AD ASTRA

Vol. I, No. V | *The Newsletter of the Atlanta Astronomy Club* | January 1987

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CLUB CALENDAR

Next Meeting: January 16
Program: Star Bowl! -- a friendly(?) competition between two teams on astronomical knowledge and skill. Teams will be formed at the meeting for competition.
Observing Sessions: January 30,31.

AD ASTRA is published monthly during the academic year by the Atlanta Astronomy Club, Inc. The Atlanta Astronomy Club, an organization dedicated to the advancement of amateur astronomy, meets on the third Friday of each month (second Friday of December) at the Bradley Observatory on the Agnes Scott College campus at 8:00 PM. Membership dues are $25 annually and include a subscription to *Sky & Telescope* magazine and use of club observatory facilities.

Editor in Chief: .... John Marsh
Contributing Editors: .... Dave Roberts, Don Barry
.... Rick Clark, Sharone Franklin, Pat Frank
President: .... Dr. Joe Gibson
Vice Presidents: .... Dave Roberts, Rick Clark
Treasurer: .... Bud Rosser
Secretary: .... Sharone Franklin

CLUB MINUTES

The December 12, 1986 meeting was held at the Bradley Observatory with Dr. Joe Gibson presiding.

The December program was an equipment show given by our club members. Those who participated and their exhibits were:

1. Don Barry described his 6" f/8 Criterion reflecting telescope and its German equatorial mount.
2. John Marsh described his 8" f/6 newtonian reflecting telescope and his home-made alt-azimuth mount.
3. Don Hall showed his Celestron C-11 that he uses for photography and how he mounts a Schmidt camera piggyback.
4. Bill Close demonstrated his equatorial camera drive.
5. Dave Roberts described his home-made widget and showed his 6" f/12 refractor.

THE CHARA STELLAR INTERFEROMETER

by Bill Bagnuolo, CHARA

A year ago the Georgia State University CHARA group (Center for High Angular Resolution Astronomy) began a design study for a large optical interferometer. Earlier this year Dr. Hal McAlister described this project in his talk to the Atlanta Astronomy Club. This note is an update on the project.

The instrument will be used for stellar interferometry, a method of measuring the sizes of objects whose angular size in the sky is too small to be resolved by a conventional telescope. The interferometer does not produce a direct image of the object, showing details as in a conventional photograph. Instead, a rather coarse image crossed by fine lines, called fringes, is formed by two or more separated apertures (or telescopes). If the fringes can be detected, it means the object is smaller than a certain angle that depends on the aperture spacing. This angle is about 0.1 arc-seconds for a 1 meter separation and 0.01 arc-seconds for a 10 meter separation. Analyzing the fringes can give the same information a direct image would provide (if it were possible to make one, that is).

Originally, the plan included two 1.5 meter telescopes on a 300 meter diameter circular track. The collimated beams of the two collecting telescopes would be directed to a "combining house" in the center of the track, where they would be interfered together. The contrast of the interference pattern (how dark the dark areas are as compared to how bright the bright areas are, known as the *visibility*) provides information about the size of the object under observation. The 1.5 meter aperture was chosen to provide a deeper limiting magnitude than others like the University of Sydney group, which uses 10 to 15 cm apertures (the atmosphere is "smoother" on this scale, and the light is not affected as much as for larger apertures, but the limiting magnitude suffers from the smaller collecting area). The circular track would enable us to get the visibility for any object separation and orientation, allowing us to eventually image the surfaces of stars and other objects, instead of just obtaining their size in one direction.

We eventually came to the conclusion that this was the wrong approach. The biggest objection to the circular track was that in our original plan the light would travel over open air on its way to the combining house, becoming distorted by thermals rising from the ground. Enclosing the beam with moveable pipes was judged to be too complex and expensive.

The whole idea of a transportation system moving the telescopes to various fixed locations to avoid moveable pipes was discarded after several long discussions. It turned out that three moveable telescopes with a rail transportation system and a "telescope--picker" transport would be almost as expensive as seven fixed telescopes, as well as more complicated.

As it turns out, seven telescopes in a Y-shaped pattern are sufficient to ensure enough different telescope separations to create images. The pattern enables the interferometer to resolve objects ranging widely in angular sizes and orientations (i.e., binary stars). We also reduced the telescope size to 1 meter for reasons of economy. The cost of telescopes goes as roughly the 2.6th power of the diameter, so a 1 meter telescope costs only about 1/3 as much as a 1.5 meter.

For the design of the telescopes themselves, we have settled on several possible eccentric alt-az designs. The telescopes would fit inside 14.5 foot Ash Domes, so the primary mirrors would have to be about f/2.5. We are sending a set of design requirements to four possible telescope vendors.

During the next six months we will investigate the path length compensation system (two light beams in the system must have their path lengths equal to within 4 microns, or less than .0002 inches!!) and tilt and higher order corrections to the light beams (to partially compensate for atmospheric turbulence). This spring we hope to investigate several potential sites and measure the local atmospheric turbulence near the ground. I hope to mention some of these results in another "update".

The Ad Astra: A Personal View

By Sharone Franklin

Last summer when Pat Frank asked me if I would write some articles for the club newsletter, I reluctantly said yes. My reticence wasn't because I didn't want to help, it was because I had very little experience with writing. I was worried that I couldn't think of any interesting subjects to write about and I wasn't sure my compositions would show proper sentence structure. This would be a challenge.

I have been working with the Ad Astra staff since August and it has been a lot of work getting the newsletter prepared and mailed. But it also has been a lot of fun. Not only am I gaining experience in writing, I am learning to use a word processor which has helped tremendously with my articles. Dave Roberts, Don Barry and I have IBM computers and Dave and Don are very adept at using the word processor. If we didn't have these computers, you would not be receiving your newsletter as early in the month as you do, nor would we be able to publish the volume of material you have become accustomed to reading. (At least I hope you are reading).

In the past, some of you edited the newsletter without assistance. This must have been an enormous responsibility and I appreciate what you must have gone through to meet the monthly deadline.

The Ad Astra staff generally works two Saturdays a month to complete the newsletter. All articles have to be typed and recorded on a floppy or hard disk to be consolidated in the newsletter format. Before we generate a master copy, we swap articles to check for sentence structure, grammar, and misspelled words. (Some mistakes still go unnoticed. Hey! Nobody's perfeck!) Once we receive the printed copies from the Xerox store, the real fun begins. We get to fold, stamp, staple and stick name labels on each copy. Someone always manages to staple at least one finger, and a few blank gum labels will inevitably find their way to someone's face. By the time we are finished, the work area looks like an infirmary!

The Atlanta Astronomy Club is something for us to be proud of. We have an adequate membership base. We share a hobby that is rare among hobbies. We are family. Which brings me to you--the readers of its newsletter. If I can write articles for the Ad Astra, so can you. You must have something on your mind that you would like to share with the rest of us. Have you been observing and would like to tell about your éxperience? Been abused by your telescope? Do you have any complaints? If you will share your thoughts by writing them down and let us publish them, you will help keep the Ad Astra varied. It will also give you a chance to display your individual talents via communication.

One final note about the Ad Astra staff. I would like to thank them for giving me the opportunity to participate. (Besides, how many girls get to have dinner with *five* handsome guys? Oh yea -- They're intelligent too!)

The Story of Vulcan

by Leonard B. Abbey, F.R.A.S.
(reprinted from the Nov. '76 Reflector)

The great impetus given to planetary astronomy by the discovery of Uranus in 1781, the major asteroids in 1801--4, and Neptune in 1845 spurred many astronomers to turn their attention to this field. Theoretical work done by the great French mathematician Leverrier had been a prime factor in the discovery of Neptune by Galle in Berlin. In fact, his calculations had been the sole cause of that discovery. (Of course, the English mathematician John Couch Adams had made similar calculations which pro-dated the Frenchman's work, but Adams' predictions were ignored by Astronomer Royal Airy until after Galle had discovered Neptune -- using Leverrier's work.) A little taste of the fame associated with the discovery of a new planet goes a long way, and Leverrier began to look for new possibilities.

The unexplained advance of Mercury's perihelion soon attracted him. He deduced that this advance could be explained by either assuming Venus to be 1/10th more massive than had been thought, or by postulation an intra--Mercurial planet. By this time the relative masses of all known major members of the solar system had been worked out to a reasonably accurate degree, so Leverrier began to investigate the possibility of another planet. In 1859 he published his preliminary findings.

In response to Leverrier's paper, a physician and amateur astronomer named Lescarbault announced that he had observed the passage of an object, which he took to be the new planet, across the sun's disk. A minor earthquake shook the astronomical world. Many observers wrote excitedly to the reticent doctor seeking further information, but he was reluctant to reply to such correspondence pending more definite results. Being unable to communicate with Lescarbault in any other way, Leverrier journeyed to Eure-et-Loire to seek a personal interview.

At that time Leverrier was the lion of the European intellectual community, and was highly aware of his fame and achievements. As a matter of fact, he was known to be rather egotistical and pompous. Imagine Lescarbault's surprise upon answering his door when he was confronted by this arrogant and angry man, who refused to identify himself, and began as follows: "It is then you, sir, who pretend to have observed the intra - Mercurial planet, and who have committed the grave offense of keeping your observations secret for nine months. I warn you that I have come here with the intention of doing justice to your pretentions, and of demonstrating that you have been dishonest or simply deceived. Tell me then, unequivocally, what you have seen."

Lescarbault then proceeded to show his equipment to Leverrier. This consisted of a small refractor (the typical, and very expensive, amateur instrument of the day), a pocket watch showing only hours and minutes and a seconds pendulum (the equivalent of our modern stop watch). All calculations had been made on a wooden board, the surface of which was cleared for new calculations with a small hand plane. Despite the modesty of the equipment Leverrier came away convinced the observations had been accurately made, and that the suspected planet had been observed. He congratulated Lescarbault on his discovery and named the new planet Vulcan.

From Lescarbault's single observation, Leverrier obtained the following data:

Longitude of Ascending Node	12° 59'
Inclination of Orbit	12° 10'
Semi-major Axis (Earth=1)	0.143
Daily Heliocentric Motion	18° 16'
Period	19 days 17 hours
Mean Distance from Sun	13,082,000 miles
Apparent Diameter of Sun from Vulcan	3° 36'
Greatest Possible Elongation	8°

Leverrier's work was now ready for its final test: a second, predicted, observation. Astronomers at major observatories were alerted and anxiously awaited the great event. Alas, Vulcan failed to show up for its scheduled passage across the sun's disk. After 127 years Lescarbault's observation remains unconfirmed.

Numerous sightings of unexplained objects transiting the sun have been reported since 1860, but none of them appear to be consistent with an intra-Mercurial planet. Sightings of unexpected star-like objects in the immediate region of the sun during solar eclipses have been reported, notably by Watson and Swift in 1878, but these observation agree neither with theory nor with each other. Belief in Vulcan began to wane by 1880.

It is possible that some of these sightings were transits of the nuclei of sun-grazing comets. Many comets which encounter the sun are never observed from earth because they both approach and recede from that part of the sky which is behind the sun from our viewpoint. This is evident from the fact that many comets have been observed during solar eclipses but are never seen otherwise. However there is no authenticated observation of the transit of a cometary nucleus across the sun's disk.

Leverrier maintained his belief in Vulcan for the rest of his life. Shortly before his death in 1877 he wrote: "There is, without doubt, in the neighborhood of Mercury, and between that planet and the sun, matter hitherto unknown. Does it consist of one, or several small planets, or of asteroids, or even of cosmic dust? Theory cannot decide this point." Theory did decide the point, though not in a manner which Leverrier, in spite of his undisputed genius, could have conceived.

The Theory of Relativity, first published in the early years of this century, has special meaning for the Vulcan problem. As with other planets, the orbit of Mercury is essentially a perfect ellipse. The direction in which this ellipse is tilted rotates slowly about the sun. The shape of this orbit, as well as the rate at which it rotates around the sun, is determined by the mass of the planet, the mass of the sun, the planet's distance from the sun, and by the perturbations caused by the other bodies of significant mass in the solar system. Astronomers of the late 19th century thought that they were aware of all these factors to a great degree of accuracy, and thus the positions of the planets could be predicted fairly precisely, well in advance. This was true with one exception. This exception was Mercury, where the rate of advance for the perihelion could not be reconciled with the most careful predictions. According to Einstein, the presence of a strong gravitational field requires the addition of new terms to the equations describing space and time, which were unknown to Newton and the other founders of celestial mechanics. Mercury is the only planet whose orbit lies sufficiently close to a very massive body (the sun) for these new considerations to be measurable. The net effect is that the Newtonian formulas, when refined by the relativistic terms, predict and advance of Mercury's perihelion exactly equal to that observed over the centuries. In fact, this is one of the three classical tests of the theory of relativity. Once again our knowledge of the solar system had been advanced by a man sitting at a table, working with only a pencil and paper!

Nevertheless, the lure of such an appealing subject as an undiscovered planet, even within the orbit of Mercury, will probably never die out. It is possible, even probable, that there are very small bodies (or cinders!) revolving in the hellish intra-Mercurial region. Some of them are most certainly man-made. What is definite, however, is that they will never be observed from earth, whether in transit across the sun, during a total eclipse, or at elongation.

The case book for Vulcan is closed. Leverrier and Lescarbault are not to be criticized for their honest and scientific approach to a very serious problem. Though they did not live to see their theory disproven, they realized, as we do, that in science there must be a thousand mistakes for every solution.

DOWN PAT

an announcement by Pat Frank

Well, the time draws near for the event of the year! The meeting you've all been waiting for - the event-of-the-decade, the one-and-only, new-and-improved, back-by-popular-demand, special fortieth anniversary edition, **STAR BOWL 1987-IV** (The Voyage Home). Yes, the captains have been shangh- I mean appointed, the teams are being ostraciz- I mean chosen, the questions plageriz- I mean written! I've asked Rick Clark and Leonard Abbey to be the opposing captains this year! Yours truly, the Honorable ("Not since I was sixteen!"), the Totally Unbiased ("Rick's gonna kick his A--!"), the Unusual ("Hey! Who wrote that?"), Patrick Henry Frank III, E.S. (Eagle Scout) will be officiating ("Again?!"). If you want to be considered for a team position ("Are you nuts?!"), then call either me or one of the captains IMMEDIATELY!

Fair Skies!

How Far Is Far?

By John Marsh

How far is far? The answer to this question was once fairly constant. For eons, it was the distance that could be walked in one day. Later, it became the distance one could comfortably ride on horseback or in a horse-drawn wagon-- maybe 30 or 40 miles in a day's time. With the Industrial Revolution, the value of "how far is far" changed radically. Early steam locomotives could pull a train some 40 miles an hour; by the close of the nineteenth century, speeds of nearly 100 miles an hour were possible. Aviation has expanded the value yet further-- 1400 miles an hour aboard the Concord SST. In Earth orbit, Russians can circle the globe in under two hours.

Impressive though these advances are, they share a common limitation-- that of being Earth centered. On the scale of the universe, these achievements are quite meaningless. On the scale of the solar system, they are simply trivial. It has taken Voyager 2, the fastest thing ever built by Man, some 9 years to reach the orbit of Uranus. Much closer to home, let's say you want to fly to Mars. In order for Delta to get you there aboard a Boeing 767 (this is, of course, impossible) with a departure date of this past Dec. 1, you hopefully allowed plenty of time-- some 22 years, in fact. This naturally assumes Mars does not move during the flight!

At about the time the first steam trains were rolling, the first stellar distances were being obtained via trigonometric parallax techniques. In 1912, Henrietta Leavitt at Harvard discovered the period-luminosity relationship of the cepheid variable stars. She found that the longer the period of the cepheid, the brighter it appeared. Edjnar Hertzsprung, and later Harlow Shapley, found this to be an intrinsic property of cepheids. As stellar distances accurate to 10% or better cannot be obtained for distances beyond 70 light years with parallax methods (the baseline of the Earth's orbit is simply too small), the period-luminosity relationship proved a great advance. It was thus possible to infer distances using cepheids out to the limit of their visibility. These stars, and RR Lyrae variables which exhibit similar behavior, have been observed in M-31 (the Andromeda Galaxy) and in several more distant systems.

Trigonometric parallax and the use of variables are two of the more useful methods of determining "how far is far" in the real universe beyond the confines of Earth. By tracing radio emission from hydrogen gas clouds; observing the distribution of super-luminous bluegiant stars, the distribution of open star clusters, and inference from observations of other galaxies, a reasonable picture of our galaxy's spiral structure has been obtained. It might be noted some evidence exist that the nucleus of the Milky Way may be quite active, having some of the characteristics of Seyfert galaxies. There is also some indication of a barred feature in the inner Milky Way-- one wonders if observers in M-31 or M-33 build careers on observations of the "peculiar" active barred spiral at the other end of the Local Group!

The Metropolitan Milky Way

How can one relate the scale of "how far is far" in the Milky Way to "how far is far" on Earth? The best was is by analogy, by scaling down the Galaxy to a manageable size. As it turns out, a scale of 1,000 light years to a mile is just about right for scaling the Milky Way to the size of metropolitan Atlanta. Best estimates for the diameter of the Milky Way fall in the area of 80,000 light years. At a scale of 1,000 light years per mile, this equates to an 80 mile diameter, or 40 miles radiating in any direction from Margaret Mitchell Square downtown (near the Georgia Pacific Building).

Perhaps the best use of this analogy is to take a sample of stars, some nearby, others quite remote, and fit then into the "Atlanta Galaxy". This will not only provide a general idea of stellar distances, but also of the vastly varying degrees of distance between near and distant stars. We'll start close by, and move progressively further into galactic space. Tabulating values for selected stars, we find:

1) Alpha Centauri-- 4.3 Light Years equals 21.5 Ft.
2) Sirius-- 8.8 Light Years equals 44 Ft.
3) Vega-- 26.4 Light Years equals 132 Ft.
4) Arcturus-- 36.2 Light Years equals 181 Ft.
5) Achernar-- 143.3 Light Years equals 717 Ft.
6) Betelgeuse-- 489 Light Years equals 2445 Ft.
7) Rigel-- 815 Light Years equals 4075 Ft.
8) Deneb-- 1467 Light Years equals 7335 Ft. (1.5 mi.)

Stars 1-4 in the list are relatively near neighbors. Stars 5-8 are moderately distant to quite remote, as in the case of Deneb.

We'll "observe" the Atlanta Galaxy from our own Barber Observatory near Villa Rica. Our observing site is about 30 miles from downtown, our analogous galactic center. This corresponds quite well to our solar system's distance from the center of the Milky Way-- given as between 25-30,000 light years. The outer edge of the Atlanta Galaxy in the direction of Villa Rica lies near Tallapoosa, close to the Alabama line. To the east, it extends nearly to Athens. Interestingly, the boundary of objectionable light pollution is at a similar distance!

How far is far-- as judged on our analogous scale as seen from Barber Observatory? By setting several of the listed stars, an idea of the extent of the visible sky can be obtained. We'll set the sun's position at the pier of the 20" reflector, and we'll assume all stars to be in the galactic plane for the sake of simplicity. Alpha Centauri lies 21.5 ft. to the southeast. It sits outside the observatory wall, in the lower observing area. Sirius is 44 ft. distant toward the southwest, near the warm-up shed. In the Barber's pasture, some 132 feet away, shines brilliant Vega. The fourth brightest luminary in our night sky is well within rock throwing distance! In fact, the 60 or so nearest stars all fit nicely within our observatory grounds.

Our miniature galactic neighborhood expands somewhat when we consider the distant stars on the list. The red supergiant Betelgeuse resides 2445 ft. toward the southwest-- nearly 56 times the distance of Sirius. Rigel, in the same general direction, is 1630 ft. further still. Indeed, most of the brighter stars in Orion are blue-white giants related to one another; born in the same general area of space. Betelgeuse is simply a foreground object. Deneb is the most distant star on our list, at about 1467 light years. In the 1,000 light year/ mile analogy, its distance is 7335 ft, almost 1.5 miles toward the northeast. At last, we are finally outside the observatory grounds, and even outside the Barber's property! Even so, this is barely halfway to Villa Rica proper.

We thus find that while a considerable differential exist between the nearer and more distant visible stars, even the distant ones are quite close by with respect to the scale of the Milky Way. It is probably a safe assumption that the most distant individual stars visible with the un-aided eye are within 5,000 light years. On the scale of the Atlanta Galaxy analogy, this corresponds to 25,000 light years-- 5 miles. Therefore, the entire visible sky of naked-eye stars can be encompassed within a five-mile radius of the 20" reflector pier. This is beyond Villa Rica, but just barely beyond Leather's Truck Stop (at the I-20 interchange)!

Using naked-eye stars alone, our greatest reach into the metropolitan Milky Way is quite local. To achieve truly metropolitan scale, larger scale objects must be used, i.e., open and globular star clusters. One interesting example is NGC-2168, the remote open cluster in the same low power field with M-35 in Gemini. This object, a mottled glow in moderate size amateur instruments, is about 26,000 light years distant. In the analogy, this is some 26 miles to the south-southeast. For the Atlanta Galaxy, we might label NGC-2168 "Bypass", a small town on the Georgia map near the location.

Finally, globular clusters can be observed to still greater distances, the most remote being over 100,000 light years out, actually outside the Milky Way as usually defined. Most globulars are grouped around the central core. In the case of the Atlanta Galaxy, we might label these "Sandy Springs", "Mableton", "Douglasville", etc.

By using clusters and super-luminous stars such as Rigel and Deneb (both are some 60,000 times as luminous as the Sun), astronomers have optically plotted portions of several spiral arms in our general region of the Milky Way. In the analogy, these would extend northeast to southwest for many miles, well into adjacent counties. As a final kicker, consider this: on a scale where the nearest star is 21.5 feet away, the nearest major galaxy, M-31 in Andromeda, is some 2,000 miles distant. If the Milky Way is the Atlanta Galaxy, then M-31 must be Los Angeles.

That's how far is far!

The following article appeared in the Penn State College of Science Alumni Society newsletter, and is reprinted with the author's permission.

A Stellar Opportunity for Amateur Astronomers

by Dr. Gordon Garmire

Amateur stargazers have always been a valuable aid to me as a professional astronomer but I believe NASA's launching of four Great Observatories over the next decade promises special new opportunities for amateur/professional cooperation and achievement.

Over the next 10 or 12 years, NASA will be placing in earth orbit four major observatories planned to give us our sharpest and most penetrating view yet of the universe.

A unique aspect of the operation of these national astronomical facilities is that the data from them will be in the public domain a year after it is taken. It should be possible for anyone with a home computer to simply call a telephone number at the National Space Science Data Center at the Goddard Space Flight Center and request data on a particular celestial object. The data then can be transferred over telephone lines to a home computer and displayed by suitable software packages.

Getting and using the data should be well within the resources of, for example, an ingenious teenager who can use computers very well and has a combined interest in computation and astronomy.

Judging from my experience with amateurs, the opportunity should generate some interesting collaborations.

For example, in a program I was involved in eight years ago, amateurs provided us with the information on when certain stars, called cataclysmic variables, brightened. These stars brighten rather randomly, so they had to be monitored constantly. Amateurs aided us by keeping track of the brightenings and calling the data into a central clearinghouse, the American Association of Variable Star Observers, in Cambridge, Mass.

In the future, I think that the Hubble Space Telescope, which is supposed to be in operation in 1988, will probably be the observatory that will attract the most amateur attention because it will be used to make observations in the optical portion of the spectrum. In other words, it will send back information about objects that can be seen with the human eye. The optical range, of course, is the part of the light spectrum with which amateurs are most familiar.

The next observatory to be placed in orbit, by 1990, will be a Gamma Ray Observatory. Initially amateurs may have less interest in this one because interpreting data from the gamma ray portion of the spectrum is a bit foreign. However, once individual gamma ray sources are identified, amateurs could have a very important role to play. For example, they could provide information on changes in the optical intensity of potential gamma ray sources as the amateurs did in our study on cataclysmic variables. Amateurs could be crucial to the project since gamma ray astronomers don't usually keep tabs on the optical sky.

The observatory I am working on, the Advanced X-Ray Astrophysics Facility, will not be launched until the mid-1990s when an infrared telescope also will be placed in orbit. I have no doubt that the wide use of personal computers in the home coupled with ever increasing computing power and storage capacity should make possible access and use of the archived data from these observatories as well.

The enjoyment of viewing the heavens with your own telescope, either homemade or purchased, has been shared by many amateurs, but the new dimension of being able to share views of the universe obtained by the very best instruments devised by humans will make it possible for the interested amateur to participate in expanding the frontiers of astronomy.

[Dr. Gordon Garmire, Penn State professor of astronomy, is head of a team developing instruments to analyze data from the Advanced X-Ray Astrophysics Facility (AXAF) scheduled to be launched by NASA in the mid-1990s. AXAF is one of the four Great Observatories scheduled to be launched by NASA over the next decade.]

Submitted by: George Weaver
Penn State Astronomy Department

OBSERVER'S ALMANAC

Moon Rise, Set, and Phase
(All times are EST)

Date	Rise	Set	Phase	Date	Rise	Set	Phase
01/15	18:26	08:27	99%	02/06	12:10	02:01	55%
01/16	19:26	09:03	98%	02/07	12:48	03:00	64%
01/17	20:25	09:34	95%	02/08	13:33	03:58	73%
01/18	21:24	10:02	91%	02/09	14:23	04:53	81%
01/19	22:23	10:28	84%	02/10	15:18	05:42	87%
01/20	23:22	10:53	77%	02/11	16:17	06:25	93%
01/21	----	11:19	68%	02/12	17:18	07:03	97%
01/22	00:24	11:47	57%	02/13	18:18	07:36	99%
01/23	01:29	12:19	47%	02/14	19:18	08:05	99%
01/24	02:39	12:58	36%	02/15	20:17	08:32	98%
01/25	03:51	13:45	25%	02/16	21:17	08:57	94%
01/26	05:04	14:44	16%	02/17	22:18	09:22	89%
01/27	06:12	15:52	8%	02/18	23:21	09:49	81%
01/28	07:11	17:08	2%	02/19	----	10:19	72%
01/29	08:00	18:24	0%	02/20	00:28	10:55	62%
01/30	08:41	19:38	0%	02/21	01:38	11:37	51%
01/31	09:14	20:48	3%	02/22	02:49	12:30	40%
02/01	09:44	21:54	9%	02/23	03:57	13:33	29%
02/02	10:11	23:00	17%	02/24	04:58	14:44	19%
02/03	10:38	23:59	25%	02/25	05:50	15:58	10%
02/04	11:06	----	35%	02/26	06:33	17:13	4%
02/05	11:36	01:00	45%	02/27	07:09	18:24	1%
				02/28	07:41	19:32	0%

(-----) indicates phenomena will occur the next day

LUNAR PHASES

Month	New Moon	First Qtr	Full Moon	Last Qtr
Jan	29 08:44	6 17:34	14 21:30	22 17:45
Feb	27 19:51	5 10:21	13 15:58	21 03:56

PERIODIC COMET NEUJMIN 2

This comet, last observed in 1927, is approaching a favorable apparition for recovery. As it may brighten to magnitude 11, there exists an excellent opportunity for amateurs to participate in the effort to find and update the elements of this object. Elements: (1950)

$W = 307.1503^{\circ}$	$w = 214.9380^{\circ}$
$i = 5.3652^{\circ}$	$q = 1.271420$
$T = 2.3958$ April 1987	
$e = 0.586533$	$P = 5.39$ years

COORDINATES FOR COMETS NEUJMIN AND SORRELLS

(all coordinates are for 7:00 PM EST on date given)

	Neujmin		Sorrells	
Date	RA-2000	Dec-2000	RA-2000	Dec-2000
Jan 15	05:45.2	+28d47	00:01.6	+12d59
Jan 20	05:41.2	+28d04	23:56.0	+12d15
Jan 25	05:38.4	+27d28	23:51.5	+11d41
Jan 30	05:37.2	+26d30	23:47.9	+11d13
Feb 05	05:37.8	+25d32	23:44.6	+10d48
Feb 10	+05:40.3	+24d43	23:42.4	+10d32

POSTMASTER:
If undeliverable, please return to:
AD ASTRA
c/o Mr. Pat Frank III
465 Pine Forrest Rd., N.E.
Atlanta, GA 30342

ATLANTA, GA 303
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7 JAN
1987

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3518 Roswell Rd. Apt. C-6
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