REFLECTIONS REFRACTIONS
of the University Lowbrow Astronomers

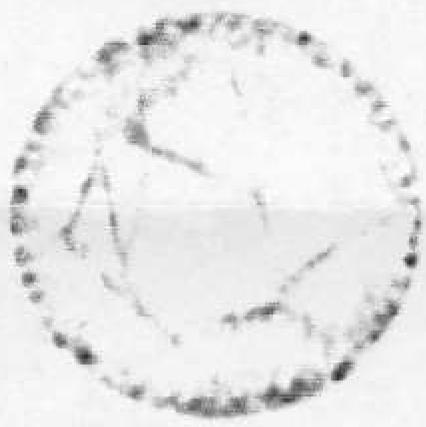
May 1999

The University Lowbrow Astronomers is a club of Astronomy enthusiasts which meets on the third Friday of each month in the University of Michigan's Physics and Astronomy building (Dennison Hall, Room 807). Meetings begin at 7:30 pm and are open to the public. Public star parties are held twice a month at the University's Peach Mountain Observatory on North Territorial Road (1.1 miles west of Dexter-Pinkney Road; further directions at the end of the newsletter) on Saturdays before and after the new Moon. The party is canceled if it's cloudy or very cold at sunset. For further information call (313)480-4514.

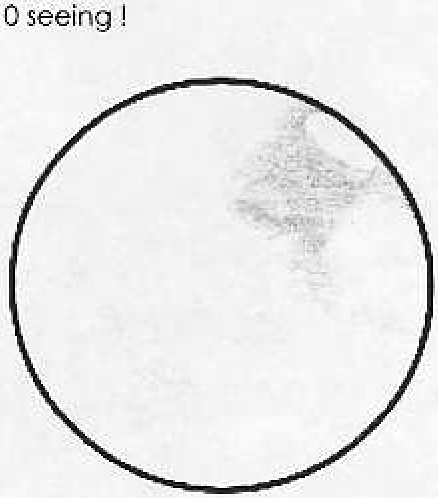
The Great Mars Sketch-Off – Current Controversy

Few clear skies and poor seeing have resulted in a limited number of sketches from the membership. Shown here are two recent submissions. Below, our President Mark Deprest, submitted this fine rendition of Mars showing the polar cap. "I think I was the only one to do a drawing, so I win The Great Mars Sketch Off" Mark was reported as saying. *[As an impartial by-stander I can only submit that perhaps Mark's statement is a little premature – Ed]*

The controversial sketch above was sent in by a self proclaimed, ex-patriot Lowbrow Kristoffel Zanik-niet from somewhere in Arizona (Doug – Check this guy's dues will you). When asked about his sketch in light of recent hi-tech imaging from sources such as the Hubble Space Telescope, Kristoffel indicated, "I've seen this stuff. I don't believe a bit of it. Decorum prevents me from say words like 'brainwashing' about you amateur astronomers. Deep in my heart I know Percival was right." *[The sketch-off continues through this month. Keep those sketches coming in and we'll publish them in REFLECTIONS – Ed]*



Mars by Kristoffel Zanik-niet, 13 inch refractor, Arizona, x1600, 11.5 out of 10 seeing !



Mars by Mark Deprest, 8 inch SCT , x338, Meade 25A red filter, From Mark's backyard

This Month:

May 15 - Public Star Party at Peach Mountain Observatory – The Moon is new and at perigee. Don't worry observe happy.

May 21 - Meeting at 807 Dennison - Mark Deprest will speak on Yesterday's Constellations. If it's clear after the meeting we will witness the Moon occult Regulus. Disappearance (past midnight) 12:11 am and reappearance at 1:12 am EDT.

May 22 - It's National Astronomy Day and we are celebrating at an Open House at the Leslie Science Center starting at Sunset.

May 23 - ATM Group Mtg

Next Month:

June 12 - Public Star Party at Peach Mountain Observatory – Venus is just past greatest east elongation and is at a whopping –4.3 mag !

June 18 - Meeting at 807 Dennison - We'll keep you informed just as soon as we figure it out.

June 19 - Public Star Party at Peach Mountain Observatory – It's OK to come late as the twilight will be doing the same two days before the Summer solstice.

June 20 - ATM Group Mtg

Musings of an Armchair Astronomer

By Lorna Simmons

How did our earliest forebears get by without the Uranometria 2000.0 (Volume 1 and Volume 2)? Or The Deep Sky Field Guide to Uranometria 2000.0? Or the Cambridge Star Atlas 2000.0? Or the Cambridge Star Atlas, Second Edition? Or Norton's 2000.0? Or Sky Catalogue 2000.0? Or Starlist 2000? Or the Millenium Star Atlas (with stellar data in compressed binary format from the Hipparcos and Tycho Catalogues)? Or the three-volume Burnham's Celestial Handbook, complete with verse? Or any of the various computer programs to make your celestial voyage pleasant? You name it. The ancients did not have it. What did the ancient astronomers do without Wil Tirion?

Whatever it was that the ancients did, they did it very, very, very slowly. They made up stories about the sky and the stars, perhaps to help memorize the positions of the constellations, perhaps for some other arcane reason. Whatever. They left few messages for us. Some of the stories passed down by these ancients still persist to this day and we have their constellations, as a result of their efforts, to which we have added the rest of the constellations to make up the complete sky. Astronomy is ancient and we owe much to ancient astronomers for their efforts.

Next time you are out in the boondocks and you look up at the sky (if the sky is clear - this is Michigan, you know), think about what you would have been able to do without your planisphere, without your telescope or binoculars, without your star charts, without your Telrad, without your CCD cameras, without your watch (do not forget your watch), without your filters, without your whatever - without any aids at all. Pretend that you know nothing at all about the sky. Notice that the stars seem to be floating slowly by above your head from east to west. Some of the stars seem to stay in sight and seem to rotate around some central position which you may want to call "north" or "south," or some other fanciful alternate name. Some of the brightest objects often change position and move backward with relation to the rest of the stars from month to month. You would see the sky most definitely moving with these few outlaws breaking the rules of the sky. Would you not think it was strange if anybody said that the earth was rotating instead of the sky? Is it not perfectly obvious that the sky is moving and the earth is standing still? Without a doubt! After all, you do not feel the earth moving. It is also perfectly obvious that the earth is flat, for that matter, and that the sun during the day and the stars at night simply float past and disappear at the horizon. Where they go, you will never know.

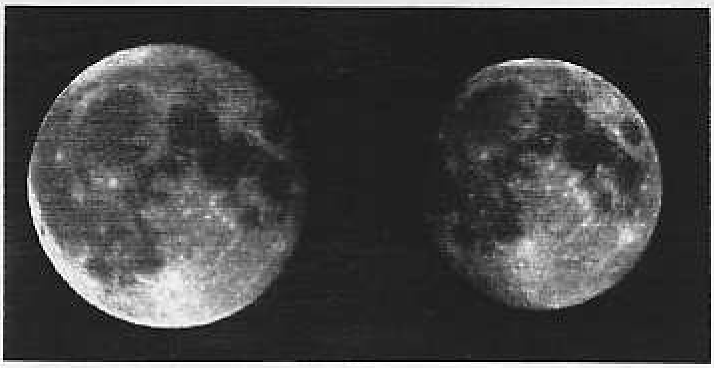
Now, go back to the first time in your life that you first saw any stars and try to remember what it was that grabbed your attention? I remember all of this when I was three years old, and I never forgot anything about that night! I am certain that, if you were like me, you would have been awestruck. If you were like me, you would have had this urge to find out what those bright lights were. How did they get there, in the first place? I cannot imagine any other thought as a first thought about the stars, unless, of course, you saw the Milky Way in its full glory! Then, you would most definitely have been awestruck. Out of your gourd! Perhaps you would have been fearful, because, after all, The Galaxy is a truly magnificent sight to behold! Awe-inspiring! I remember my thoughts upon first viewing the Milky Way in its complete splendor. I long to see it again, but the light pollution prevents this.

Do you remember how you first began to make sense of this wonderful sight? Early humans did, but most of their ideas were wrong. Nevertheless, these wrong ideas seemed to work for them to help with their attempts in understanding the positions of the stars on the sky. When we look at the sky, we see it as the ancients saw it. We do not imagine what is actually happening. We treat the stars, the Messier objects, the NGC objects, everything in the sky, as if they are slowly passing overhead. We sense (even though we know it is incorrect) that the earth upon which we are standing is stationary; we do not feel it moving. Of course, the stars appear to be traveling past us in the sky. This is the way it all appears to us, the observers. How could any thinking individual come to any other conclusion?

Thankfully, some of our ancestors thought differently. However, if you were to think otherwise at certain times during the history of humankind, you might have been burned at the stake, like Giordano Bruno. You could have been put under house arrest, as was Galileo Galilei for promoting the ideas of Nicolaus Copernicus. Copernicus, himself, was smart enough to keep it all to himself! He arranged for his ideas to be published when he was on his deathbed. No martyr, he! All brain!

However, even Copernicus was wrong. Even Galileo was a little wrong! Tycho Brahe had another idea about the movement of the solar system which had the earth at the center with the moon traveling around the earth, but with everything else (stars and all) moving around the sun. Of course, we know this was wrong. Wrong, wrong, wrong! Johannes Kepler, who worked for Brahe, got the brilliant idea that the planets moved in ellipses with the sun at one of the foci. Do you think that he could get Galileo to believe in that? Of course not! Was it not perfectly obvious that the celestial objects moved in perfect circles? Of course! I have not mentioned the failed theories of Aristotle and Ptolemy. In their time, these theories were very useful constructs for understanding the positions of the celestial objects on the "Celestial Sphere."

Now, as you stand and wonder while your are looking up, remember how marvelous it is to live today, with so much knowledge and without the strictures which would prevent creative thoughts from passing through your conscious mind. In addition, you can continue on to contemplate white dwarfs, neutron stars, black holes, blazars, quasars, the collapsing universe, the accelerating universe, even, if you prefer, the steady state universe, without a worry in the world. Nobody is going to take you to the "funny farm" or burn you at the stake for having weird, unconventional, ideas about the cosmos. Enjoy! But do not forget to check them out.



Inconstant Moon

The Moon at Perigee and Apogee

By John Walker, May 1997,

A public domain article at http://www.fourmilab.to/earthview/moon_ap_per.html

One of my favorite science fiction stories is Larry Niven's *Inconstant Moon*, about a night when the full Moon shone brighter than ever before. I won't say any more about the story so as not to spoil it for those who have yet to discover this most atypical gem in Niven's vast treasure chest. Find it; read it; enjoy!

Everybody notices the phases of the Moon, but to most people every full Moon is alike--the rising or setting Moon looks large due to perspective's playing tricks on the eye, but surely the full Moon high in the sky is always the same, right? Wrong.

One of the most spectacular phenomena in naked-eye astronomy escapes notice by the vast majority of people simply because the eye and brain can't compare the size and brightness of objects observed on separate occasions. This page explores the inconstant Moon in our everyday sky. While not as dramatic as that conjured up by the imagination of Larry Niven, we'll discover in it a celestial phenomenon seen by everybody, yet *observed* by only a few individuals.

Earth's Eccentric Companion

The Moon's orbit around the Earth is elliptical, with a substantial eccentricity (as major Solar System bodies go) of 5.49%. In addition, the tidal effect of the Sun's gravitational field increases the eccentricity when the orbit's major axis is aligned with the Sun-Earth vector or, in other words, the Moon is full or new.

The combined effects of orbital eccentricity and the Sun's tides result in a substantial difference in the apparent size and brightness of the Moon at perigee and apogee. Extreme values for perigee and apogee distance occur when perigee or apogee passage occurs close to new or full Moon, and long-term extremes are in the months near to Earth's perihelion passage (closest approach to the Sun, when the Sun's tidal effects are strongest) in the first few days of January.

The image above shows how strikingly different the Moon appears at a full-Moon perigee and apogee. Most people don't notice the difference because they see the Moon in a sky that offers no reference by which angular extent may be judged. To observe the difference, you have to either *make* a scale to measure the Moon, or else photograph the Moon at perigee and apogee and compare the pictures, as I've done here.

The following table shows larger images of perigean and apogean full Moons, with details of the position of the Moon at the moment the pictures were taken. If your screen can't display the images one above another, use the side by side image above to appreciate the difference in size. *[Do use the image at the beginning of this article – Ed]*

Views from Mill Valley, CA, USA, 37°54' N 122°32' W; all times UTC

Perigee

Date/time: 1987 August 10 08:00
Julian day: 2447017.83

Moon:	Age: 15 Days, 19 Hours Phase: 98% Full: 1987 August 9 10:18 Perigee: 1987 Aug 8 19:00, 357643 km
Geocentric:	Distance: 359861 km Right ascension: 22h 12m Declination: -14° 7.1'
Topocentric:	Distance: 359000 km Angle subtended: 0.5548° Altitude: 60.16° Azimuth -68.13°

Apogee

Date/time: 1988 February 2 06:00
Julian day: 2447193.75

Moon:	Age: 14 Days, 5 Hours Phase: 99% Full: 1988 February 2 20:52 Perigee: 1988 February 3 10:00, 406395 km
Geocentric:	Distance: 405948 km Right ascension: 8h 37m Declination: +22° 30.1'
Topocentric:	Distance: 404510 km Angle subtended: 0.4923° Altitude: 35.45° Azimuth -22.01°

Are the Pictures Accurate?

Since we can determine the position of the Moon at the time the exposures were made, it's possible to verify whether the resulting images agree with our calculations. To do this, we first measure the size of the Moon's disc in the perigee and apogee images, then compute the size ratio. This should agree, within the accuracy of the measurement, with the ratio of angular sizes computed from the distance of the Moon when the respective photos were shot.

To avoid errors due to the Moon's not being perfectly full in either of the images, we'll measure the vertical extent of the disc, which is fully illuminated. Due to its inherent roughness, resolution limits of the optics and film, and distortion caused by turbulence in the Earth's atmosphere ("seeing"), the Moon's limb is not perfectly sharp in these pictures, so some judgement enters into the measuring process. Trying to use a consistent ratio of brightness on the two images, I measure the Moon in the perigee image to be 363 pixels high and the Moon at apogee to be 323 pixels, yielding a perigee/apogee ratio of 1.1238. I believe these size estimates are correct within ±1 pixel, giving tolerance limits on the ratio of 1.1173 to 1.1304.

For sufficiently small angles, the sine of an angle is approximated closely by the angle in radians. The Moon's angular extent viewed from Earth is small enough that this approximation is adequate for this calculation, so we can simply use the ratio of viewing distances as a proxy for the Moon's angular size. Dividing the perigee distance by that of the apogee gives 405948/359861 = 1.1281, in close agreement with the ratio of image sizes.

But we can do better than this: the perigee and apogee distances are calculated based on the distance between the *centres* of the Earth and Moon. Now from any sufficiently distant viewpoint the distance to the Moon's limb is essentially the same as that to its centre, but an observer on the surface of the Earth is necessarily closer to the Moon than the centre of the Earth. While the Earth's surface is not an ideal place to do astronomy, it sure beats setting up your telescope at the Earth's core, where 6378 km of rock attenuates even the brightest moonlight something terrible! So, what we're really interested in is not how far the Moon was from the centre of the Earth (its *geocentric* coordinates), but how far it was from the *telescope* when each picture was made. This is not an insignificant consideration: an observer at the equator observing the Moon at zenith is 1.8% closer to the Moon's limb than an observer 90° east or west in longitude, watching the Moon set or rise at the same moment.

What we want, then, is the position of the Moon relative to the observer, its *topographic coordinates* for the observing site. An easy way to calculate this is to transform the Moon's position in the spherical geocentric coordinate system into rectangular (Cartesian, or *XYZ*) coordinates with the origin at the centre of the Earth. The observer's position in the same coordinate system is easily calculated from the latitude and longitude of the observing site and, if you want to be as precise as possible, the distance from the centre of the Earth to the observing site, taking into account the Earth's ellipsoidal shape and the site's altitude above mean sea level. Then the distance from the observer, (X_O, Y_O, Z_O), to the Moon, (X_M, Y_M, Z_M), can be calculated with the distance formula for rectangular coordinates:

Sense of Scale - The Earth-Moon System to Scale, 650 km/pixel

$$\sqrt{(Xm-Xo)2 + (Ym-Yo)2 = (Zm-Zo)2}$$

This calculation gives an observer to Moon's limb distance of 404510 kilometres for the apogee image and 359000 km for the perigee image, with a perigee to apogee ratio of 1.1268, even closer to the best estimate of the image size ratio, 1.1238.

Space is called "space" because there's so much *space* there. Astronauts who flew to the Moon were struck by how the Earth and Moon seemed tiny specks in an infinite, empty void. So large are the voids that separate celestial bodies that most illustrations exaggerate the size of the objects to avoid rendering them as invisible dots. Compared to most other moons in the Solar System (Pluto's moon Charon is a notable exception), the Earth's Moon is very large compared to the planet it orbits, so it is possible, just barely, to draw the Earth-Moon system to scale in a form that will fit on a typical computer screen. The image above shows the Earth at the left and the Moon at the right, as they would appear to an observer looking from the direction of the Sun when the Moon is at first quarter; both worlds are fully illuminated (as is always the case when viewing from sunward, of course), and the Moon is at its maximum elongation from the Earth. Earth's orbital motion is toward the left, with the arrow at the top showing how far the Earth and Moon travel along their common orbit about the Sun every hour.

On this scale, all human spaceflight with the exception of the Apollo lunar missions has been confined to a region of two pixels surrounding the Earth: seeing the Moon's orbit in its true scale brings home how extraordinary an undertaking the Apollo project was. Of all the human beings who have lived on Earth since the origin of our species, only 24 have ventured outside that thin shell surrounding our Home Planet. Even the orbit which geosynchronous communications satellites occupy is only a little more than a tenth of the way to the Moon.

The mean distance to the moon, 384401 km, is the semimajor axis of its elliptical orbit. The closest perigee in the years 1750 through 2125 was 356375 km on 4th January 1912; the most distant apogee in the same period will be 406720 km on 3rd February 2125 (have your camera ready!). These extrema are marked on the chart, although in reality extreme perigees and apogees always occur close to a new or full Moon, not at a quarter phase as illustrated here. The mean distance is not equidistant between the minimum and maximum because the Sun's gravity perturbs the orbit away from a true ellipse. Although the absolute extremes are separated by many years, almost every year has a perigee and apogee close enough to the absolute limits to be indistinguishable at this scale.

The Moon's orbit is inclined 5.145396° with regard to the ecliptic (the plane in which the Earth's orbit around the Sun lies or, more precisely, the plane in which the centre of gravity of the Earth-Moon system [its *barycentre*] orbits the Sun), so as seen from the centre of the Earth the Moon drifts up and down slightly more than five degrees in the course of each orbit. The dark grey wedge shows the limits of the Moon's excursion above and below the plane of the ecliptic.

The Moon's orbital inclination, combined with the inclination of the Earth's axis of rotation, causes the Moon's declination, as observed from the Earth, to vary between ±28.5° when the Moon's inclination adds to that of the Earth, and ±18° when the two inclinations oppose one another; the maxima and minima of declination repeat every 18.6 years, the period in which the ascending node of the Moon's orbit precesses through a full circle.

How Bright the Moonlight?

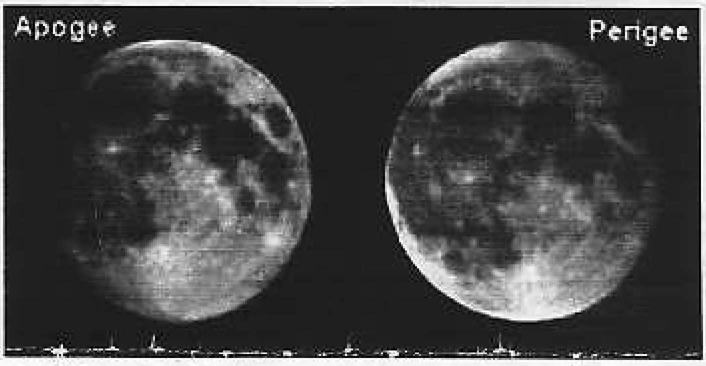
When the Moon is full near perigee, you'd expect it to be brighter than a full Moon near apogee and it is: *lots* brighter; let's figure out how much. Since the Moon shines by reflecting sunlight (not very well–it reflects only about 7% of the light that strikes it, comparable to a lump of coal) the following two factors determine the intensity of moonlight at the Earth:

1. The intensity of sunlight striking the Moon.
2. The distance reflected light travels from the Moon to the Earth.

Since the difference between the minimum and maximum distance of the Moon, 50345 km, is an insignificant fraction of the average distance from the Sun to the Earth and Moon, 149597870 km, the intensity of sunlight at the Moon can be considered constant and ignored in this calculation. (Sunlight intensity at the Moon does vary, of course, due to the eccentricity of the Earth's orbit around the Sun, but we'll ignore that smaller annual effect here since we're concentrating on lunar perigee and apogee.) The intensity of light varies as the inverse square of the distance between a light source and the observer, so taking the ratio between the perigee and apogee distances in the photographs above as typical, the distance at apogee was 1.1363 times the perigee distance, and hence the Moon's intensity at perigee was the square of this quantity, 1.2912 times brighter--about 30%. Using the long-term extremes plotted in the drawing in the previous section yields only a slightly greater intensity difference: a distance variation of 1.1413, with the Moon shining 1.3026 times brighter at perigee.

Like the variation in angular size, few people ever notice this substantial difference in the intensity of moonlight at perigee and apogee because there's no absolute reference against which to compare them. If you could flick a switch and move the Moon back and forth between apogee and perigee, the difference would be obvious, though not as evident as you might expect from a 30% change in illumination due to the logarithmic response of the human eye. Another document on this site discusses the differences between the linear response of photographic film and electronic sensors as opposed to the human eye, and how computer image processing techniques can allow producing images that approximate visual perception.

An interesting project would be to photograph the same landscape with identical film, lens, and exposure at lunar perigee and apogee and compare the resulting images. If you're interested in doing this with conventional film photography, be sure to use reversal transparency (colour slide) film rather than negative print film. Unless you have control of the entire process of development and printing, the automatic balancing done by photo labs, combined with the great latitude of print film, intended to compensate for non-optimal exposures, will hide the difference in illumination. With slide film, the negative directly reflects the light intensity of the exposure and should show the difference between moonlight at perigee and apogee. If you undertake this experiment, concentrate on making the exposures as close as possible to the same interval before or after the full Moon as opposed to aiming for the precise moment of perigee or apogee. The Moon brightens dramatically when full--it is more than twice as bright at the moment of fullness than only 2½ days before or afterward. A slight difference in phase can swamp the more subtle and slowly changing brightness due to the Moon's distance, yielding misleading results.



A Different Point of View

You may have noticed while examining the pictures above that the two images of the Moon differ not only in size, but in the position of features on the disc of the Moon. This might seem puzzling in light of the frequently-stated assertion "the Moon always keeps the same face toward the Earth". But this generalisation is not strictly true; in fact, the combination of the eccentricity and inclination of the Moon's orbit causes the Moon, as seen from the Earth, to nod up and down and left and right. These apparent motions, the lunar *librations*, allow us to observe, over a period of time, more than 59% of the Moon's surface from the Earth, albeit with the terrain in the *libration zones* near the edge of the visible disc, only very obliquely.

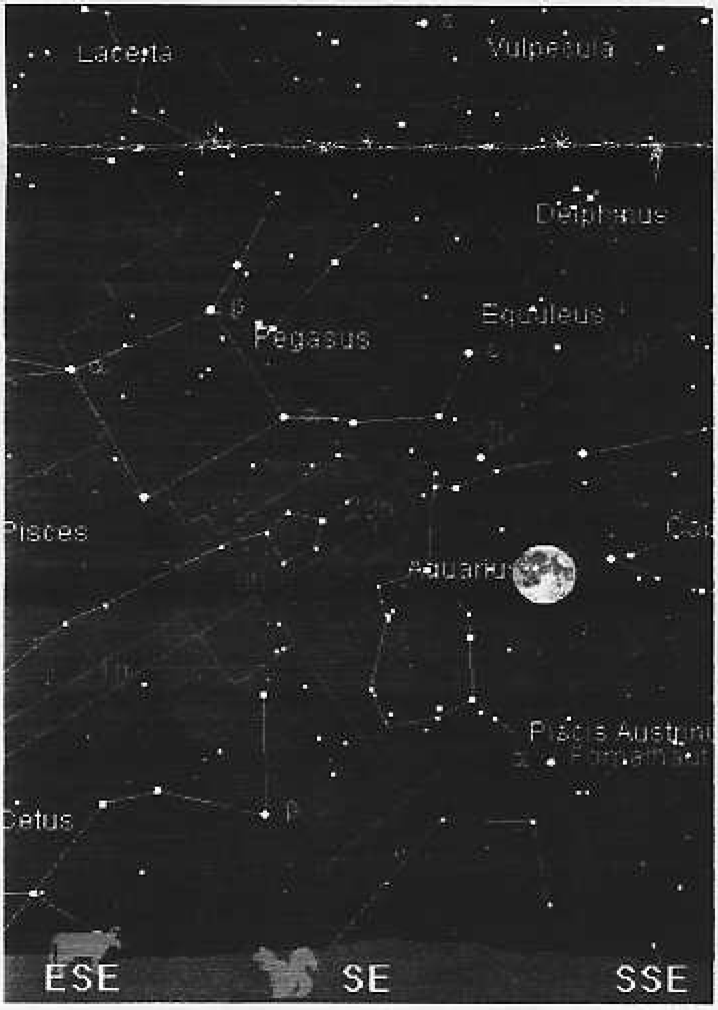
In the image at left, I've rescaled the perigee and apogee images so both are the same size, and combined them into an image which blinks back and forth for easier comparison. (If the image doesn't blink, your Web browser doesn't support GIF animations; click on the image to view a side-by-side image for comparison, then use your browser's "Back" button to return here. If the blinking image annoys you, your browser's "Stop" button should make it stop blinking.)

As the image blinks from the apogee to perigee view, the Moon appears to rotate around *Mare Crisium*, the dark circle near the upper right (northeast) limb of the Moon. To understand the difference in the appearance of the Moon in these two images, consider the position of the Moon with respect to the Earth as shown in the following charts prepared with Home Planet (http://www.fourmilab.to/homeplanet/). You can produce your own custom sky maps and horizon images on the Web with our *Your Sky* (http://www.fourmilab.to/yoursky/) page.

The light blue line is the *celestial equator*, the projection of the Earth's equator onto the sky. The red line marks the *ecliptic*, the plane in which the Earth orbits the Sun. At the time the perigee picture was taken, the Moon was south of the ecliptic due to its position along its inclined orbit, and as a result, observers on Earth at that time were looking down onto the Moon's north pole, with the Moon's equator appearing below the middle of the visible disc. Since the Moon was, at that moment, south of the equator as seen from Earth, an observer in the northern hemisphere was additionally displaced northward and could see farther past the north pole of the Moon.

At the time of the apogee photo, the situation was the opposite; the Moon was both above the ecliptic and 22½° north of the celestial equator. Consequently, observers on Earth saw the south pole of the Moon tilted toward them, with the lunar equator displaced toward the northern limb of the Moon.

In addition to the north-south displacement due to the inclination of the Moon's orbit, the eccentricity of the Moon's orbit creates an east-west displacement. The rate at which a massive solid body such as the Moon rotates with respect to the distant stars is, for all practical purposes, constant. Since the Moon's is tidally locked to the Earth, it rotates on its axis in a time equal to the time in which it completes an orbit around the Earth. Observers on Earth view the Moon not from the centre of a circle, however, but from a focus of its elliptical orbit. When the Moon is closer to the Earth, around perigee, its orbital motion is faster and carries it past the Earth faster than its constant rotation speed. When the Moon is near apogee, its slower orbital motion causes the rotation to get ahead of the orbital mo-



Perigee: 1987 August 10

Apogee: 1988 February 2

tion, revealing terrain on the other side of the mean limb.

The bright crater Tycho near the southern limb of the Moon makes a convenient marker; notice how much more terrain to the south of that crater is visible in the apogee image.

Finally, the difference in the illumination of the Moon is due to the perigee picture's being taken almost a day after full Moon, as compared to the apogee picture, exposed 15 hours before the Moon was full. Practical considerations such as the Moon's position in the sky, the time of sunset and sunrise, and the need for clear skies usually require compromises which prevent capturing the Moon at precisely the moment it is full. The brightness of the Moon varies dramatically around the time of full Moon; as is evident from these pictures, the difference in appearance less than a day on either side of full is readily perceptible.

Tips for Perigee and Apogee Chasers

If you're interested in making your own photographs of the Moon at perigee and apogee, or just observing the Moon visually, perhaps with a ruler held at arm's length to gauge its angular size, visit our Lunar Perigee and Apogee Calculator (http://www.fourmilab.to/earthview/pacalc.html) which, assuming your Web browser supports JavaScript, will prepare a list of closest perigees and farthest apogees for any given year, along with the interval separating each perigee or apogee from the nearest new or full Moon.

As with most projects in amateur astronomy, unless you're a full-on fanatic (you know, the kind who would go all the way to Australia to get a glimpse of Halley's Comet near perihelion--*gosh* it was hot and dry out there in the outback!) you have to compromise between the ideal situation and the constraints of real-world observing conditions. Our calculator will show you the various photo opportunities available in the coming months and years; you'll notice that more apogees occur close to extreme distances than perigees. If you want to make perigee and apogee pictures which are easily compared, you're better off choosing perigees and apogees as close as possible to full Moon (or close to the same time before or after full phase) rather than focusing on the moment of perigee or apogee with substantially different phase; as you can see from the pictures above, even over a relatively small interval around full Moon the appearance of the Moon changes noticeably, which may obscure, in part, the essential difference between perigee and apogee.

Never trust the weather forecast! If it's clear the night before the optimal full Moon at perigee or apogee, take some "just in case" shots so you don't come up empty-handed if the fog rolls in or a thunderstorm brews up before sunset on the night you planned to photograph the Moon. The images in this document are, in fact, all "contingency samples", made in one case the night before fog wiped out my planned observing session and, in the other, the night after.

Details

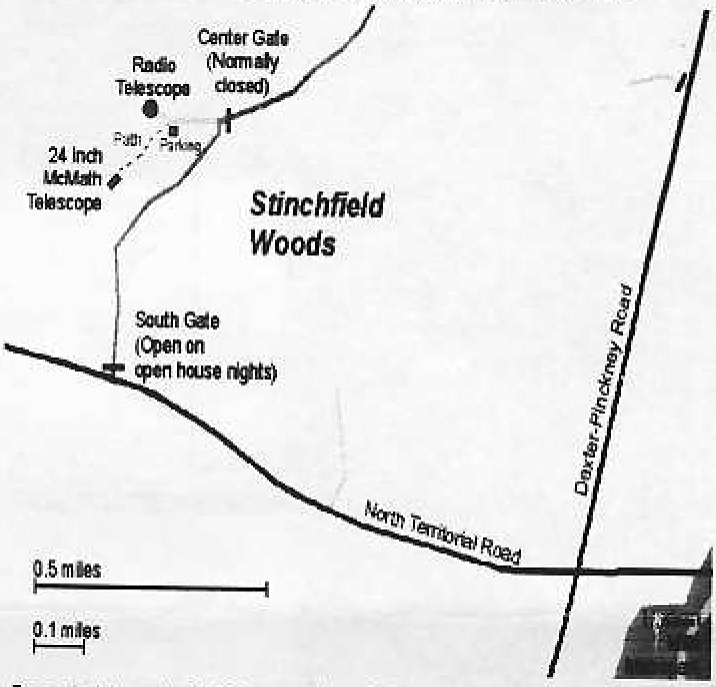
All photographs were made with a VERNONscope Brandon 80 mm apochromatic refractor and a Nikkormat camera body. Perigee exposures were made on Kodak Tri-X (ASA 400, emulsion TX5063) film, and apogee exposures on Kodak Plus-X (ASA 100, emulsion PX5062) film; both black and white negative films. Exposure times were bracketed over a wide range and the best chosen by examination of the negatives; no record of exposure time was made. The slower Plus-X film was chosen for the apogee exposures after examination of the perigee film showed that only the shortest exposures yielded usable negatives.

The best negatives, chosen by examination under a magnifier on a light table, were transferred to a Kodak Photo CD, from which the images were viewed with the imgview utility on a Silicon Graphics Indigo^2 workstation. Selected images were then extracted into bitmaps at "Level 4" (1536×1024 pixel) resolution. The contrast and brightness of the images were adjusted to facilitate comparison and improve appearance on computer displays limited to 256 shades of grey, and the apogee image was passed through a moderate high-pass sharpening filter to enhance detail in the smaller image. The images were not adjusted in scale: they correspond pixel-by-pixel to the contents of the original negatives. All image size measurements were made on the original, unprocessed images, viewed directly from the Photo CD.

Using a Photo CD to transfer the images from the original negatives to the computer preserves far more of the light intensity range than making a print from the negative and scanning it. In addition, you're guaranteed the negatives will be transferred with a uniform scale. If you have prints made by a commercial lab, you may discover, especially if they're done months apart as is often the case when chasing perigees and apogees, that the negatives have been printed at sufficiently different magnifications as to render comparison impossible. Unless you make the enlargements yourself with uniform magnification, there's no way to be absolutely sure the image size on the prints corresponds to the scale of the image on the negative. The automated scanning process used to create a Photo CD guarantees identical scale, especially if you have all the negatives scanned in one batch.

Places and Times:

Dennison Hall, also known as The University of Michigan's Physics and Astronomy building, is the site of the monthly meeting of the University Lowbrow Astronomers. It is found in Ann Arbor on Church Street about one block north of South University Avenue. The meeting is held in room 807. Monthly meetings of the Lowbrows are held on the 3rd Friday of each month at 7:30 PM. During the summer months, and when weather permits, a club observing session at Peach Mountain 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 inch telescope which is maintained by the Lowbrows. The observatory is located northwest of Dexter. The entrance is on North Territorial Road, 1.1 miles west of Dexter-Pickney Road. A small maize-and-blue sign marks the gate. Follow the gravel road one mile to a parking area near the radio telescopes. Walk along the path between the two fenced in areas (about 300 feet) to reach the McMath telescope building.

Public Star Parties:

Public Open House/Star Parties are held on the Saturday before and after each new Moon at the Peach Mountain Observatory. Star Parties are canceled if the sky is cloudy at sunset or the temperature is below 10 degrees F. Call 480-4514 for a recorded message on the afternoon of a scheduled Star Party to check on the status. Many members bring their telescopes and visitors are welcome to do likewise. Peach Mountain is home to millions of hungry mosquitoes - bring insect repellent, and it does get cold at night so dress warmly !

Amateur Telescope Making Group meets monthly, with the location rotating among member's houses. See the calendar on the front cover page for the time and location of next meeting.

Membership:

Membership dues in the University Lowbrow Astronomers are $20 per year for individuals or families, and $12 per year for students and seniors (age 55/+). This entitles you to the monthly REFLECTIONS newsletter and the use of the 24" McMath telescope (after some training). Dues can be paid to the club treasurer Doug Scobel at the monthly meeting or by mail at this address:

1426 Wedgewood Drive
Saline, MI 48176

Magazines:

Members of the University Lowbrow Astronomers can get a discount on these magazine subscriptions:

Sky and Telescope: $29.95 / year
Astronomy: $27 / year
Odyssey: $16.95 / year

For more information contact the club Treasurer. Members renewing subscriptions are reminded to send your renewal notice along with your check when applying through the club Treasurer. Make the check payable to "University Lowbrow Astronomers".

Newsletter Contributions:

Members and (non-members) are encouraged to write about any astronomy related topic of interest. Call or E-mail to Newsletter Editors at:

Bernard Friberg (743)761-1875 Bfriberg@aol.com
Chris Sarnecki (734)426-5772 chrisandi@aol.com

to discuss length and format. Announcements and articles are due by the first Friday of each month.

Telephone Numbers:

President:	Mark Deprest	(734)662-5719
Vice Presidents:	Lorna Simmons	(734)525-5731
	Dave Snyder	(734)747-6537
	Paul Walkowski	(734)662-0145
Treasurer:	Doug Scobel	(734)429-4954
Observatory Director:	Bernard Friberg	(734)761-1875
Newsletter Editors:	Chris Sarnecki	(734)426-5772
	Bernard Friberg	(734)761-1875
Keyholders:	Fred Schebor	(734)426-2363
	Mark Deprest	(734)662-5719

Lowbrow's Home Page:

http://www.astro.lsa.umich.edu/lowbrows.html

Dave Snyder, webmaster
http://www-personal.umich.edu/~dgs/lowbrows/

Monthly Meeting

May 21, 1999, 7:30 pm

Room 807 Dennison Hall

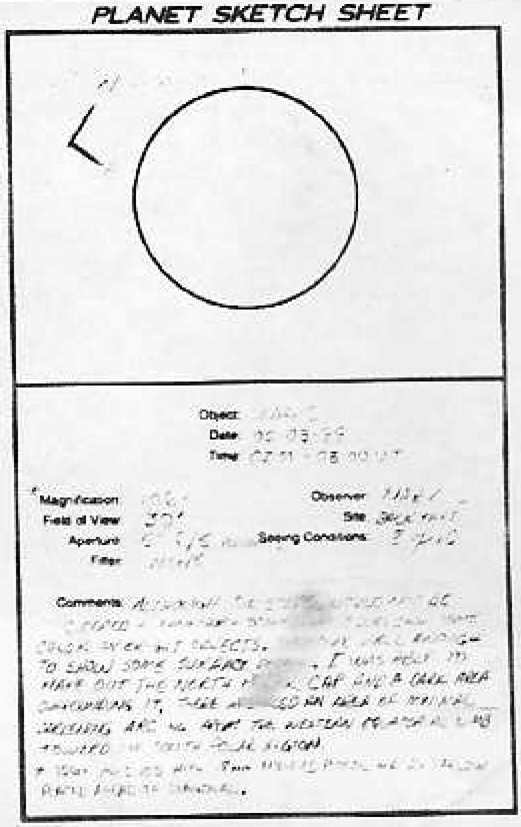
Physics & Astronomy Building

The University of Michigan

Mark Deprest

Presents

Yesterday's Constellations



University Lowbrow Astronomers

Ann Arbor, Michigan

UNIVERSITY LOWBROW ASTRONOMERS
3684 Middleton Drive
Ann Arbor, Michigan 48105

DETROIT MI 482 PM 17 MAY 1999

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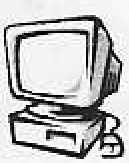

Lowbrow's WWW Home Page:
www.astro.lsa.umich.edu/lowbrows.html

Check your membership expiration date on the mailing label!

48105/2022