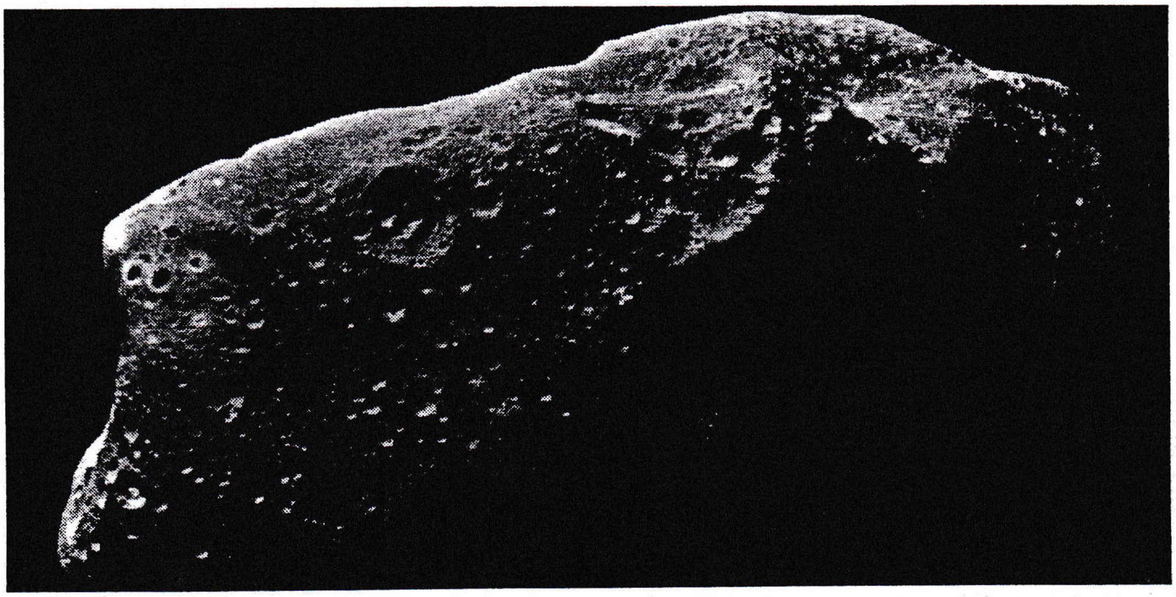
REFLECTIONS



REFLECTIONS

October 1993

The asteroid 243 Ida as seen by the Galileo spacecraft on August 28, 1993. This image is low-resolution scan of a composite of five frames acquired at ranges of 3,821 to 3,057 kilometers. The smallest discernable feature size here is about 80 meters.

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:

October 9 - Public Open House at the **Peach Mountain Observatory**. Of course this newsletter only got mailed today so you couldn't have gotten it in time, but then they 're predicting rain this night as of press time...

October 15 - Meeting at the **Detroit Observatory** in **Ann Arbor**. Prof. Richard Teske of UM's Astronomy Department will talk about NASA's Columbus project - the Search for ExtraTerrestriel Intelligence (SETI): Will it Work? Also, this time we'll really hold the judging for the T-shirt design contest.

October 16 - Public Open House at the **Peach Mountain Observatory**. It's been a pretty cloudy year so far, but Saturn is still looking good, and the winter stars are starting to pop up. Wear long johns!

Cheaper than Truth!

Thanks to our illustrious VP, Paul Etzler

Have you ever noticed that you drop things – small things – lens caps, screws, adapters, those vital little pieces without which your optics would be as dusty (and perform as well) as your car? Ever notice that the probability of dropping things goes up as the night gets darker and as the grass gets longer? And, come to think of it, almost all of them are painted black, and they're impossible to find in the grass at night? Well, folks, it's time for you to wisen up and get cheap! Run down to your favorite hardware store and pick up a length of 1/2" wide reflective tape – 3M makes it – and grab your scissors and make some stickers! This stuff will reflect the light from your flashlight so you can find things easily, and with a Sharpie™ pen you can even label things! Neat, ain't it?

Next Month and Beyond:

November 1 - Computer Subgroup Meeting at **Kurt Hillig's** house (a Monday). Call Kurt at 663-8699 for directions.

November 6 - Public Open House at the **Peach Mountain Observatory**. The Moon is in its third quarter, so skies should be dark until midnight - a good opportunity to serve the public yet still stay awake during the sermon the next day...

November 13 - Public Open House at the **Peach Mountain Observatory**. New Moon, plan on staying up all night!

November 19 - Meeting at the **Detroit Observatory**. Joady Ulrich of the Royal Astronomical Society of Canada, Windsor Centre, will talk on "The Earth as a Planet".

November 20 - Public Open House at **Peach Mountain**. Saturn and the Moon will be a nice target in the early evening, and Orion will rise shortly after midnight. Anyone for M42?

December 1 - Computer Subgroup Meeting

ATTENTION ALL MEMBERS!

Keith Bozin, our Open House Coordinator (and Official T-shirt Design Contest Referee), was in a rather nasty traffic accident a few weeks ago – hence his absence at the last meeting. He's mostly OK, but is moving a bit slowly (in part because he no longer has a car) and so won't be around until January or so. In the interim, we need people to take on the responsibility for hosting our open houses. Please, check your schedule and pick a date when you can be in charge for an evening. **We need your help!** Call Doug Nelle at 665-0131 to sign up. Do it NOW!

The Comet Pre-Crash Bash

by H. J. Melosh

Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ

The imminent impact of periodic comet Shoemaker-Levy 9 with Jupiter has generated a tremendous amount of excitement within the scientific community. On Monday and Tuesday, 23 and 24 August, 1993 more than 120 scientists from all over the United States gathered for an impromptu "brain-storming" workshop at the Lunar and Planetary Laboratory of the University of Arizona in Tucson, Arizona. The workshop was convened by H. J. Melosh, and attendance from outside Tucson was impressively heavy, in spite of only 2 weeks notice of the meeting.

The workshop's format featured a number of invited speakers followed by long periods for general discussion and unscheduled presentations by participants. As it happened, discussion was lively and many ideas were exchanged between observers and theoreticians. This report can only outline the highlights.

The scientific portion of the meeting was opened by Carolyn Shoemaker, who described the discovery of the comet by her, Gene Shoemaker and David Levy at the Mount Observatory in California on 26 March 1993. Carolyn first recognized the comet as a strange wisp in her microscopic stereo . Accustomed to the appearance of comets, she was puzzled by the linear form of the coma. It looked like a galaxy on edge—except that its apparent elevation above the background in stereo indicated that it had moved substantially between exposures of the two plates. Not knowing just what to make of the object, which Carolyn described as a "squashed comet", the discoverers called Jim Scotti, who was observing with the Spacewatch telescope on Kitt Peak, Arizona. Scotti imaged the object with the 91 cm telescope and revealed the "string of pearls" appearance of the multiple nuclei. It was then clear that a most unusual comet had been found. Carolyn brought the discovery plates and comparator to the workshop, and nearly all the participants experienced the thrill of viewing the first image themselves.

Jim Scotti described his experiences in observing the comet, along with the discovery that, not only was the comet in orbit about Jupiter, but that it was targeted to impact the planet about 21 July next year. Orbital computations performed by Brian Marsden, based partly on Scotti's observations, show that it passed within about 1.6 RJ of Jupiter on about 8 July 1992, well within the Roche limit (about 2.7RJ), where tidal forces exceed self gravity. Scotti described work he did with H. J. Melosh in modeling the tidal breakup of Shoemaker-Levy 9's progenitor, which produced a close fit to the observed chain orientation (which is at a substantial angle to the orbit direction) and resulted in a predicted progenitor diameter of only about 2 km. Tidal stresses at closest approach were only about 10^-4 bar for such a comet, suggesting that it was initially only a loose aggregation of negligible strength, held together by its own self gravity. The tidal breakup model was used to predict the future evolution of the chain, with the result that all of the fragments should hit Jupiter at about the same latitude and longitude with respect to the dawn terminator. Scotti also emphasized that the comet is accompanied by considerable quantities of dust that extends in slightly canted "wings" beyond the end of the visible nuclei. No discrete nuclei have been found in these dust bands, and it is unclear exactly what their dynamical relation to the comet might be.

Scotti's presentation generated considerable discussion. The geometric relations of the sun, Jupiter and the dust bands were obscure to most participants, and some lively discussion ensued. Many questions were asked about the size estimate, and Z. Sekanina reported work done at JPL by D. Yeomans and P. Chodas on similar breakup models. The Scotti-Melosh model neglects cometary rotation and self-gravity of the fragments, and Sekanina argued that rotation might change the detailed results, although he agreed that the parent comet could not have been more than a few km in diameter. Luke Dones noted that he had computed a similar tidal breakup model that includes self-gravity of the fragments and found that its inclusion made little difference to the results. Discussion also centered on the origin of the dust bands, with many participants concluding that the dust is being shed by a large number of meter-plus diameter boulders spread out beyond the ends of the chain of discrete nuclei. No mechanism for the dispersion of this dust was agreed upon.

Hal Weaver then described the results of several Hubble Space Telescope exposures of the comet. Hubble was unable to resolve the individual nuclei, and an upper limit of 5 km was placed on their diameters. Most of the brightness in these images is due to dust in the coma. No OH emission, or any other molecular emission, has yet been detected – the spectrum seems to be a red-scattered solar spectrum. This observation triggered a lively debate about whether S-L 9 is a comet or an asteroid. Although some OH emission might be expected from the exposure of amorphous ice upon breakup, the final consensus was that even a water-rich comet would not be expected to show detectable OH emission at 5 AU from the sun. It was stated than no comet has shown OH farther than 3.3 AU from the sun, and that the absence of emission lines does not imply that S-L 9 is not a comet.

Torrance Johnson then described observational opportunities from spacecraft. Although the predicted impact point is not visible from Earth, the Galileo spacecraft happens to be in an orbit from which the impacts will be visible. Although Galileo is too far from Jupiter to get good images of the impacts themselves (the disk of Jupiter will be 60 pixels across from Galileo, so the impact sites will occupy only one pixel), good data should be obtained on integrated IR and visible light emission as a function of time, even for the most pessimistic estimates of nucleus size. Galileo instruments should also be able to record radio emissions associated with comet/magnetosphere interactions. An important issue was obtaining good predictions of the impact times far enough (days to weeks) in advance to allow optimum use of the limited recorder space and slow downlink data rate. Johnson further discussed the intriguing possibility of using the Voyager 2 spacecraft to view the impacts. Although resolution is very poor (2 pixels across the disk), Voyager 2 would look almost directly down over the impact site, and the integrated data thus collected might be very useful. Johnson noted that it is very convenient that there will be 20-odd impacts over 6 days, because if brightness estimates are initially poor and the first exposures are not set correctly, there will be multiple opportunities to correct them for later impacts.

After a further discussion period, during which several participants urged that more consideration be given to Jupiter's thermal perturbation of the comet during its close pass last year (both mechanical spallation effects and the possibility of volatile evaporation were suggested), Gene Shoemaker presented his recent work on the orbital history of S-L 9 and other comets with similar orbits. He noted that, besides S-L 9, other Jupiter family comets have apparently spent time as temporary satellites of Jupiter, although none has previously been caught in this condition. Comets Gehrels 3 and Helin-Roman-Crockett, when their orbits are integrated backward, once made several loops about the planet and in the future both will experience additional temporary capture episodes. Most such objects evidently enter orbit through the L1 point, then exit sometime later through L2 whence they take up heliocentric orbits similar to Jupiter's orbit. It is nevertheless rare that one of these objects makes a pass inside the Roche limit. He estimated that at any given time there is a steady state population of about 1 comet of diameter > 2 km in orbit about Jupiter, and that Jupiter can capture a comet about once a century. He also described attempts to find pre-discovery images of S-L 9's parent (pre-close encounter) comet. Although plates of the appropriate region exist, so far none have revealed the comet, suggesting that it may have been too faint. However, efforts to find images of the parent are continuing.

The next segment of the workshop focused on the physical effects of the impact on Jupiter. Z. Sekanina opened this discussion by describing his work on the tidal breakup of a comet passing within the Roche limit and emphasized the low strength implied. He then described the flight of the projectile through Jupiter's atmosphere in terms of models originally developed to model meteors in Earth's atmosphere. He emphasized the importance of ablation effects and the possibility of intermediate flare-ups before the final episode of energy deposition. He attempted to estimate light curves and showed several examples from terrestrial meteors, illustrating the complexity of the observed curves.

Kevin Zahnle described his work on energy deposition of entering comets, following up on his model originally developed to model airblasts from meteorites entering Venus' atmosphere and the 1908 Tunguska event on Earth. He argued that the projectile would break up as it entered, thus increasing its drag and depositing its energy in a relatively small altitude interval. The energy deposited would then heat the surrounding gas, which would expand upward in a classic fireball. For km size projectiles, most of this energy deposition takes place about 200 km below the upper cloud decks, and so is not directly visible, but the fireball should become visible when it rises back up into the upper atmosphere, about 1 minute later. He argued that ablation is not important for large projectiles, although what "large" meant was debated by the participants, and he reported that a check by Chris Chyba showed that his results changed somewhat when a different ablation model is used. Temperatures in the shock wave ahead of the entering projectile were estimated to reach 30,000 K during the high speed part of the entry. Zahnle closed his talk by showing a video of a numerical computation of the expansion of a fireball in a stratified atmosphere modeling that of Jupiter.

Several participants showed results from numerical computations currently in progress. Tom Ahrens presented a computation using an SPH hydrocode that followed the entry of a 10 km diameter projectile. He and T. Takata found that the projectile penetrated relatively deeply, depositing most of its energy 500 km below the 1-bar level. The impact generated a 6 km/sec upward plume and partitioned about 70% of its energy to atmospheric heat. David Crawford described similar computations that use the Sandia hydrocode CTH, although his work mainly focused on the projectile. It was clear that several groups are ready to do hydrocode computations of the comet entry, but due to the need for lengthy supercomputer runs none has yet encompassed the entire impact process. A major point of interest was whether any atmospheric gasses would be ejected at high enough speed to enter space around Jupiter and perhaps affect the radiation belts or magnetosphere. None of the computations presented showed such high speed jets, but it was not clear that any of them have been carried out with sufficient accuracy to be sure of their absence. Other issues were the importance of thermal radiation (not included in any of the hydrocodes) and the need for an accurate equation of state.

Attention then turned to the longer term effects of an impact on the atmosphere of Jupiter. Andy Ingersoll organized his own sub-workshop on atmospheric effects. The presentations were lead by Dave Stevenson, who noted that the amount of material in the comets, if reduced to fine dust and mixed through the upper atmosphere of Jupiter, was itself sufficient to cause albedo changes over the entire planet. The probability of such complete mixing was not known, however. Andy then addressed the question of whether the vorticity changes induced by the rising fireball could produce structures like either the great "red" or smaller "white" spots. He noted that the amount of energy in one of the smaller white ovals (10^29 ergs) is comparable to the kinetic energy of one of the cometary fragments. The problem is that an undetermined amount of this energy in the rising fireball is likely to be radiated away. The rising fireball is also likely to inject a large quantity of volatiles – some from the comet itself and some from Jupiter – into the upper atmosphere. Ingersoll and Stevenson presented a simple analytic model of the geostrophic adjustment of the Jovian atmosphere to a sudden heat pulse. They concluded that some energy would be radiated away from the heated region by gravity waves [Note: not gravitational radiation; these waves in the Jovian atmosphere are analogous to large ocean waves on Earth – called "gravity" waves, as distinguished from the small "capillary" waves - Ed.], and the rest would remain as a circular vortex – a high-pressure weather system some 2000 km in diameter for a 1 km diameter comet fragment. They predicted that in the near IR some variability of molecular absorption features should occur.

Tim Dowling used his Jovian general circulation model to examine the effects of a sudden injection of heat in the atmosphere. He found that the result was a narrow ring of gravity waves that propagated outward from the impact site and spread several times around the planet and showed a video illustrating the waves' propagation. Preexisting jet streams in Jupiter's atmosphere destroyed the vortex that formed immediately after the impact. No new spots of long duration formed in the simulation. Dowling emphasized that a fundamental parameter of the model, which depends on the temperatures and thickness of the Jovian "weather layer", is only poorly known for Jupiter, but that the best way to measure it is to determine the speed of gravity waves. Since the predicted waves are narrow, HST observations of Jupiter may be required to detect them.

The first day of the workshop ended with an extended discussion of what observations should be made. The general feeling was that all possible observations should be made at all possible wavelengths and at the highest possible resolution, but practical considerations tempered this grandiose wish. Heidi Hammel and others emphasized the desirability of IR imaging in addition to spectral studies. John Spencer discussed the possibility of observing the flash emitted by the entering comets by its reflection off one of Jupiter's moons. This is best done by observing a nearby moon while it is eclipsed by Jupiter. John showed an ephemeris of the Galilean satellites in which it appears that one or another satellite will be in a favorable location for a large fraction of the time. He also discussed the feasibility of observing flashes reflected from Amalthea and described the virtues of using methane band filters which screen out much of Jupiter's light.

The final session of the workshop opened Tuesday morning. Alex Dessler gave a lively presentation on the magnetospheric effects of the comet and its attendant dust. He analyzed dust charging and interactions with the magnetic field, showing that the charge on dust particles should increase many-fold as they cross the magnetopause. This increases the electrostatic stress on the particles and may thus cause them to break down into even finer dust. This may cause the magnetosphere itself to become temporarily visible, and provide the first-ever image of the magnetosphere. To do this a telescope with a wide field of view is needed – around 2 degrees. Something like a Schmidt telescope would be ideal, with observations starting about 2 months before impact to catch the first entry of dust into the magnetosphere. Dessler also argued that some of the dust from the comet would not impact the planet, but instead go into temporary orbit (the "decapitated comet" model). The presence of the dust might quench the inner radiation belt and cut off the synchrotron emission. The timescale for the radiation belt to reestablish itself is highly uncertain ("bets" from participants on the timescale ranged from 30 minutes to 11 years!), but observing the effects of such a disturbance will reveal a great deal of information on energy fluxes in this region. A final possibility that gave rise to much discussion centered on whether an atmospheric "backsplash" kicked up by the comet's entry would inject a significant amount of material into the Io torus. If gas is present, it will become ionized and may strongly intensify the current flow in the torus.

Jay Melosh, in collaboration with Paul Schenk, made the final presentation in which he described crater chains on Callisto and argued that they had been made by tidally split comets like S-L 9 (although not necessarily comets in orbit about Jupiter) that ran into Callisto on the way out from Jupiter. All but one of the 13 chains on Callisto are on the Jupiter-facing hemisphere and three crater chains have been found on the Jupiter-facing hemisphere of

Planetary Longitude

Phil Stooke

University of Western Ontario

In a follow-up to a sci.astro news thread about sunspots, the question arose: how are planetary longitudes defined (i.e. where are the Greenwich or Prime Meridians?). Luckily I've just written an article including this info for the Van Nostrand Reinhold Encyclopedia of Planetary Sciences.

Basically, there are two methods, one from an astronomical background, one from geography (ultimately):

1. Define the orientation of the prime meridian at a moment in time, then count rotations until any other time to figure out where the Prime Meridian will be then. This works for the Sun, Jupiter, etc. where there are no other fixed features to refer to. Example:

Sun - heliographic longitude is measured from a prime meridian which was at the ascending node of the solar equator on the ecliptic at 12:00 U.T. on 1 January 1854 and rotates with a sidereal period of 25.38 days.

(this ignores differential rotation, which is better thought of as the result of winds in the sun's outer layers anyway... weather on the Sun? Yup... but not usually thought of that way).

This is fine if the rotation period is known, but if it is not exactly known then surface features would appear to drift in longitude.

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Mars - 0° longitude passes through the center of the crater Airy-Zero, a small crater inside Airy in Sinus Meridiani. This was chosen to conform as closely as possible to 19th century definitions. (Sir George B. Airy was once director of Greenwich).

This is done where there is good imaging and where permanent surface features are seen. For Io, where we thought they might be covered up rapidly by volcanism, the mean sub-jupiter point is used. For the Moon, the mean sub-earth point is taken as the zero, but the actual definition is tied to a nearby conspicuous crater, Mosting A (at 5 deg. 9 min. 35 sec. longitude). I.e. the 5 deg. 9' 35" meridian passes through Mosting A.

As the Moon example suggests, most planetary satellites have zero longitude at the sub-planetary point. For asteroids, suitable craters will be chosen. The Gaspra definition is currently in press (or nearly so) in a special Gaspra issue of Icarus – it is near the 'sharp' end of Gaspra and runs through a prominent crater.

The Winter Hexagon

Paul Nienaber, SJ

Xavier University, Cincinnati, OH

The "Winter Hexagon" (or "Winter Circle") is an asterism (a grouping of stars that's not an "official" constellation) consisting of seven bright stars that are high in the southern sky during winter months (from northern latitudes, e.g. Central U.S., that is). Starting with the brightest and southernmost, running counterclockwise, they are:

Sirius (in Canis Major; an A1 star)
Rigel (in Orion; B8)
Aldebaran (in Taurus; K5)
Capella (in Auriga; G)
Castor & Pollux (in Gemini; A1 & K0; Pollux is slightly brighter)
Procyon (in Canis Minor; F5)

The nice thing (at least from a pedagogical point of view) is that they (along with Betelgeuse, in Orion, M2, toward the center of the Hexagon) provide a mini-catalog of star colors (and hence a nice segue into temperature discussions) — from blue-white Sirius and Rigel, through yellowish Pollux, to orange-red Betelgeuse.

Hipparcos: Mission Accomplished!

ESA Press Release No. 37-93

Paris, 17 August 1993

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The Hipparcos satellite carried out its measurements in a highly elliptical 10-hour orbit, ranging between 500 km and 36,000 km above the Earth's surface, resulting from non-functioning of the satellite's apogee boost motor shortly after launch. A redesign of the on-board attitude control system, and the addition of two more ground stations into the control network, nevertheless allowed ESA's operations team at ESOC (Darmstadt, Germany) to operate the satellite with close to full efficiency.

An enormous wealth of scientific data was gathered by Hipparcos. Even though data analysis by the scientific teams involved in the program is not yet completed, it is clear that the mission has been an overwhelming success. "The ESA advisory bodies took a calculated risk in selecting this complex but fundamental programme" said Dr. Roger Bonnet, ESA's Director of Science, "and we are delighted to have been able to bring it to a highly successful conclusion, and to have contributed unique information that will take a prominent place in the history and development of astrophysics".

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continued...

Crash Bash continued...

Ganymede. A tidal splitting model accounts for the observed 200-600 km lengths and linearity of the chains, whereas a rotational splitting model would result in loops of craters, not lines. Melosh described a model that attempted to relate the diameter of craters in the chain with the length of the chain using impact crater scaling laws. He found that to fit the data he had to assume that either the scaling laws failed by a factor of 2, or that the cometary fragments had densities of 0.1 gm/cm^3. Paul Weissman pointed out that this model was not strongly supported by the data, which could be interpreted equally well by the supposition that all comets were composed of a variable number of lumps of the same size, lumps big enough to create 10 km diameter craters when they strike Callisto.

The workshop closed with a discussion of what is worth doing. Theoretical modelers were urged to refine their hydrocode computations of atmospheric entry, observers were urged to start thinking about telescope time allocations, especially for HST, and various instrument development projects were discussed. John Spencer suggested pooling orders for custom filters, such as methane band filters. Paul Weissman urged the participants to be careful when talking to the press to avoid over-dramatizing the impact effects visible from Earth.

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Computer Subgroup Report

by Roger Tanner

The meeting got started with about 5 members of the club present. I proposed to demonstrate the process of averaging images together to improve the signal to noise ratio of a CCD image. At the same time, I would demonstrate a prototype image processing program called "PIXFIX" written by Bruce Johnston of the Warren Astronomical Club. Bruce had joined us for the meeting to get some feedback on the program. The images were of NGC 7331 and were taken out at Peach Mountain a clear steady night in August. NGC 7331 is a 9.5 magnitude Sb type spiral galaxy in the constellation of Pegasus. There are three 200 second images and three corresponding dark frames. A version of the averaged image was in the last newsletter.

First we looked at just taking one image and subtracting one dark frame. The resulting image showed the nucleus and a wisp of noise at the top where the arms spread out. The arms were only represented by one or two gray scales and the noise in the image was several gray levels. The next step was to average the three dark frames together to get a lower-noise dark frame. Each time a dark frame is taken the telescope is capped and an image is taken; this records the electrical and thermal noise produced by the system in the absence of light. However thermal and electrical noise are random, and each time a slightly different amount of noise is recorded, varying around an average value. So subtracting one dark frame from a light frame removes the constant part of the thermal noise, but leaves the slight variation which shows up when the image is stretched.

The second experiment was to averaging three dark frames together. This reduces the noise component by the $\sqrt{3}$, a factor of 1.73. Subtracting the averaged dark frame from a single light frame produced an image which showed less noise but not much more arm detail.

The third experiment was to average the three light frames together after each light frame had the averaged dark frame subtracted. Unfortunately, the three images do not overlay exactly, as I had adjusted the position of the guide scope between each exposure. The align capability of the program was demonstrated by aligning one of the frames to the other. PIXFIX has the ability to align two frames to 1/2 pixel accuracy, which is required to get things to line up without increasing the size of all the stars. A great feature of the align capability is the blink compare with the frame you are trying to align to so you get a quick compare of your alignment success. It is very easy to just keep hitting the arrow keys until you don't see any movement when the two images are blinked. When you get it as close as you can by whole pixel moves, you toggle into half pixel mode to make fine adjustments. In the half pixel mode, the shifted image is interpolated from the whole shifted images.

During this process Bruce answered several question about his software. He wrote the software in Borland C, and is going to sell it in a few months for about $30. He is targeting the same users as Richard Berry's image processing program AstroIP. PIXFIX has improved speed and several additional features such as the align feature, and dodging and burning capability. He has added several contrast stretching methods and a very handy quick view feature to quickly look at any one of the four image buffers. Anyway, the image of the three light frames added together showed the three arms with much less noise. Some clouds near the nucleus also showed up after the histogram optimize stretch. This prompted Stuart Cohen to explain that this was a straight forward result of the Central Limit Theorem applied to random signals. After this we experimented with various stretching and enhancement schemes. Various members suggested new stretch options and Bruce suggested the final two-level stretch to darken the background. The most successful appeared to be a histogram stretch followed by a exponential stretch. Then a unsharp mask was used to bring out detail and finally a two level exponential stretch gave the final image. This showed a more detail than I had been able to get by myself, which means that group image enhancement can improve your images! Along the way, several images were generated by masking out the bright and dim parts of the galaxy and operating on each differently, and adding them back together. This produced a very different kind of image, with more detail in each part but strong discontinuities where they were added together.

After the image processing, we logged on to CompuServe and downloaded a GIF file viewer and loaded it onto Mark Vincent's laptop computer. This would allow him to display any GIF images that were brought to any future computer subgroup meeting. To test this out, we looked at several images Kurt Hillig downloaded from somewhere on the Internet [the Pine Mountain Observatory in Oregon; see the August issue of *Reflections* - Ed.].

We also looked at the latest news on the Sky and Telescope news line. The news mentioned the magnitude 8.5 Nova in Sagittarius, and the four new ice balls found out near Neptune and Pluto. Also there was a summary of recent research that indicated that the crater in the Yucatan area of Mexico may be 300 Km across and is the largest known in the solar system. Logging on Sunday night while writing this report I got the latest news on the Hubble repair flight preparations (they are readying Endeavour for an end of October roll out and the November 30th flight). This is a handy way to keep up on the latest news of novas and other new astronomical events. They update the news every Saturday.

The meeting adjourned with no decision as to the host of the November 1 meeting, but in a late-breaking *Reflections* exclusive, we've learned that Kurt Hillig has volunteered! Call him at 663-8699 for directions.

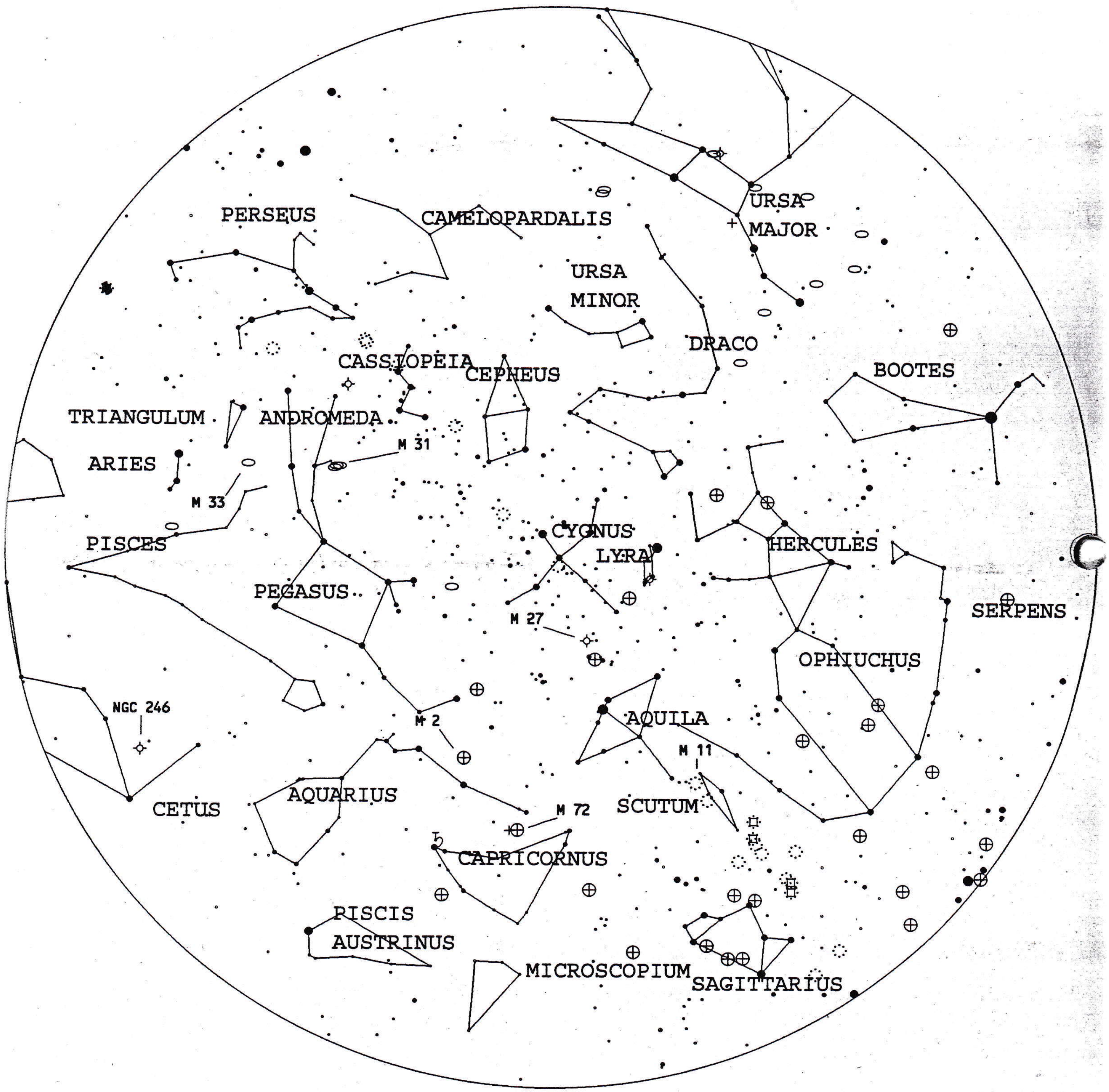
Hipparcos Retired continued...

sand stars, precise distance measurements (in most cases for the first time), and accurate determinations of the stars' velocity through space have been derived. The resulting Hipparcos Star Catalogue, expected to be completed in 1996, will be of unprecedented accuracy, achieving results some 10-100 times more accurate than those routinely determined from ground-based astronomical observatories.Final accuracies on the stellar positions, distances and annual motions measured by Hipparcos, are in the range 1-2 milli-arcseconds (equivalent to the angular size of a golf ball viewed from the other side of the Atlantic Ocean). A further star catalogue, the Tycho Star Catalogue of more than a million stars, is being compiled from additional data accumulated by the satellite. These catalogues will be of enormous value in astronomers' attempts to understand and describe the properties and evolution of stars, and the dynamical motion of these stars within our Galaxy. In the process, Hipparcos has discovered many thousands of new binary star systems, measured the precise light variations of many hundreds of thousands of stars over its operational lifetime, and has provided an accurate and independent validation of the predictions of General Relativity.

The scientific activities associated with the Hipparcos mission are under the responsibility of four European scientific teams, together comprising about 100 scientists, and led by Professor Erik Hoeg (Copenhagen University Observatory, Denmark), Professor Jean Kovalevsky (Observatoire de la C:te d'Azur, France), Dr. Lennart Lindegren (Lund Observatory, Sweden) and Dr. Catherine Turon (Observatoire de Meudon, France). The analysis and interpretation of the vast amount of data generated by Hipparcos is considered to be the largest single data processing challenge ever undertaken in astronomy.

The Hipparcos results will represent a milestone in mankind's understanding of the structure and evolution of our Galaxy, and an invaluable legacy to future generations of astronomers.

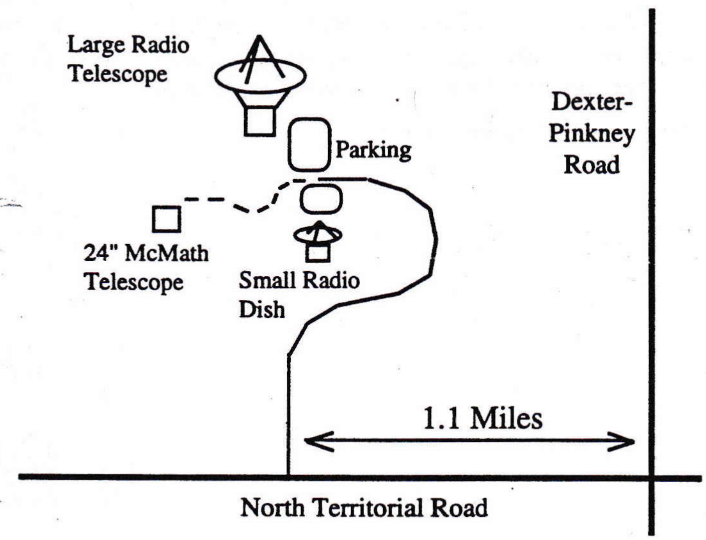
10/16/93 8:25pm EDT Stars to 5th mag



☞ 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 any meeting or by mail at this address:

1426 Wedgewood Dr.
Saline, MI 48176

☞ 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. Call the editor (Kurt Hillig) at 663-8699(h) or 747-2867(o), 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
	Paul Etzler	426-1939
	Fred Schebor	426-2363
	Tom Ryan	662-4188
Treasurer:	Doug Scobel	429-4954
Observatory:	D. C. Moons	254-9439
Newsletter:	Kurt Hillig	663-8699
Membership:	Steve Musko	426-4547
Open House:	Keith Bozin*	549-9525

* Doug Nelle is filling in until Keith returns in January

Peach Mountain Keyholder:

Fred Schebor 426-2363

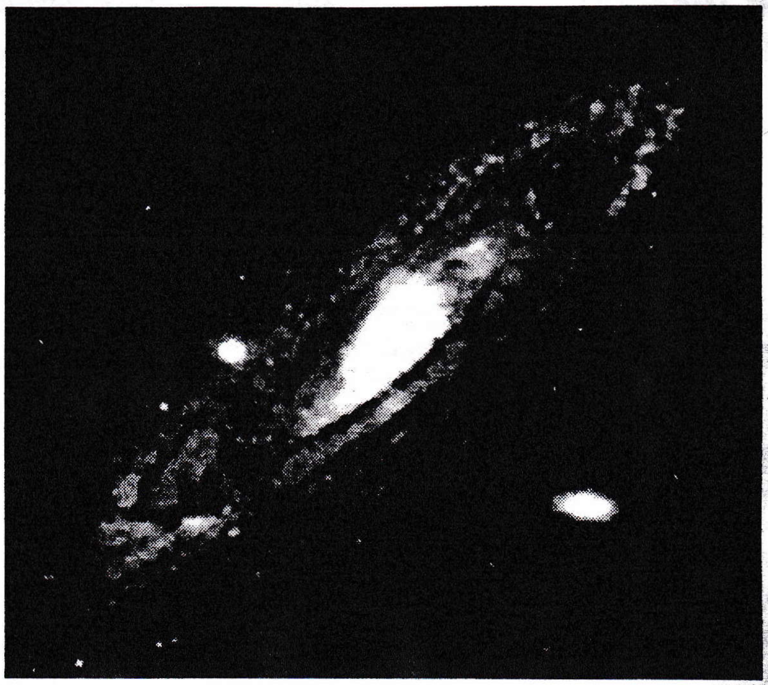
Monthly Meeting:

Dr. Richard Teske
on
SETI:
Will it Work?

also:
The Tee-Shirt Design Contest (Really)!

Oct. 15, 1993 at 7:30 PM

At the
Detroit Observatory in
Ann Arbor



M31 – the Andromeda Galaxy – with its two companion galaxies NGC205 and M32. 2.6 million light-years away, it's the farthest object visible to the naked eye. This image, from the image library of the Voyager II program, has been processed to eliminate most of the foreground stars.

University Lowbrow Astronomers
840 Starwick
Ann Arbor, MI 48105