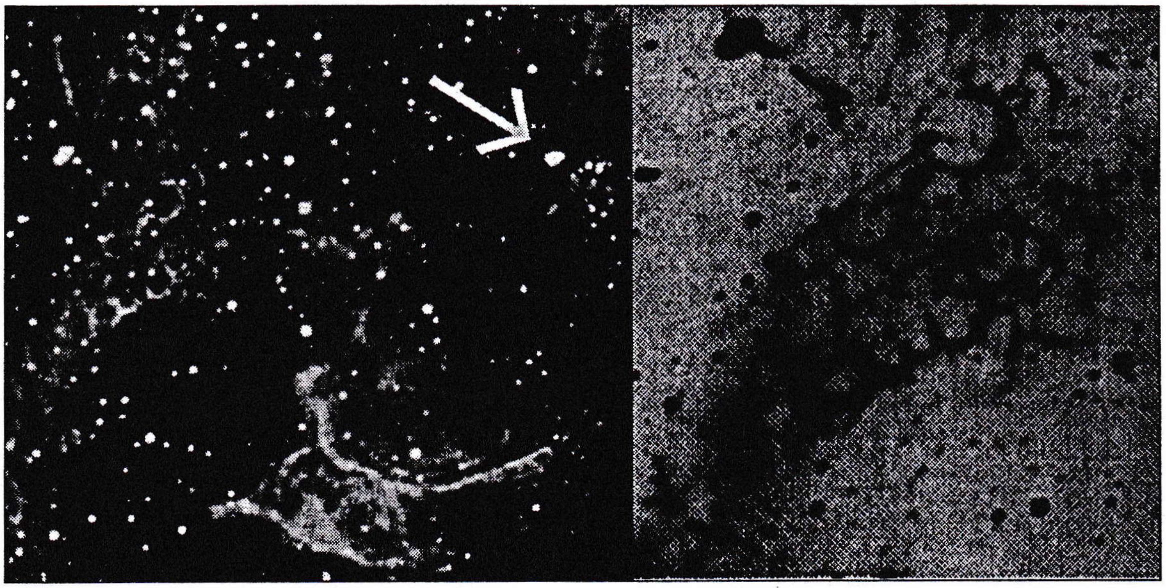
REFLECTIONS



An Hα image of a cluster of bubbles, each ca. 10 LY across, near SN 1987A (arrow) in the Large Magellanic Cloud. Discovered by Lifan Wang of the University of Manchester with the European Southern Observatory's New Technology Telescope in La Serena, Chile.

July 1993

Kurt Hillig
Editor

Of the University Lowbrow Astronomers

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 Detroit Observatory at the corner of Observatory and Ann Streets in Ann Arbor. Meetings begin at 7:30 PM and are open to the public. Public star parties are also held twice a month, at the University's Peach Mountain Observatory on North Territorial Road (1.1 miles west of Dexter-Pinkney Road; map on page 7) on the Saturdays before and after the new moon; the star party is cancelled if it's cloudy at sunset. For further information, call Stuart Cohen at 665-0131.

This Month:

July 16 - Meeting at the **Detroit Observatory** in **Ann Arbor**. Our own Tom Ryan on "The Amazing Stepper Motor" - a look at what makes scope drive systems work.

July 17 - Public Open House at the **Peach Mountain Observatory**. Uranus is just past opposition, and should be an easy target for the 24". Rumor has it the digital setting circles are working!

July 20-21 – Iapetus Eclipsed by Saturn. Story inside!

July 24 - Public Open House at the **Peach Mountain Observatory**. Who cares if it's cloudy? The mosquitos are collecting blood for the Dexter chapter of the Red Cross....

Cheaper Than Truth!

Do you have one of those older-style tripods made of wood? Do the legs slide together when you adjust them for height? Do they then slide together when you're trying to use them because the bolts just can't be tightened enough before they start to rotate in their holes? Then you have a tripod just like everybody else's! To keep the bolts from turning, get some perforated plumbers strap (or drill a hole in a piece of band steel). Put the bolt through the hole in the strap, through the tripod and attach the nut. Then bend the end of the strap up over the bolt head and mash it down with a hammer. Bend the other strap end down around the tripod leg. Now the bolt head cannot turn. To tighten the bolt securely, even with gloves on, replace the hex nut or small wing nut with an extra-large wing nut found at specialty hardware stores. Not only are regular small and large wing nuts available, but they come in metric sizes also!

Next Month and Beyond:

August 1 - Computer Subgroup Meeting at **Tom Ryan's** house. Call him at 662-4188 for directions.

August 9 - Newsletter Submission Deadline I'm on vacation the first week of August so I won't be around to harass people about subgroup reports, star charts, speakers and titles, etc. You've been warned – no excuses will be accepted!

August 11-12 - Perseid Meteor Shower! No guarantees, but there's a good chance of a major meteor storm this year.

August 14 - Public Open House at the **Peach Mountain Observatory**. Jupiter's heading toward oblivion in the west, but Saturn should be ready for some prime-time viewing.

August 20 - ☆ Meeting / Picnic at **Peach Mountain ☆**

August 21 - Public Open House at **Peach Mountain**.

August 24 - Mars Observer, Mars Orbit Insertion. We can't exactly *see* it, but I thought you'd like to know....

September 1 - Computer Subgroup Meeting

"The accolades for my accompishments are misplaced. I do not know what I may appear to the world; but to myself I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me."

"If I have seen farther than others, it is because I stood on the shoulders of giants."

– Sir Isaac Newton

Attitude Control Systems

by David Ward
NASA / Goddard Space Flight Center, Greenbelt, MD

(And no, D.C., this is *not* about the beer at the Brown Jug!) Ever wonder just how those weather and spy satellites, deep space probes, etc. manage to keep working for decades – always able to point at what they're supposed to be looking at without running out of fuel? There was a discussion on the network several weeks ago about the Hubble Space Telescope and its pointing control system, and I managed to persuade one of the more intelligible correspondents to provide more details....

Modern spacecraft Attitude Control Systems (ACS) have evolved dramatically over the past thirty years. Early spacecraft used simple spin techniques to maintain boresight pointing to within a few degrees. This basic design, which used stored angular momentum to provide gyroscopic stiffness to early spacecraft, required few components for control, and was a relatively lightweight, reliable design. This system is the basis of one type of ACS system, called a *momentum bias* spacecraft. Momentum biasing is effective in providing a low-cost spacecraft that can point to within a few tenths of a degree.

On the other hand, many missions require pointing that is dramatically more stable than a momentum bias can provide. Usually these missions (which tend to be scientific telescopes or similar instruments) require arcsecond pointing accuracy and stability, as well as the ability to point at several different targets in a short period of time. These requirements are best served by a *zero-momentum* spacecraft, which attempts to keep its overall angular momentum at zero in order to cancel gyroscopic effects. This type of system controls external disturbances actively, by using reaction wheel momentum to counteract the buildup of external momentum due to external torques. Excess momentum is constantly dumped from the spacecraft back to the environment through use of magnetic forces and thrusters.

Although the two types of systems are different, and employ different philosophies regarding spacecraft control, both have some common elements. Generally, similar sensor complements can be used to determine each spacecraft's attitude. Also, similar actuators are used (in different "flavors") to perform the control. Finally, since most momentum bias systems are hybrid passive-active controllers (i.e. controlling is minimized by gyroscopics, which allows for active control similar to a zero momentum system), the actuators share some characteristics. Essentially, both are sized according to the same three disturbance torque sources: aerodynamics, gravity-gradients, and solar pressure.

Since the main purpose of the Attitude Determination subsystem is the same, no matter how simple the controller is, common elements are seen in nearly all spacecraft ACS. Generally, a set of gyroscopes is flown for rate sensing and for attitude propagation. Gyros use the same principle as the momentum biased controller: a spinning mass with a certain momentum will stay fixed in inertial space as the spacecraft rotates, and will require a cross-axis torque to maintain alignment with the spacecraft. The applied torque is measured to give a measurement of the spacecraft's rotation rate. ACS systems typically also include a set of sun sensors, for sun determination (useful for coarse or accurate measurement, depending on the sensor), and an Earth sensor or set of star trackers, depending on the requirements of the mission, in order to provide absolute position information to update the gyros attitude propagation. Finally, a magnetometer is flown to determine the direction and strength local magnetic field around the spacecraft.

The actuator complement is somewhat more a function of the spacecraft's controller and the external environment. As mentioned before, the simplest type of control involves spin stabilization about the prime axis of inertia. In that controller, only thrusters are needed to provide the initial momentum bias. A passive momentum bias system which had to spin about another axis would require a nutation damper, a device which maintains the momentum bias about the preferred spin axis and does not let the spin transfer to the prime moment of inertia (in test airplanes, this is known as a flat spin). Nutation damping requires a simple sensor, such as an accelerometer, and either thrusters or a momentum wheel to continue to maintain the correct momentum.

Active momentum bias systems typically use *momentum wheels* for reactive control and for momentum storage. A momentum wheel is a wheel which is designed to run at a biased speed (around 75% of its maximum speed) in order to hold a momentum bias, but which fluctuates around that speed to counteract torques on the spacecraft. Either magnetic torquer bars or thrusters are used to unload the excess momentum stored as a result of the active control.

Zero-momentum systems generally employ *reaction wheels*, which are similar to momentum wheels except they are designed to operate around zero rotational speed, and can spin in either direction. Additionally, zero momentum systems sometimes (such as the Hubble Space Telescope) must be able to slew from target to target in a short time period. This is accomplished by spinning up the correct reaction wheel, which forces the spacecraft to spin in the opposite direction. As the wheel slows to its original state, the spacecraft's rate also slows. As with momentum bias systems, magnetic torquers or thrusters are used to unload momentum.

Momentum must be unloaded from reaction/momentum wheels because some external torques are secular (i.e. continuously present), and would take all of the momentum storage capacity of most wheels in a few hours. As mentioned above, magnetic torquers are generally used for this purpose in Lower Earth Orbits (LEOs). Magnetic torquers are several windings of wire about a magnetic core (usually bar shaped – hence the name) which provide a magnetic dipole when current is passed through the coils. This dipole reacts with the local magnetic field to provide a torque to the spacecraft. By sensing the spacecraft's momentum buildup and the local field, it is possible to command the bars to provide torque that will allow the wheels to return to their zero-momentum state (thus, "unloading" momentum). This process is very slow, so it is run continuously through spacecraft operations. Spacecraft in Geosynchronous orbits, and deep-space probes, usually use thrusters to unload momentum, since the magnetic field 22,000 miles up or more is not strong enough to unload the momentum buildup.

[NOTE: The simple unloading equations are as follows – use at your own discretion: **H** = spacecraft angular momentum, **B** = local magnetic field, and **M** = magnetorquer's dipole moment; since **T** = **M** x **B** (spacecraft torque, from physics), the desired **M** = **H** x **B** (commanded dipole to unload momentum). I thought I'd add this in, just in case. If you do the vector math, you'll see torque is always in the <u>same</u> direction as the spacecraft stored momentum.

By using this unlimited magnetic torque, the storage capabilities can be relieved.]

Actuators for the different types of ACS are sized according to their external disturbances, which include primarily aerodynamics, gravity gradients, and solar pressure. In LEO orbits (around 100 miles up), aerodynamics and gravity-gradient torques overwhelm solar pressure. Aerodynamics tend to give both cyclic and secular aspects to momentum buildup, and gravity gradient torque will have a cyclical momentum disturbance on a spacecraft. Therefore, the momentum storage capacity on a set of reaction wheels will be determined by the amount of momentum buildup over a certain period, as well as the cyclical momentum storage expected for the orbit (as well as slew rate requirements, if applicable). A set of magnetic torquers, if used, will be sized to provide unloading of the secular momentum buildup. Momentum wheels will be sized to provide enough momentum for necessary gyroscopic stiffness, with margin for active control.

[NOTE: Here's a description of *gravity-gradient torques*: again, use at your own risk. Assume a two-point mass spacecraft, i.e. it looks like a dumbbell. If this spacecraft is in orbit, parallel to the horizon, then both masses are equally distant from the center of Earth, and gravity is the same on both masses. Now, tilt the spacecraft clockwise. The left point mass is now further from the center of Earth – so its gravitational pull is weaker – and the point mass on the right is closer so its pull is stronger. That's G-G torque. Effectively, parallel to the Earth is stable, but it won't stay there (i.e. it's conditionally stable); but perpendicular to the Earth is unconditionally stable. One spacecraft I'm aware of (LDEF) used G-G torque for control, so that it basically flew perpendicular to Earth for its whole mission. Usually, this is not a preferred orbit.]

In the future, ACS systems will continue to use these two systems of control for pointing spacecraft. Current R&D is generally involved with developing better sensors with less noise, and better actuators, which will provide more control torque with less unwanted torque (bearing noise, etc.) at a lighter weight and lower cost. Better computers on spacecraft have allowed ACS engineers to use better algorithms to combine sensor readings for better attitude determination (the Kalman filter). Finally, modern control techniques such as the Linear Quadratic Regular, H space control, neural networks, and other state space controllers are beginning to be considered as a replacement for the PID (proportional-integral-derivative) controller used on most spacecraft. There are many changes required of ACS to keep up with the increasing mission requirements. I hope we can keep up.

Iapetus Eclipse, July 20-21!

Although Saturn is nearing opposition, it's shadow is still offset to one side as seen from Earth. On the night of July 20-21, Saturn's moon Iapetus will pass through this shadow, in an eclipse that will last several hours. It will enter the shadow about 21:30 UT (about 5:30pm EDT), but should exit from Saturn's shadow at about 05:00 UT (1 am EDT) and spend the next several hours drifting through the shadows of the rings. There's more info in the July Sky & Tel.

This will not be an easy visual event; Iapetus in full sunlight is about 11th magnitude, while Saturn is about 0.5 mag. A good CCD camera, possibly even a video camera, should be able to resolve this with care. Accurate photometry by amateurs around the world is expected to help significantly in understanding both the nature of the rings and the detailed orbit of Iapetus. Interested observers are welcome to spend the night on Peach Mountain – call Fred Schebor at 426-2363 to find out who will have the key.

Planet X Nuked!

by Kurt Hillig
and the sci.astro newsgroup

Several years ago I read a Scientific American article titled "Did Galileo see Neptune?", which showed a couple observations Galileo had recorded several nights apart. There was a dot on his drawings that had changed position during the interval, but Galileo did not investigate it as he was concerned with other phenomena - the motions of Jupiter's moons.

The upshot of the article was that this might have been Neptune; but then-current knowledge indicated it could NOT have been, unless there had been several observation errors of Neptune's position since then. But if it wasn't Neptune, what was it?

What happened was that Jupiter did occult Neptune at a time when Galileo was making regular observations of Jupiter's moons and could have seen it. He did see it, and he probably recognized it as something odd - at least, he recorded it as a star, and he did not normally record stars in his drawings - but he was unable to pursue the question further. This was mid-winter, observing opportunities were limited by bad weather... and Galileo's telescope did not have setting circles on it, which meant he couldn't find a faint object like Neptune unless it was very near a naked-eye object like Jupiter.

(There were in fact several later cases of Neptune being mis-recorded as a star. One early star mapper actually noticed that its location didn't match the position he'd recorded the previous day, and carefully corrected his "mistake"!)

The problem is not that it wasn't Neptune - there was nothing else in that position that Galileo could have noticed - but that the best estimates of its position based on Galileo's notes didn't quite match pre-Voyager best estimates of Neptune's orbit. This is rather iffy data in several ways, between limited knowledge of Neptune's orbit (we haven't observed it long enough to see even one full orbit) and the uncertainties involved in converting Galileo's notes into precise positions.

The discrepancy between the calculated orbits of Neptune (and Uranus) with those actually observed - with Galileo's observation providing the earliest and largest discrepancy - has long been considered evidence for "Planet X". This was envisioned as a tenth "large" planet (more than about 3000 km in diameter) beyond the orbit of Pluto.

Recent analysis by Dr. E. Myles Standish from NASA's Jet Propulsion Laboratory indicates that Planet X does not exist. When Voyager 2 made its flybys of Uranus and Neptune in the late 1980's, the superb precision with which its path could be tracked by radio interferometry made it possible to determination the masses of these planets with great accuracy.

When these new measurements of the mass of Neptune are inserted in the equations, the irregularities vanish. The published mass of Neptune is now known to have been off by five-tenths of 1 percent. When the new value for Neptune's mass is factored into the equations, the orbits of the outer planets are shown to be moving as expected, going all the way back to the early 1800's, and Galileo's observation now matches the calculations.

The results of Dr. Standish's analysis are published in the May issue of *The Astronomical Journal.*

Computer Subgroup Report

by Stuart Cohen

A small group (three members) attended the computer subgroup meeting at Paul Etzler's house deep in the woods outside Dexter. While we were waiting for others to arrive, we discussed the wonderful news that the encoders have been installed in the 24" scope on Peach Mountain. The rest of the group, though, was apparently wandering around Parker road – having failed to obtain a map or directions to Paul's house [apologies for having the wrong phone number in last month's *Reflections* - Ed.]. Nevertheless, a good time was had by all, as we participated in the regular " two chip" program. First, the corn chips, dip and pop were served, followed by the silicon chip exercise of viewing the "Voyager" program (also exhibited at last month's club meeting). After some general viewing of deep sky maps and images of various objects, we discovered that an annular solar eclipse will occur nearby, fairly soon. On May 10, 1994 at 12:16 the track of annularity will just about bisect Lake Ontario. This means that unless you have a boat, you should join us in the Toledo town square since that will be the only place it will show up. Even Cleveland, which is right on the Lake, will not be annular – at least if the program is right.

So if you want to be on the forefront of astronomical discoveries like this, come to the next computer subgroup meeting! It will be August 1, 1993 at ??? ?????'s house. Call him for directions if you got lost last time.

Volunteers Needed!

Now that we have an Open House Coordinator, we need people to host the open houses. Host's duties are: 1) Pick up the key and open the gate before sunset; 2) Open the observatory and roll back the roof; 3) Post the signs on North Teritorial Road and on the fence near the parking lot; 4) Have fun, talk to people, look through a scope once in a while; 5) Make sure that the signs are returned, the 24" scope is put to bed and the gate is locked after everyone leaves. If you're interested, call Keith Bozin at 549-9525 (or on CompuServe at 72630,3402)!

Open house dates for July through December:

July	17, 24	New Moon 19 Jul 93
August	14, 21	New Moon 17 Aug 93
September	11, 18	New Moon 15 Sep 93
October	9, 16	New Moon 15 Oct 93
November	6, 13, 20	New Moon 13 Nov 93
December	11, 18	New Moon 13 Dec 93

Dry T-Shirt Contest!

At the June 18 meeting we discussed selling T-shirts as a way to raise some needed extra cash. I was volunteered to organize this project. It was sugested that we come up with two designs – one for ourselves and another for sale at open houses. So, in the true American competitive spirit, I am launching a contest!

The two winning designs will receive free T-shirts (and possibly some other prizes if I stumble across some worthy tokens between now and Judgement day [sic]). The design may contain up to 3 colors and must be easily transfered for silk screening. Judging will take place during the 17 September meeting, so bring your designs to that meeting or arrange to have them there. If you have questions or suggestions, call Keith Bozin at 549-9525.

Perseid Storm Coming?

Excerpted from press notice PN93/4 from the Royal Astronomical Society News and Information Service, 17 May 1993

Two astronomers from the University of Western Ontario in London Ont., Canada, are warning of the potential danger to orbiting artificial satellites if the Earth runs into a dense clump of meteoroid particles streaming through space during the Perseid meteor shower this coming August. Writing in the 1 June issue of the Monthly Notices of the Royal Astronomical Society, Drs. Martin Beech and Peter Brown point out a combination of circumstances that increases the probability of a damaging impact on a large satellite, such as the Hubble Space Telescope, to a level that is not negligable. At the same time, observers may be treated to an exceptional meteor display in the early hours of 12 August.

The Perseid meteor shower is one of the most prominent of the regular annual showers, peaking on about 12 August each year. It has been known for a long time that the Perseid meteoroids come from the periodic Comet Swift-Tuttle and are scattered all around the comet's orbit. Comet Swift-Tuttle takes about 135 years to go round the Sun and made one of its rare returns to the vicinity of the Earth and the inner solar system at the end of last year.

Over the last few years, meteor watchers have noticed an enhanced activity peak in the Perseids lasting for about one hour. Material ejected recently from the comet appears to be responsible. This year, the Earth will cross the Perseid meteoroid stream behind the comet when it has not long passed our way. The circumstances of this encounter will be very similar to the ones that produced the spectacular Leonid meteor storms of 1966 and 1833. Beech and Brown reckon that the likelihood of an enhanced display from the Perseids this August is therefore high, though there is the usual note of caution since the exact distribution of dust particles in the wake of the comet is not known. Their best guess is that an outburst will begin at about 1 a.m. GMT (9 p.m. EDT) on 12 August.

Martin Beech said, The idea that satellite damage may occur became clear once we are able to derive a value for the number of 'large' meteoroids (that is, weighing several micrograms or more) that may encounter the Earth during a Perseid storm. There has not been a spectacular meteor storm since 1966 when the space age had hardly begun, so we thought it was worth trying to speculate on possible damage." A typical Perseid meteoroid that produces a visible meteor of magnitude 2.5 has a mass of around 2.5 micrograms and a velocity of order 60 kilometres per second. Such a meteoroid would inflict severe damage - a crater of 5 cm diameter has been estimated - if it struck an artificial satellite.

The impact probability for a typical communications satellite is small but, given the large number of such objects in Earth orbit, the possibility of one being damaged is reasonably high. Larger satellites, like the Hubble Space Telescope (HST), have higher impact probabilities. Beech and Brown note, for example, that the probability of the HST being struck by a Perseid meteoroid during a storm that lasts for about 15 minutes is the same is its being struck by a one-metre-sized object in a 17-year period: 0.1 per cent. The observed activity of a meteor shower is measured in terms of 'Zenithal Hourly Rate' (ZHR). The normal peak ZHR of the Perseids is around 100. The Leonid storm in November 1966 had a ZHR of 100,000 for a period of 2040 minutes.

"The satellite impact probabilities we find are certainly small, but are not negligable", says Martin Beech. "Given the uncertainty in our knowledge of the Perseid stream structure near the nucleus of Comet Swift-Tuttle, our results could be out by a factor of ten either way. We shall have to wait and see what happens."

The June Meeting in Review

by Bill Razgunas

When do we have open houses?

The new moon did not cooperate with the open house schedule this month, as it had the discourtesy of occurring on a Saturday. This caused confusion because the Lowbrows traditionally have their open houses on the Saturdays before and after the new moon. Highlights of our discussion included:

1) Keith Bozin is the Open House Coordinator and has the responsibility of deciding when open houses will be scheduled.

2) Tentative dates are set, with people assigned, through November. It was indicated that some of the people are assigned and may not know it. It was agreed the Keith and others would be making a mutual effort to communicate about who is in charge of upcoming open houses. [See the call for volunteers elsewhere in this issue – Ed.]

3) A request was made that the newsletter be published earlier. It would be helpful if it is received by LBA members before the first open house scheduled in any particular month. [Note: if you people would get articles, names of speakers and titles of talks, etc. to me earlier this might be possible. Not that I'm complaining.... – Ed.]

4) Due to the combination of "light-sky" and "dark-sky" enthusiasts (i.e. lunatics and star-gazers), we will conduct three LBA open houses in June and November, assuming that the weather cooperates.

5) Getting hold of a lunar calendar (didn't you buy one through the club this year?) and planning our schedules farther into the future was brought up.

The Observatory is GOOD (a brief tirade by our Supreme Exalted Observatory Director, D. C. Moons)

Ongoing improvements are an indication of everyone's effort to make it even better. However, it's good now! I'm sure my 10 year old son would say that it's TOTALLY RAD. To help make the observatory even more TOTALLY RAD, everyone was asked to help clear out the office to make space for an EVEN-MORE-TOTALLY-RAD porta-potty. Other improvements are coming, such as the computer subgroup's digital setting circles project. Details relating to money and manpower are to be the subjects of another meeting.

The Root of All Evil....

Bill Durrant gave an inspiring list of ways that the LBA can obtain funds. The group became really alive with this topic. People were excited about many of the possibilities:

1) Increasing membership dues [tax and spend? - Ed.]

2) Add a handling charge for the magazine subscriptions.

3) Having a donation box at the open houses (strictly voluntary - the University does not allow us to charge an admission fee). This was one of the favorite ideas. Keith Bozin will be responsible for implementation.

4) Prepare a set of slides for sale

5) Sell T-shirts with Lowbrow Logo

6) Make & sell lapel pins

7) Charge a fee to make our expertise available to private groups. This could be in the context of showing a video tape.

The LBA decided to form an ad-hoc committee to determine the contest rules for the T-shirt design. Keith Bozin will form [in fact is the sole member: see article - Ed.] this committee.

It was also suggested that a coffee pot be provided at the open houses. The suggestion was expanded to include other drinks. This could also be a source of revenue.

Miscellany

Who will look into getting permission for LBA's to see the classic telescope installed at the University (i.e. the refractor upstairs in the Detroit Observatory)? Paul Etzler will follow up.

Anyone have any contacts in Palo Alto, CA? The club now is the owner of a photomultiplier tube made in that part of the country. What is a photomultiplier tube? It is a photosensitive vacuum tube which is able to measure the intensity of very faint light with a high level of accuracy. [Note: actually, PMT's are very good on sensitivity, but accuracy requires frequent recalibration - Ed.] How accurate/sensitive? What is the device's useful operating range and requirements? How is it's output calibrated so that it provides data in units that astronomers find useful? We need to know everything related to it's proper "care and feeding". It is an Electro Optics Associates type PM-102 serial 024. Specifications, instructions or any useful data would be helpful. Talk to D. C. Moons if you've got some info.

They Talk, and Talk, and Talk....

What do Kurt Hillig, Doug Nelle, and Fred Schebor have in common? What is the INTERNET? What can the INTERNET be used for? How close did comet Lexell come to having a head on collision with the earth in 1770? What help is there when trying to locate and observe a comet which isn't visible to the naked eye? If you need to simulate the collision of two galaxies, where should a person go? How hard is it to design a stable solar system? The answer to all the above questions are provided in "cryptogram" form below:

-Thy ar all mmbrs f th LBA's COMPUTR SUBGRP.

-Th NTRNT s a "supr-ntwrk" f cmputr ntwrks tyng togthr svral mllon cmputrs.

-Th NTRNT's uss ar mny. Dwnldng usfl sftwr s n f zllns f thngs tht can b dn n th NTRNT. USENET NEWS s n on-ln bulltn-brd/confrnc wth thsnds f nws grps dscssng astrnmy, plntry scnce, HST, STS schdl, JPL anncmnts, tc.

I rcmmnd th bk THE INTERNET COMPANON by LAQUEY/RYER fr ths wh dsr t knw mr. Ths paprbck bk s avlbl at plcs lk Egghd Sftwr r Brdr's.

-Th Cmt Lxll cam uncmfrtbly cls t th rth n 1770, basd n Krt's smulatn f th trajctry usng th prgrm *Vygr II* n hs Mcntsh.

-Hlp s lso avlbl t lcat cmts usng th prgrm *Dp Sky*, dmnstrtd by Dg Nll.

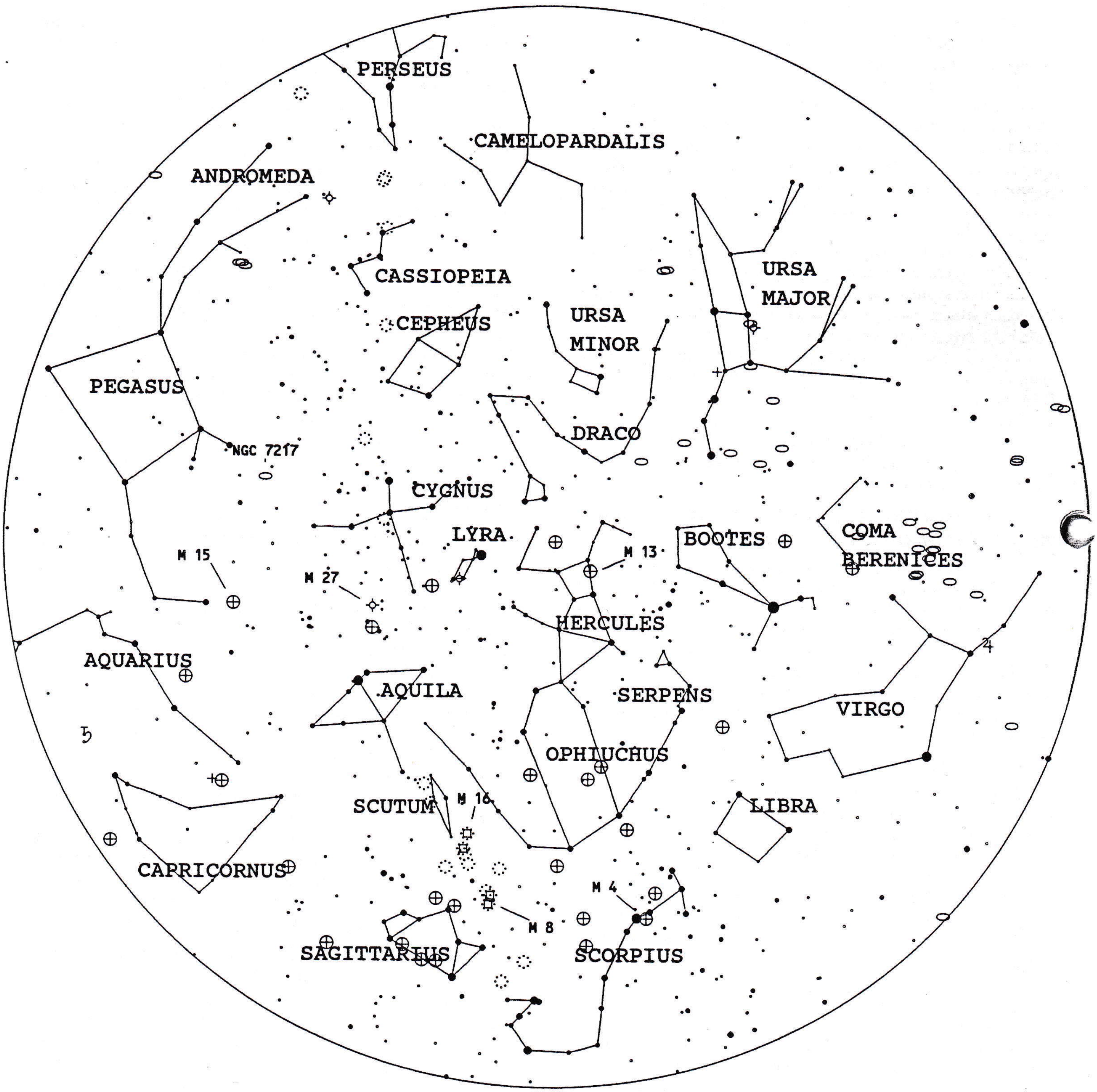
-Frd Schbr dmnstrtd tw fre prgrms whch r avabl; on fr simltng th cllsn f tw glxs (wth a nce "mvie" h'd mde), nd a solr-systm simltr prgrm whch s usful n tstng th lngvty f n arbtry cllctn f strs nd plnts. S Frd r Krt fr mr nf.

Many thanks to the computer group for their successful presentation at the LBA meeting. (And if you have problems reading the above, just add random vowels until it makes sense!)

Island Lake Star Party!

City Camera of Dearborn MI, in collaboration with a number of local astronomy clubs (including the Lowbrows) is sponsoring a public Star Party at the Island Lake State Recreation Area on September 18, 1993. Activities will include an afternoon swap meet, a scope collimation clinic and evening star-gazing, with both public and private viewing areas available. Door prizes from City Camera are rumored to be in the works The only cost will be the $3.50 park entrance fee. Details are still to be finalized, but this looks like a great way to meet some other local amateurs. If you're not headed for AstroFest (or Peach Mountain - unfortunately we've got an open house scheduled) it should be a good time for all. More details next month, or call Brian Gosshaux at 313/390-3935.

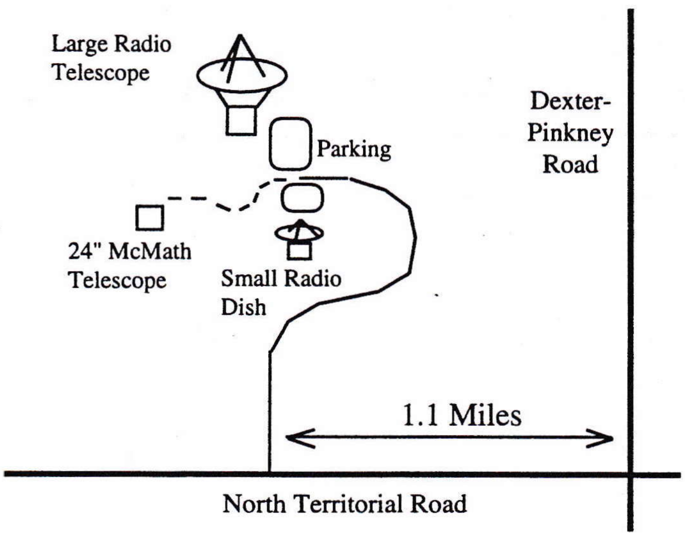
7/17/93 11:17pm EDT Stars to 5th mag



☞ Places:

The Detroit Observatory is in Ann Arbor, at the corner of Observatory and Ann Streets, (across from the old University of Michigan hospital and between the Alice Lloyd and Couzens dormitories on the UM campus). The Detroit Observatory is an historic building which houses a 19th century 12-inch refractor and a 6-inch transit telescope.

The 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 and used by the Lowbrows. The observatory is located northwest of Dexter; the entrance is on North Territorial Road, 1.1 miles west of Dexter-Pinkney 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.



☞ Times:

The monthly meetings of the Lowbrows are held on the third Friday of each month at 7:30 PM at the Detroit Observatory. During the summer months, and when weather permits, a club observing session at Peach Mountain will follow the meeting.

Computer group meetings are held on the first of each month, rotating among members' houses. See the calendar on p.1 for the location of the next meeting.

Public Open House / Star Parties are held on the Saturdays before and after each new moon at the Peach Mountain Observatory. Star Parties are cancelled if the sky is cloudy at sunset – call 426-2363 to check on their status. Many members bring their telescopes; visitors are welcome to do likewise. Peach Mountain is home to millions of hungry mosquitos – bring insect repellant, and wear warm clothes!

☞ Dues:

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

4653 Pitchpine W. #2D
Ypsilanti, MI 48197

☞ Magazines:

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

Sky and Telescope: $20 / year
Astronomy: $16 / year
Odyssey: $16.95 / year

For more information, contact the treasurer.

❐ Sky Map:

The sky map in this issue of *REFLECTIONS* was produced by Doug Nelle using *Deep Space 3D*, drawn for the end of twilight on the monthly meeting date.

✎ Newsletter Contributions:

Members (and non-members) are encouraged to write about any astronomy-related area in which they are interested. Please call the newsletter editor (Kurt Hillig, 663-8699, or send e-mail to khillig@umich.edu) to discuss length, format, etc. Announcements and articles are due 14 days before each monthly meeting. Contributions should be mailed to:

Kurt Hillig
1718 Longshore Dr.
Ann Arbor, MI 48105.

☎ Telephone Numbers:

President:	Stuart Cohen	665-0131
Vice Pres:	Doug Nelle	996-8784
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Newsletter:	Kurt Hillig	663-8699
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Open House:	Keith Bozin	549-9525

Peach Mountain Keyholder:

Fred Schebor 426-2363

Monthly Meeting:

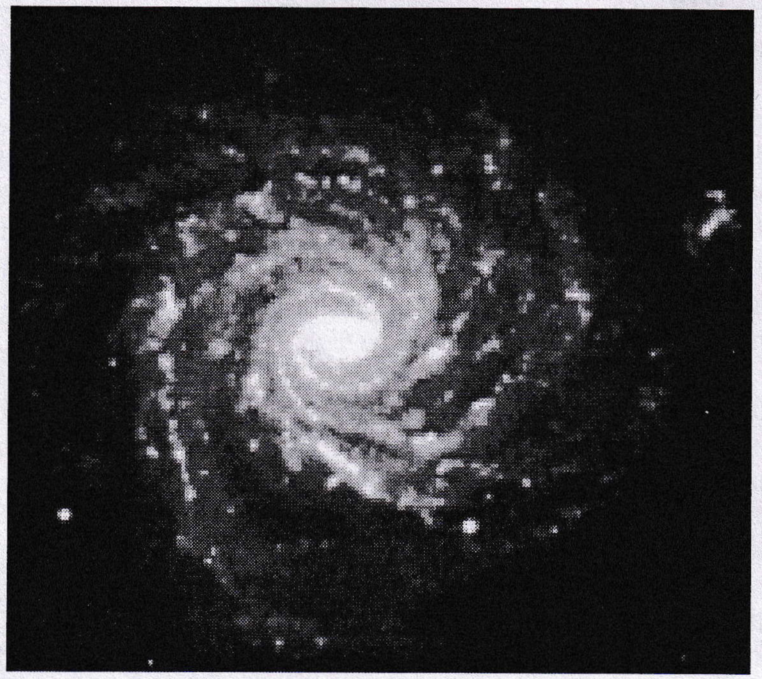
Tom Ryan

on

"The Amazing Stepper Motor"

July 16, 1993 at 7:30 PM

At the
Detroit Observatory in
Ann Arbor



NGC1232 in Eridanus (RA 03h09.8m, Dec. –20° 35'), is an Sc galaxy of 9.9 magnitude about 8' across. This image is from the Deep Sky Object Image library for the Voyager II program from Carina Software.

University Lowbrow Astronomers
840 Starwick
Ann Arbor, MI 48105