AD ASTRA

Vol. II, No. IV | *The Newsletter of the Atlanta Astronomy Club* | December 1987

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CLUB CALENDAR

Next Meeting: December 11, 8:00 p.m. at Bradley Observatory
Program: To be announced.

AD ASTRA is published monthly during the academic year by the Atlanta Astronomy Club, Inc. The AAC, a non-profit organization, is dedicated to the advancement of amateur astronomy, and fostering the social, literary, and educational needs of its members. Meetings are held on the third Friday of each month (second Friday of December) unless otherwise announced in this publication. Membership dues are $25 annually and include a subscription to *Sky & Telescope* magazine and use of club observatory facilities.

Editor in Chief: .... John Marsh
Managing Editor: .... Don Barry
Technical Editors: .... Sharone Franklin, David Roberts, Rick Clark, Richard Jakiel

Submissions: Article submissions are most welcome, and may be delivered to the editor for consideration.

CLUB MINUTES

The November 20, 1987 meeting of the Atlanta Astronomy Club was held at the Bradley Observatory with President Lee Wilson presiding.

Club member, Ken Guyton, gave a lecture titled: *The Dark Sky Paradox or Olbers' Paradox.* Mr. Guyton explained why the night sky is indeed dark even though innumerable stars are emitting photons from all directions. He gave a brief history of this subject by describing the opinions of Johannes Kepler, Edmund Halley, Harlow Shapley and of course Heinrich Olbers.

Past and present astronomers have had different theories as to why the night sky is dark. Some have argued whether or not space is finite or infinite and of the homogeneity of stars within this space. Others have suggested an absorbing gas might limit the amount of starlight that we can see. The present theory for a black sky is that much of the light from distance stars has yet to reach us (the universe is simply too young) and that what light does reach us is somewhat redshifted.

IS DR. FAUST AN ASTRONOMER?

by John Marsh

> Sign on the line! In these next days you will get Ravishing Samples of my arts; I am giving you what never Man saw yet.
>
> Mephistopheles to Faust; *Faust, Part 1*, by Goethe

INTRODUCTION

IN THIS past October's issue of *Sky & Telescope*, the Focal Point section presented two countervailing views on the subject of Professional Astronomy's relationship to the Strategic Defense Initiative (SDI). The matter of the military's relationship to science has always been a crucial one. Applied science has benefited particularly. One excellent example from our own century bears this out most graphically -- World War II. The development of advanced electronics, including computers, traces directly back to war research. Radio Astronomy is another direct beneficiary. Left over apparatus used for the development of radar formed the basis of the first professional radio telescopes. Other examples of applied science with military origins include modern jet aviation, and, of course, Russian space flight.

It has been said that really large, large numbers are understood by only two classes of people - government economists and astronomers. This has never been so true as it is today, with budget deficits becoming quite astronomical themselves. Sadly, those same government economists are increasingly less willing to allocate funds for pure (so-called) scientific research. Astronomy, perhaps the "purest" of the sciences, has suffered particularly severe cutbacks. The situation is so bad that Kitt Peak National Observatory, ostensibly our nation's premier astronomical research institution, has not the funds to keep its buildings painted!

Now it appears that new types of "high tech" military research may change this equation. In particular, SDI could potentially offer astronomy a windfall in both funding and equipment. Is this good? The following are some thoughts on the subject inspired by the *Sky & Telescope* exchange.

I. SHOULD WE STOP WORRYING AND COME TO LOVE SDI?

Simon P. Worden, astronomer, Air Force Lt. Colonel, and science advisor in Ronald Reagan's White House, does make some valid points in his side of the SDI debate. He points out that Sacramento Peak Observatory, now a unit of AURA (Associated Universities for Research in Astronomy), began as an Air Force facility. He also points out that the 1,000 ft. Arecibo radio telescope was originally an Air Force project.

Based on these past precedents, Worden argues that professional astronomy should both endorse and participate in SDI research in order to reap future benefits. As an example of the kind of true benefits that can be expected, he describes a 10 meter reflector to be built at White Sands, New Mexico, for SDI development work. When SDI laser testing using this telescope is complete, Worden asserts, it will likely be turned over to astronomers. Fine and good, but does this imply that professional astronomy has an obligation to support (and assist) in controversial military projects?

The basic thesis in Worden's argument is that one cannot separate military technical research funding from funding targeted at "pure" science. He argues (with probable correctness) that a linkage exists between development of new technology astronomical optics and SDI optics. In other words, astronomy is dependent on military research; without SDI funding, there would be no funding for next generation astronomical instruments. If pure researchers kill off basic research for military projects (SDI or otherwise) their own funding dies as well. To quote directly, "The choice is not between 'clean' civilian and 'dirty' SDI work; it is between SDI or nothing at all."

II. MAYBE WE SHOULD WORRY.

There can be little doubt that Col. Worden's arguments are valid; the question is whether this sad situation should be tolerated. Rather the Strategic Defense Initiative is a viable defense system or not is irrelevant to the larger question of the marriage of "pure" science with military research projects. (The salient points in Carl Sagan's rebuttal, i.e., it can be easily overwhelmed, it can be circumvented by using strategic bombers or Cessna 172's, etc., answers the SDI question anyway).

We should not doubt that American astronomers are, as a group, just as patriotic as any other section of society. Indeed, the ideals that our country has traditionally stood for, i.e., freedom of expression, freedom of travel, and freedom of association are all vital to the health of scientific research.

American astronomers thus have a vested interest in preserving these basic aspects of our society. And that is precisely the point. By becoming increasingly drawn in to military and other projects specifically related to "national security", they risk losing the open atmosphere necessary to sustain the life of a vital science. If the astronomical community does become totally dependent on such things as SDI research for its funding and equipment, it risks coming under government control. Clearly, this could have a "chilling effect" on the free flow of ideas within the astronomical community. Big government science often means classified science; the results of complete government dependence would be particularly damaging to the international nature of the science.

This brings up the aspect which I consider to be of greatest importance. Since the inception of modern science, the free flow of ideas across international boundaries has been of critical importance. In astronomy, this process began with correspondence between Galileo and Kepler. A spectacular example of international cooperation in astronomy was the *Carte du Ciel* (Map of the Sky) project of the late 19th-early 20th century. It sought to map the entire sky by photographic means, at a time when photography was just coming into importance. Involved were observatories in England, France, Germany, and individuals from other nations as well. In particular, cooperation between French and German observatories illustrates how science (astronomy in particular) can transcend political rivalries. Predictably, this mutual cooperation ended with the decision of the respective governments to declare war on each other in 1914. The *Carte du Ciel* was never completed.

Today, much useful collaboration takes place between Russian and American astronomers. Considering our national security establishment's penchant for paranoia, allowing astronomical research to become closely tied to military work (such as SDI) would seriously compromise such collaboration. Bart J. Bok, whom I regard as something of a personal hero, put great value on the importance of international cooperation. Astronomy's high profile as an international science was considered by Bok to be one of its greatest attributes.

While some interaction between astronomy and government is unavoidable, even desirable, it is vitally important for the science to retain its basic independence. If it should ever come down to a choice between government (esp. military) funding and the continued independence of research and communication of research, the choice should be obvious. Caution should be exercised when dealing with Mephistopheles, lest astronomers risk losing their souls and sliding into the pit of isolation.

THE TELESCOPE WITHIN

by Don Barry

What watchful cares do interpose betwixt your eyes and night?

Brutus, *Julius Caesar*, ii(1), Shakespeare

Imagine, if you will, an autofocus camera, f/2.2-f/8, capable of slewing at 500°/s, tracking at 30°/s, and possessing some 120 million active pixel elements, capable of detecting one out of every 5 photons received. We are indeed fortunate that each of us possesses two of these technological wunderkinder, which are the human eyes.

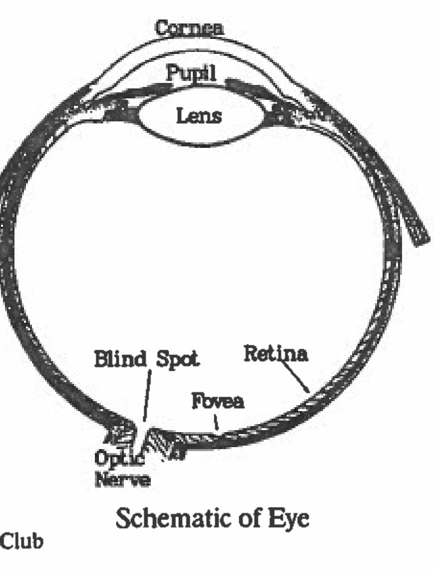
In this era of computerized astronomy, the eye has taken second place to the bewildering variety of equipment available to the modern practitioner; historically, however, visual observations were epochal in making the discoveries that now define the structure of our solar system, and our place in the galaxy. In antiquity Ptolemy catalogued 1022 stars visually, superseded only by the great Tycho Brahe some 14 centuries later. It was Tycho's catalogue, accurate to 1' of arc, that facilitated the production of Bayer's first modern atlas, the *Uranometria*. Data in Ptolemy's and Brahe's catalogue revealed the phenomenon of precession, and for a few close stars, proper motion.

With Galileo's advent of the telescope, visual astronomy entered its golden age. The rotational periods of Mars, Jupiter, and Saturn were determined visually, and even in this century companion moons to these planets were found by skilled observers as telescopes grew. The great Messier and New General Catalogues grew out of the tradition of visual amateur astronomy, culminating in the works of Webb, Flamsteed, Struve, Dawes, and Herschel.

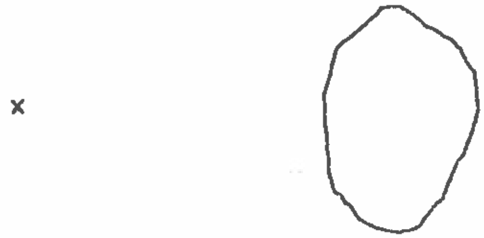
It would seem that the rise of instrumental astronomy with the the photographic plate, spectroscope, photomultiplier, CCD, and brethren, would reduce visual observations to historical curiosities. In many ways, though, the eye is still the most adaptable, sensitive, and general purpose instrument available to the astronomer.

Structurally, the eye and retina are the result of aeons of refinement that have produced a visual system capable of adapting to light over levels differing by factors of 10^{14}. The eye, in collaboration with feedback mechanisms in the visual cortex, automatically focuses on objects "locked onto" by the mind, and can track these objects in the visual field smoothly and automatically, almost without a thought.

The schematic reveals the plan of our eye-camera. Light rays enter through the cornea, which is a lens system of some 42 diopters strength. The pupil, an automatic light-adjusting device, varies the aperture of the visual system from 2 through 8 mm. The entering



Schematic of Eye



The Author's Macula

rays then pass through the crystalline lens, a gradient-index device consisting of many onion-like layers, which is automatically shaped by muscles that adjust its strength from 20 to 30 diopters. In the 24 mm from corneal surface to retina, the light ray passes through 4 regions of varying index of refraction, from 1.336 (near water) in the aqueous humor, to 1.413 (between water and glass) in the lens. It then impacts on the retina, which transmits the image to the brain.

This surface is perhaps the most remarkable component of the eye. The human retina consists of a tiling of two distinct cellular types, labelled as "rods" or "cones" according to their appearance through the microscope. In the center of our visual field, around a pitlike depression called the *fovea centralis*, cones predominate. This region, which we regard as the "center" of our visual field, even though it is offset some 5 degrees from the optical axis of the eye, is packed with light receptors-- some 15,000 occupy a circle only a quarter of a millimeter across. This density exceeds that of a modern CCD detector by a factor of 3, provides good photonic response, and provides color sensitivity lacking in the CCD. But strangely enough, this region of the retina is scarcely used by astronomers.

The reason lies in the relative insensitivity of cones to low levels of light. Chicken eyes contain only cones, and the poor birds are forced to roost hours before we perceive that darkness has fallen. As the vista dims, our color vision fades, and we rely more and more on the rods of our retina, which though scarce in the fovea, are richly spread throughout our peripheral vision.

At night, we perceive shades of grey rather than colors, except in bright objects. Through a telescope, most objects are colorless, except the planets, bright double stars, and bright emission and planetary nebulae. For the majority of dim objects, then, there is a disadvantage to a direct glance at the object, because the image is projected on the portion of the retina least sensitive to light. Rods increase in density quickly outside the fovea, peaking in the visual field some 19 degrees horizontally away from center or 15 degrees vertically. Recent studies indicate that there are more rods above the fovea than in other directions, therefore perhaps the best technique of using the astronomer's "averted vision" is to look above the object of study, and glimpse its detail through peripheral vision.

Although we don't realize it, each of us has a sizable hole in our visual field, only a short distance away from the center of our fovea. It is possible to actually make a drawing of this region, called the macula, which is the insensitive area where nerve fibers enervating the retina bundle prior to leaving the eye at the optic nerve. In the drawing, there is an X and to its right, an irregular patch. This is a sketch of the author's macula. To make your own sketch, place a blank sheet of paper before you, about a foot away, and place a small X at its left. Closing or covering your right eye, and keeping your head stationary, hold a pen over the right side of the paper, following the pen's tip with your eye. When the X falls on the macula, it will disappear from peripheral vision. By moving the pen, the X will appear and disappear, revealing the boundary of the macula, and allowing a sketch to be made. There is considerable variation among individuals, and even between eyes. If your macula is unusual, mail it to AD ASTRA, and we'll publish it in a future issue.

Blind spots such as the macula, called *scotomas* in medical parlance, are rendered unobtrusive by the sophisticated visual processing of the brain, which "fills in" these areas according to the surrounding field. Fortunately, the blind spot is small and unique in most people, so it does not complicate the process of astronomical observation.

Knowledge in hand, we can optimize our visual performance at the telescope. Dim objects fare best when viewed away from the enter of the visual field, preferably by looking above them (placing them below the center of field). Telescope optics should be selected so that the projected exit pupil will all fit in the eye's pupil. This can be done by dividing the focal-length of the eyepiece by the focal-ratio of the telescope. The pupil dilates up to 8mm in youth, decreasing gradually to a maximum of 3 mm at advanced age. A wide field 24mm eyepiece, for example, in the f/4.5 20" telescope owned by the club yields a 24mm/4.5=5.3mm exit pupil, which is suitable for most observers. And the eye should be allowed to adapt, both in pupillar dilation and retinal "recharging", for at least half an hour before serious observing commences, hence the expostulations and vituperations on unexpected bright lights at observing sessions!

At altitudes of 5000 feet and above, subtle hypoxia (oxygen shortage) dims vision. To an observer on Mauna Kea, the skies look almost as sparse and dim as a mid-city dweller might see them. Above 5000 feet, oxygen can be breathed to enhance vision, although some studies indicate that simply increasing blood sugar may help compensate somewhat for the atmosphere's thinness.

Finally, alcohol and smoking have deleterious effects on the eye's sensitivity. Alcohol actually reduces blood flow (and thus oxygenation) in the retina, if an appreciable amount is present. Nicotine constricts both the pupils and the retinal vessels, and is incompatible to the social graces for communal observing anyway.

Optically, then, the eye is superbly designed. The retina has a near optimal curve for receiving the projected image of the lens, and the diffraction spot on the retina, some 3.7 microns in size, is almost the size of a cone cell. Neurally, the 120 million sensors on the retina are multiplexed onto the 1 million fibers of the optic nerve so that full detail is preserved in the center of the visual field, where it is needed.

For all its versatility, individual eyes have much variation. It was reported recently in *Science* that the cone density in the inner fovea can differ by a factor of 3(!) among individuals, and similar disparities in rod density are suspected. So there may yet be truth in ad hoc classifications of visual astronomers as being "detail", "color", or "dim" observers. As we age, we cope with further variation in pupillar accomodation, focusing degradation, cataracts, retinal degeneration and developing opacity of the eye's fluids and membranes. At age 80, we may experience a visual loss of some 2.5 magnitudes. But even then, the retina remains more sensitive to real-time incoming photons than the best photographic emulsion available.

These remarkable attributes of the retina perhaps explain why visual astronomy is therefore very much alive, and continues to complement instrumental astronomy. Dollfus reported spikes he saw in Saturn's rings in the 50's, which were dismissed until confirmed by Voyager at a distance 20,000 times closer. Although Schiaparelli's "canali" remain an albatross still burdening visualists, the eye still reveals more detail than detected by current technology photographic-optical systems. Transient phenomena of all sort, from purported lunar outgassings to cloud and spot phenomena on the Jupiter and Saturn, still respond best to the time-honored methods of the amateur. The ability of the eye to reject bad seeing conditions, and then freeze a view during a moment of clarity, remains unmatched.

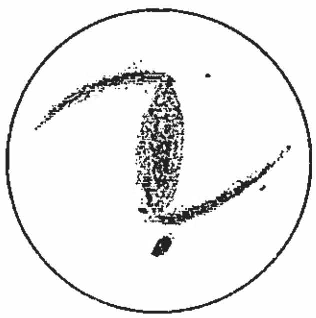
For the first time in two decades, considerable activity is now beginning in the North Jovian bands, as reported in the December *Sky & Telescope*. The best sensor for recording these phenomena remains the oldest one. You're using it right now.

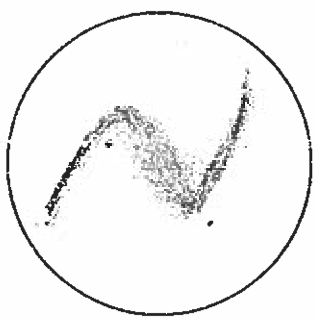
SMALL, ROUND, AND DIM

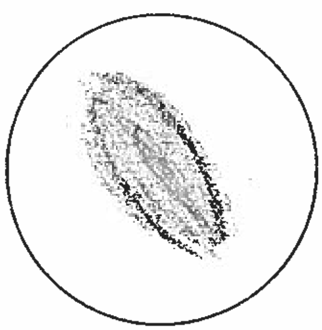
by Richard Jakiel and Rick Clark

One of the more interesting aspects of deep sky observing is attempting to draw and describe the morphology of various objects. Last month, this column looked at the large spiral M-33 in considerable detail. This month we examine several large barred spiral (SB) galaxies located deep in the southern sky.

The tour begins with NGC 1097, a large 10.6 magnitude barred spiral in Fornax. In the club's 20" telescope, the central bar was nearly 8 minutes long (oriented nearly north-south) with a bright central nucleus. The spiral arms are faint but distinct, and just above the northern arm is the small elliptical galaxy, 1097a. It is about 0.5' across and around magnitude 13.0. Lying to the west is NGC 1398, another bright SB galaxy. Using the 13mm Nagler in the 20" scope, a bright central bar was visible embedded in a nebulous haze.

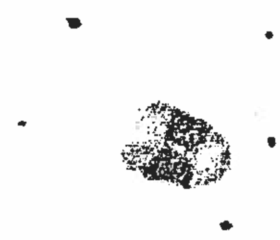

NGC 1097+1097A


NGC 1365


NGC 1300

"Bar hopping" to the south is NGC 1365, a giant SB galaxy, and one of the brightest members of the Fornax Galaxy Cluster. Located over 55 million light years away, this compact cluster of bright galaxies is easy to see with a 8" or 10" telescope. The 13mm Nagler eyepiece reveals NGC 1365 as bright and large, with very distinct spiral arms. Less than two degrees to the northwest there is a tight clump of 10-12 magnitude galaxies, of which 9 lie within a one degree field.

In nearby Eridanus is NGC 1300, a classic SB galaxy, often portrayed in popular astronomy textbooks. Although of low surface brightness, an 8" telescope reveals the nucleus and central bar. In the 20", the central bar lies embedded in faint nebulosity, with the oval nucleus aligned with the bar.

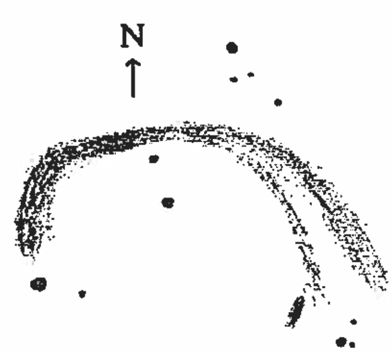


Above: The planetary nebula M76 in Perseus, drawn by Rick Clark with his homebuilt 17.5" Newtonian at 128x. *Left:* Several barred spirals in the Fornax region, drawn by Richard Jakiel through the 20" f/4.5 Newtonian with a 13mm Nagler eyepiece.
Below: The emission nebula NGC 6888 in Cygnus, as drawn by Rick Clark with the 20", 13mm Nagler, and Lumicon UHC filter.

Returning to northern skies, we come to the 12th magnitude planetary M76 in Perseus. In most telescopes it is seen as a small rectangular patch of light but in the 20" with a UHC filter much more detail is revealed. The object shows some hooks of light and starts to appear more round than rectangular, as the drawing shows.

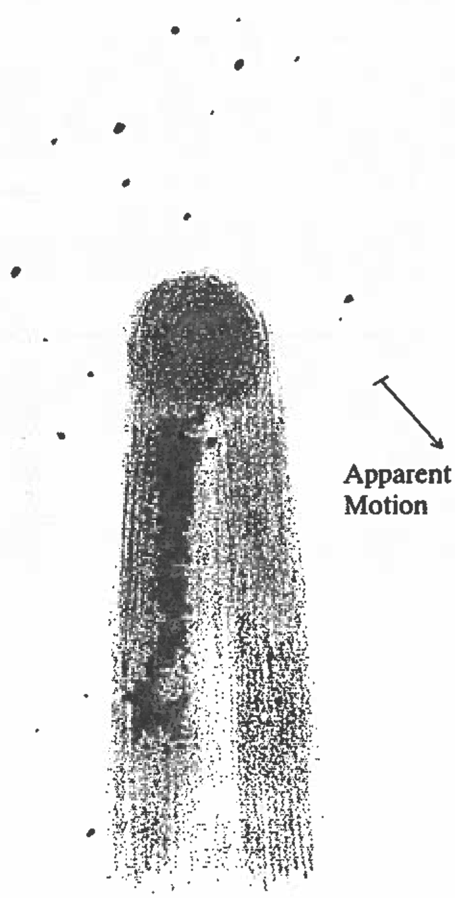
Moving along the Milky Way, we come to the magnificent cluster NGC 7789. This is a beautiful cluster of hundreds of stars, magnitude 11 and dimmer. This cluster is unusual in the sense that it doesn't seem to have a central condensation like most others. Also, the stars do not vary greatly in brightness; this creates a beautiful dusting of stars.

Continuing down the Milky Way to Cygnus, we come to NGC 6888-- a very interesting diffuse nebula near the star Gamma Cygni. This nebula is barely visible in a 6" scope, but in the 20" it reminds me of the nearby Veil Nebula. I suspect that this object is a supernova remnant, judging from its distinct "C" shape. The drawing, however, does not show much of the detail present; the brighter areas show many filaments and knots.



Comet Bradfield has given a fine evening show these last few weeks, and should continue to be fairly bright through December. On 14 November it displayed a 1 1/2° cleft tail, in a rich field of stars. The comet gave several nice binocular views as it passed near several star clusters in early November, and it now moves through Aquila as it recedes from the earth. Expect it to fade to SRD classification through January and February.

Our journey ends with three small, dim, and round galaxies in Pegasus: NGC 1, 2, and 7839. NGC 1 is small, round, and dim (surprise!), and in the same field with NGC 2 which shows up as a non-descript smudge of light. Forming an "L" with these two galaxies is 7839, another small, round galaxy. It is interesting to note that the first NGC object is in the same field with the last existent object; NGC 7840 was present in the original catalogue but no object has been found in its reported position.



Above: Comet Bradfield, again drawn by Richard Jakiel on the evening of 11/14/87. The tail was approximately 1 1/2 degrees in length. A 10" f/6 Cave Newtonian was used to execute the drawing.

NOTES FROM THE CENTRAL BUREAU

IAU bulletin 4496, dated November 24, reported the discovery of a possible supernova in M31 by Metlova of the Sternberg State Astronomical Institute. The reported photographic magnitude was 11.0, and precise positions were given. Although the claimed discovery was on November 21, no forward was made of the claim until some two days later.

Researchers in California and the Northeast, receiving the report in daylight hours, quickly planned their observations from photographic surveys, tentatively identifying a possible Wolf-Rayet progenitor, and projecting a maximum brightness of magnitude 4 should the supernova be type I, or 5 if type II. Everyone waited for the sun to set.

Surprise! IAU bulletin 4498, dated late November 24, states: "Numerous reports have been received noting that there is no new object at the position reported on IAUC 4496 to a limiting magnitude of 15." Apparently an errant silver halide crystal spawned a plate defect that sent world astronomers scurrying for a hoped second local-group supernova in the present year. Oh well. Maybe next year.

Hoshimi Ichimura, of Hoshimi-machi, Saitama, has discovered a comet, designated 1987d1. The comet has a close perihelion, and may reach magnitude 0 for the few days spent near the sun. Unfortunately, it is another southern-hemisphere object, and is not well placed for viewing from any location except earth orbit during its brief bright reign. It will be a morning object in late January fading quickly as it emerges from twilight.

Orbital elements for Comet Ichimura(1987d1)

T= 1988 Jan 9.92 ET	w=329.82
	W=225.31
q=0.1978 AU	i=40.23

Sigeru Furuyama, of Ibaraki, Japan, has reported discovery of a comet near 10th magnitude just above the Hyades of Taurus. No orbital elements are available as this issue goes to press.

Ephemeris for Comets Ichimura and McNaught

Date	Comet	RA (2000)	Dec	Mag	Time
23 Dec	McNaught	17:41.0	-05d27	8	7:00 AM
26 Dec	McNaught	17:47.5	-02d52	8	7:00 AM
29 Dec	McNaught	17:54.2	-00d15	8	7:00 AM
02 Jan	McNaught	18:03.3	+03d19	8	6:00 AM
05 Jan	McNaught	18:10.5	+06d05	8	6:00 AM
08 Jan	McNaught	18:17.9	+08d54	8	6:00 AM
11 Jan	McNaught	18:25.7	+11d48	8	6:00 AM
14 Jan	McNaught	18:33.7	+14d42	8	5:00 AM
14 Jan	Ichimura	19:03.9	-18d35	1	7:00 AM
17 Jan	McNaught	18:42.1	+17d42	8	5:00 AM
17 Jan	Ichimura	19:23.5	-14d19	4	7:00 AM

OBSERVER'S ALMANAC

by Don Barry

Moon Rise, Set, and Phase

(All times are EST)

Date	Rise	Set	Phase	Date	Rise	Set	Phase
12/15	02:09	13:48	33%	01/06	20:13	09:42	95%
12/16	03:10	14:17	24%	01/07	21:11	10:11	91%
12/17	04:15	14:50	15%	01/08	22:06	10:37	85%
12/18	05:24	15:31	8%	01/09	23:02	11:01	78%
12/19	06:35	16:21	3%	01/10	23:58	11:24	68%
12/20	07:46	17:22	0%	01/11	----	11:48	60%
12/21	08:50	18:33	0%	01/12	00:56	12:14	50%
12/22	09:45	19:48	3%	01/13	01:57	12:44	40%
12/23	10:30	21:04	8%	01/14	03:02	13:21	30%
12/24	11:08	22:16	16%	01/15	04:11	14:05	21%
12/25	11:40	23:25	25%	01/16	05:22	15:00	12%
12/26	12:09	----	36%	01/17	06:29	16:07	6%
12/27	12:37	00:31	47%	01/18	07:29	17:21	1%
12/28	13:05	01:36	58%	01/19	08:20	18:39	0%
12/29	13:35	02:40	68%	01/20	09:02	19:55	1%
12/30	14:08	03:44	78%	01/21	09:37	21:08	5%
12/31	14:46	04:48	85%	01/22	10:08	22:18	12%
01/01	15:30	05:50	92%	01/23	10:38	23:25	21%
01/02	16:21	06:49	96%	01/24	11:06	----	31%
01/03	17:16	07:42	99%	01/25	11:36	00:31	42%
01/04	18:15	08:29	99%	01/26	12:09	01:37	53%
01/05	19:15	09:08	98%	01/27	12:46	02:41	63%

(----) indicates phenomenon does not occur on given day.

MONTHLY SATELLITES

The Russian space station Mir was boosted to a higher orbit around 22 November, invalidating predictions in the previous newsletter past that date. It continues to dock regularly with Progress resupply craft, and preparation continues for launch of an additional experimental module (like Kvant) that should join with Mir early next year.

I'd be interested in hearing from people who make use of these predictions and of your success in sighting the satellites. My address is: Don Barry / 2867 Ashford Rd. / Atlanta, GA 30319.

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Friday evening, 11 December 1987
 Time(EST)    Az    El   Range RA/Date D/Date  Mag
06:22:41PM 212.6 28.1 00658 21:03.5 -20d52 +0.3
06:23:57PM 137.5 69.7 00356 00:04.3 +18d00 -0.6
06:25:13PM 057.7 28.6 00650 04:26.6 +41d03 +1.2
Shadow entry.
 MIR                    USSR            D/S=0.79

Saturday evening, 12 December 1987
 Time(EST)    Az    El   Range RA/Date D/Date  Mag
06:41:38PM 277.2 20.5 00830 18:23.5 +17d00 +0.4
06:42:54PM 323.4 29.2 00641 17:37.3 +58d39 -0.1
06:44:10PM 007.8 19.8 00853 09:38.0 +74d22 +0.9
Shadow entry.
 MIR                    USSR            D/S=0.54

Tuesday evening, 29 December 1987
 Time(EST)    Az    El   Range RA/Date D/Date  Mag
07:13:02PM 283.7 24.7 00720 20:05.5 +24d17 +0.0
07:14:18PM 224.6 42.0 00481 23:02.5 -03d56 -0.6
Shadow entry.
 MIR                    USSR            D/S=0.67

Wednesday evening, 06 January 1988
 Time(EST)    Az    El   Range RA/Date D/Date  Mag
06:56:21PM 214.8 17.8 01225 22:49.0 -28d40 +2.9
06:57:39PM 206.2 36.2 00759 23:56.7 -15d52 +1.9
06:58:58PM 137.0 68.1 00511 02:26.7 +16d47 +1.4
07:00:16PM 063.2 37.2 00748 05:54.0 +39d22 +2.7
Shadow entry.
 SALYUT 7               USSR            D/S=0.62

Thursday evening, 07 January 1988
 Time(EST)    Az    El   Range RA/Date D/Date  Mag
06:25:12PM 207.0 17.0 01259 22:50.0 -33d06 +3.1
06:26:31PM 193.5 33.1 00808 00:07.7 -21d54 +2.3
06:27:49PM 135.7 54.3 00576 02:34.2 +06d01 +2.1
06:29:08PM 074.3 34.4 00790 05:24.8 +29d58 +3.1
06:30:26PM 060.0 17.8 01237 07:03.4 +34d27 +4.1
Shadow entry.
 SALYUT 7               USSR            D/S=0.59

Friday evening, 08 January 1988
 Time(EST)    Az    El   Range RA/Date D/Date  Mag
07:33:34PM 300.1 17.7 01239 20:04.0 +34d27 +2.5
07:34:53PM 329.1 20.7 01127 18:58.5 +59d43 +2.4
Shadow entry.
 SALYUT 7               USSR            D/S=0.35

Saturday evening, 09 January 1988
 Time(EST)    Az    El   Range RA/Date D/Date  Mag
07:02:22PM 295.8 19.9 01154 19:54.8 +31d59 +2.3
07:03:40PM 327.7 23.7 01031 18:56.9 +60d03 +2.2
07:04:58PM 358.6 19.3 01180 14:03.8 +75d26 +2.8
Shadow entry.
 SALYUT 7               USSR            D/S=0.36

Sunday evening, 10 January 1988
 Time(EST)    Az    El   Range RA/Date D/Date  Mag
06:31:09PM 291.0 22.3 01071 19:47.3 +29d06 +2.2
06:32:28PM 326.3 27.3 00935 19:00.2 +60d24 +2.0
06:33:46PM 000.5 21.6 01096 13:06.9 +77d51 +2.6
 SALYUT 7               USSR            D/S=0.40
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AD ASTRA

Please direct all address changes or corrections to:
Rick Clark, ALCOR
584 South Mt. Carmel Rd.
McDonough, Georgia 30253

Membership renewals to:
Bud Rosser, Treasurer
5198 Avanti Court
Stone Mountain, Georgia 30088

W. Tom Buchanan
105 Carriage Station Circle
Roswell, GA 30075
8901

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