditional techniques. This was discussed for JIMO (which was a planned tour of Jupiter's Moons that was cancelled earlier this year).

To make use of the superhighway easier, we could place a permanent space station at one of the metastable points (probably L1). Going between L1 and various other destinations (including points on the Moon or L2) is easier than doing so directly from the Earth.

Given the current budget restrictions that NASA must work with, it is not clear when we will make regular use of the superhighway. Even when we do, it is likely that its primary use will be for unmanned missions. However this is could be another useful technique in planning space missions.

References

------. "Basics of Spaceflight." http://www2.jpl.nasa.gov/basics/

------. "Cassini-Huygens: Operations-Gravity Assists." http://saturn.jpl.nasa.gov/mission/gravity-assists.cfm

------. "MESSENGER - Unlocking the Secrets of Mercury."

http://www.nasa.gov/mission_pages/messenger/main/index.html ------.

"SP-423 Atlas of Mercury - MARINER 10 MISSION AND SPACECRAFT." http://history.nasa.gov/SP-423/mariner.htm

------. "Voyager - Science - Planetary Voyage." http://voyager.jpl.nasa.gov/science/planetary.html

------. "The Lagrange Points." http://map.gsfc.nasa.gov/m_mm/ob_techorbit1.html *[a discussion of Lagrangian points and a few satellites that have used or might use L1 or L2]*.

Baez, John. December 19, 2005. "Lagrange Points." http://math.ucr.edu/home/baez/lagrange.html *[contains a good discussion of Lagrangian points, the Trojans and the superhighway]*.

Karttunen, H. et al. 1996. *Fundamental Astronomy.* Berlin: Springer, pp. 201-202 *[contains a brief discussion of Lagrangian points and the Trojans]*.

Kaufmann, William J. and Freedman, Roger A. 1999. *Universe.* Fifth edition. New York: W. H. Freeman and Company, p. 394 *[contains a brief discussion of Lagrangian points and the Trojans]*.

Klarreich, Erica. April 16, 2005. "Navigating Celestial Currents." *Science News.* (Volume 167, Number 16, pp. 250-252) *[a non-technical discussion of the Interplanetary Superhighway]*.

Szebehely, Victor G. and Mark, Hans. 1998. *Adventures in Celestial Mechanics, 2nd Edition.* New York: John Wiley and Sons.

How Dark is Dark?

By John Causland

Now why would anyone, Lowbrow or other, get it in their blood to jump in the car on a perfectly clear night, knowing that Lowbrows were on "the hill" and not join them with the 61? Well, it all started the night before at Clayton's. A wonderful gathering including Clayton, Mark D., Yasu and Yumi, Doug Scobel and Mike Radwick. Clayton had also provided the wonderful service of taking apart and regreasing my CG11 mount. Perhaps in response to his service, I felt impelled to grab my "newest" astro toy, a Sky Quality Meter, and voyage out onto the asphalt seas between Ann Arbor and Lake Hudson and so some all in one night measuring.

My quota of observing photons had been fully satisfied at Clays the night before. The moon was down, and this second night in a row was clear. My head was still reeling with tunes from the Top of the Park. Time for a drive, why not? When Else Would Anyone Ever Bother Drive to Lake Hudson And Back To Take 5 Minutes of Sky Quality Meter Measurements? And then do the same at Clay's and Peach Mtn, all on the same night to establish a relative base line of comparison.

First, about the Sky Quality Meter: http://unihedron.com/projects/darksky/

It's really a nifty little unit that runs off a 9 volt battery and is about the proverbial size of a pack of cigarettes with a digital readout and sampling chip on one end. I bought it when I was headed out to Arizona in February and wanted to know really how dark dark can be. My measurements while observing from the rim of the Grand Canyon were telling. There's something strange about standing there cursing the "sky glow" of the zodiacal lights because it's obscuring the stars. The SQM has been out for about a year. It's not my intention to sell you on the SQM here, but to either verify or blow away what you already believe about how dark our favorite sites are. Here's what the website and a review say about the SQM:

"Finally, an affordable meter for measuring sky brightness for astronomers! The "Sky Quality Meter" measures the brightness of the night sky in magnitudes per square arc second. Unprecedented sensitivity in a handheld meter! Designed by Dr. Doug Welch and Anthony Tekatch. "The SQM gives the average night sky brightness weighted for the angular response inside an acceptance area which has a diameter of 55 degrees down to 1/10 attenuation..." Check the website for more detail.

I've taken numerous readings from my driveway, about midway between downtown Ann Arbor and Peach Mtn. An average moon down night registers 19.9 and a really dark night, such as we had after I returned home from Clayton's Friday 6/24 was 20.02. I mention this as the SQM really does return consistent results.

And now for the winners and losers:

The darkest readings taken by other SQM users were:

21.86 - Mt. Graham, Arizona

21.87 - Mauna Kea visitors' center.

16.70 - Hialeah, Florida

My readings – just to indicate the wider sampling range:

21.80 - South rim of Grand Canyon (Can it get any darker than this!!!)

15.1 Full moon zenith

16.0 Full moon horizon

17.35 Cloudy night full moon

6/24 a really good dark Lowbrow night at Clay's

20.87 - Clayton's (My driveway: 20.02)

6/25 the wild one night ride: A bit less dark than 6/24. (Note the previous night for comparison)

20.90 - Lake Hudson - 11:45 pm

20.72 - Clayton's - 12:45 am

20.67 - 3 mi south of Manchester

20.52 - Peach Mtn. - 1:30 am

19.90 - My driveway

6/27 Dark and clear, but humid at 2 am

19.85 - My driveway

19.65 - Huron River Dr. nr. Wagner

19.10 - Barton Pond

18.75 - Main St at M14 ramp

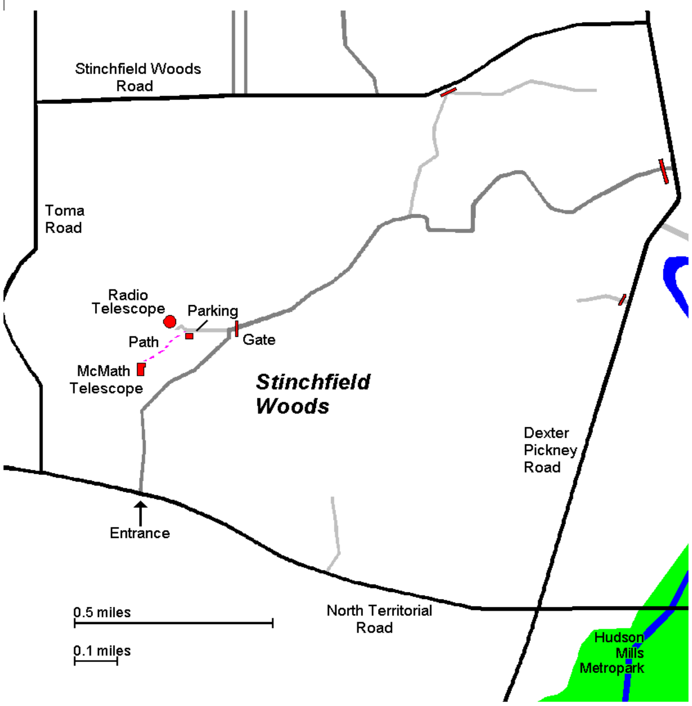
19.00 - Leslie Park

Conclusion: On a really good night, Clayton's almost matches an average dark night at Lake Hudson with a max .20 difference. Peach Mtn falls back by about the same .20 amount from Clay's to Lake Hudson. My driveway, 10 miles closer to Ann Arbor drops .50. And, eek, Leslie drops off a full 1.00 at the convenient, but north edge of Ann Arbor's sky glow. Most importantly, for the short distance drive, Peach Mtn. gives the most photons for the gas money at 1.50 better than Leslie and .50 better than my driveway, but is only .20 worse than Clayton's and .40 worse than Lake Hudson! Long live Peach Mtn!

Places & Times

Dennison Hall, also known as The University of Michigan's Physics & Astronomy building, is the site of the monthly meeting of the University Lowbrow Astronomers. Dennison Hall can be found on Church Street about one block north of South University Avenue in Ann Arbor, MI. The meetings are usually held in room 130, and on the 3rd Friday of each month at 7:30 pm. During the summer months and when weather permits, a club observing session at the Peach Mountain Observatory will follow the meeting.

Peach Mountain Observatory is the home of the University of Michigan's 25 meter radio telescope as well as the University's McMath 24" telescope which is maintained and operated by the Lowbrows. The observatory is located northwest of Dexter, MI; the entrance is on North Territorial Rd. 1.1 miles west of Dexter-Pinckney Rd. A small maize & blue sign on the north side of the road marks the gate. Follow the gravel road to the top of the hill and a parking area near the radio telescopes, then walk along the path between the two fenced in areas (about 300 feet) to reach the McMath telescope building.



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 Mountain observatory, but are usually cancelled if the sky is cloudy at sunset or the temperature is below 10 degrees F. For the most up to date info on the Open House / Star Party status call: (734)332-9132. Many members bring their telescope to share with the public and visitors are welcome to do the same. Peach Mountain is home to millions of hungry mosquitoes, so apply bug repellent, and it can get rather cold at night, please dress accordingly.

Membership

Membership dues in the University Lowbrow Astronomers are $20 per year for individuals or families, $12 per year for students and seniors (age 55+) and $5 if you live outside of the Lower Peninsula of Michigan.

This entitles you to the access to our monthly Newsletters on-line at our website and use of the 24" McMath telescope (after some training).

A hard copy of the Newsletter can be obtained with an additional $12 annual fee to cover printing and postage. Dues can be paid at the monthly meetings or by check made out to University Lowbrow Astronomers and mailed to:

The University Lowbrow Astronomer c/o Kathy Hillig

7654 W. Ellsworth Road
Ann Arbor, MI 48103

Membership in the Lowbrows can also get you a discount on these magazine subscriptions:

Sky & Telescope - $32.95 / year

Astronomy - $34.00 / year or $60.00 for 2 years

For more information contact the club Treasurer. Members renewing their subscriptions are reminded to provide the renewal notice along with your check to the club Treasurer. Please make your check out to: "University Lowbrow Astronomers"

Newsletter Contributions

Members and (non-members) are encouraged to write about any astronomy related topic of interest. Call or Email the Newsletter Editor: **Mark S Deprest (734)223-0262 or msdeprest@comcast.net** to discuss length and format. Announcements, articles 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 Presidents:	Jim Forrester	(734) 663-1638
	Nathan Murphy	(734) 395-1043
	Kurt Hillig	(734) 663-8699
	Bob Gruszczynski	(734) 461-1257
Treasurer:	Kathy Hillig	(734) 663-8699
Observatory Director:	D. C. Moons	(586) 254-9439
Newsletter Editor:	Mark S Deprest	(734) 223-0262
Key-holders:	Bernard Friberg	(734) 761-1875
	Fred Schebor	(734) 426-2363
	Charlie Nielsen	(734) 747-6585
	Mike Radwick	(734) 453-3066
	Paul Walkowski	(734) 662-0145
Webmaster	Dave Snyder	(734) 747-6537

Lowbrow's Home Page

http://www.umich.edu/~lowbrows/

Email at:

Lowbrow-members@umich.edu

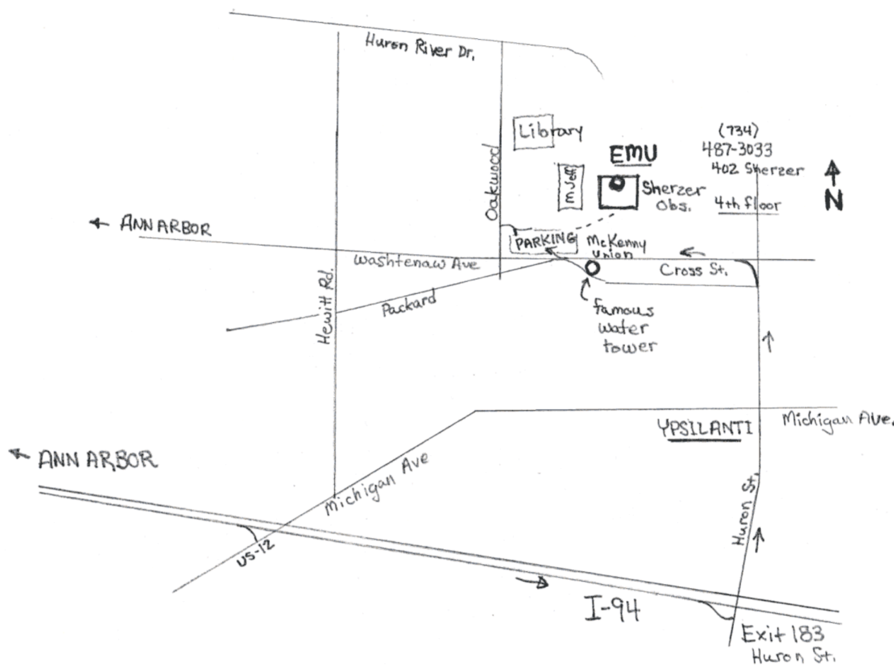
University Lowbrow Astronomers

Kathy Hillig
7654 W. Ellsworth Road
Ann Arbor, MI 48103

Phone: 734-663-8699
E-mail: hilligk@hotmail.com

Reflections & Refractions

Website
www.umich.edu/~lowbrows/



******* Due to the Ann Arbor Art Fair the July 21st *******

University Lowbrow Astronomers' monthly meeting will be held in room 402, Sherzer Hall on the Campus of Eastern Michigan University.

The Lowbrows wish to thank member Norb Vance for making this location available to us!

University Lowbrow Astronomers
7654 W. Ellsworth Road
Ann Arbor, MI 48103

Check your membership expiration date on the mailing label