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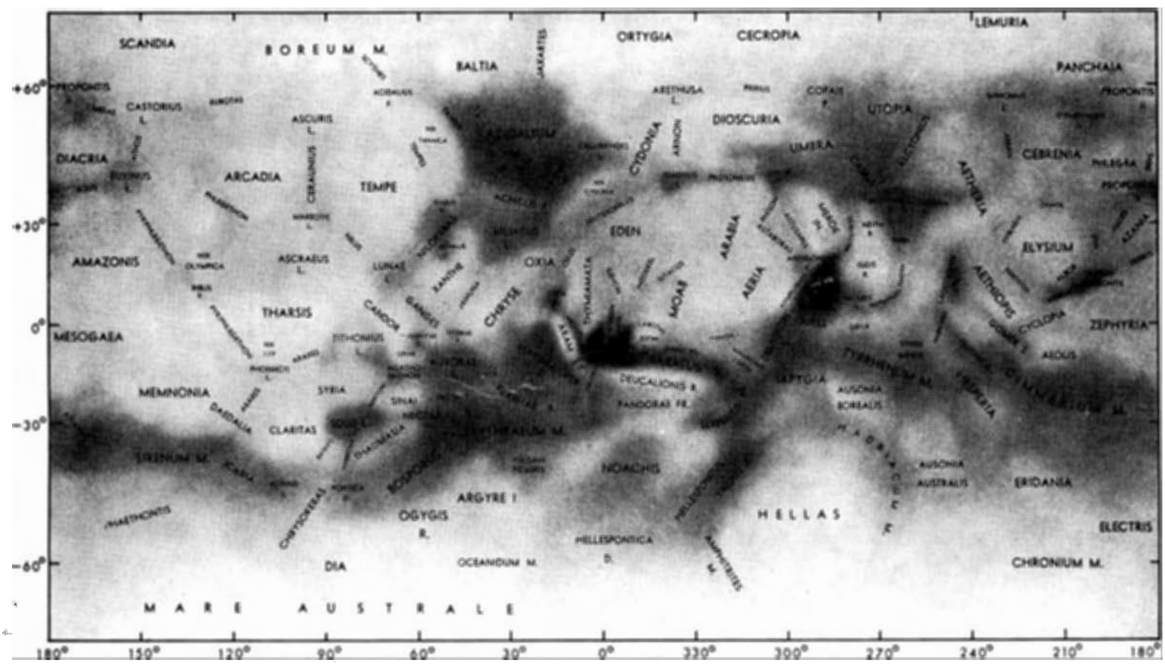

Chart of Mars in 1969. Mars Recorders Chick Capen and Don Parker invite attention to their report on pages 78-84. Features they there discuss can be identified with the aid of this chart, rendered by the Lowell Observatory staff from red-light photographs taken in 1969 by the International Planetary Patrol. North at the top. The Red Planet is hurrying to its opposition on February 25, 1980.

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ASSOCIATION OF LUNAR & PLANETARY OBSERVERS — ALPO

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IN THIS ISSUE

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NEW DEVELOPMENTS IN PLANETARY PHOTOGRAPHY

By: C. F. Capen, ALPO Mars Recorder, Braeside Observatory, CO
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Abstract

The results of using Perfection Micrograin Developer with Kodak Technical Pan Film (Estar-AH Base) SO-115 Film and other high contrast pan films over the past year are reported and illustrated. The improved PMD is introduced in its new tablet form. The latest suggestions from Eastman Kodak, Scientific and Technical Photography Section, for using special developers for wide latitude, fine-grain photography with SO-115 Film are presented. Suggestions for using the micrograin developer are given in detail.

Introduction

In the J.ALPO article "Recent Advances in Planetary Photography" (Ref.1) it was stated that fast emulsion films and hot developers were used for a brief period in an attempt to beat poor atmospheric seeing with short camera exposures at the telescope and to achieve as high a contrast as possible. The results were grainy images that would not take enlargement, giving a chalk-&-blackboard appearance which showed only 2 or 3 steps of the possible 10 steps of the gray tonal scale and limited by a narrow exposure range. Several years of valuable planetary imagery were thus lost to the scientific community. Today it is common practice for planetary astronomers to use hi-contrast, fine-grain, and slow emulsions to record a wide range of planetary disk albedo features at the telescope, and later in the darkroom to bring out as many of these details as possible with less active (low contrast) developers. Ultra Fine Grain (UFG) Ethol Developer has been used with great success for over a decade. In the above article (Ref.1) Perfection Micrograin Developer (PMD) was introduced for use on extended planetary images.

PMD In a Fix

During the past year many planetary astronomers have experimented with PMD. According to the reports received by the Mars Recorders, most users of PMD achieved good to excellent results, a few found only a slight improvement in their photographic techniques, and one highly experienced astrophotographer found PMD to be worthless! Why such a range of results? In the past, a developer has either worked for a specific application or it hasn't. If one excuses the pun, the acceptable results have either been black or white, without prejudice. It is a fact that darkroom procedures can vary greatly, but surely this cause cannot explain the differences reported by these experienced astrophotographers. Various factors are probably the cause for success or failure.

The activity of Perfection Micrograin Developer, Ethol Ultra Fine Grain (1:1), H & W Control 4.5, and other dilute developers may be strongly dependent upon the age of the solution and the pH (a measure of H Ion Concentration) of the mix water. PMD was originally packaged as a powder in 1 gallon size which would develope about 20 rolls of 35-mm film. Since the shelf-life of PMD was discovered not to be as long as originally indicated, most users found it economical and convenient to divide the 1 gallon package into quarters or eighths, to mix these smaller quantities as needed for developing one or two rolls at a time, and to store the remaining powder in air tight plastic bags within a glass jar to keep out moisture. Astrophotographers located in wet climates found it good insurance to enclose within the jar a silica-gel desiccant.

New PMD Reliable and Consistent

Readers will be pleased to learn that the manufacturer of PMD has since improved and changed the packaging of his developer to the form of brown tablets which can economically be used to prepare "one-shot" quantities of the solution. It requires only four little pills to make enough solution for use in a one reel developing tank. There are 80 tablets per jar, which will make the large quantity of 7.5 gallons of developer. If moisture is kept away from the tablets, they should store until used.

Why convenient tablets? All reducing agents, such as PMD, begin to lose potency within hours after being mixed with water. In order to solve this problem, Perfection Developers are formulated dry into tablets which are not activated until properly mixed with water. This unique "one-shot" developer will deliver precisely the same strength every time it is used - no more surprises when you open the tank. Instead of the one universal developer for all pan films, Perfection Photographic Products have now formulated three specialized developers: Perfection Micrograin Developer for use with Kodak High Contrast Copy @ 15 ASA and Kodak SO-115 @ 100 ASA which gives negatives with full tonal range and microscopic resolution that make grainless enlargements up to 30 x 40" from 35-mm film, Perfection High Speed/Fine Grain Developer for use with Kodak Pan-X and Pan-F @ 100 ASA with good tonal range and enlargements up to 11 x 14", and Perfection Super Speed Developer for use with Kodak Tri-X @ 4000 ASA which produces full tone negatives for enlargements up to 5 x 7".

The above developers are sensitive to irregular agitation and over-agitation, which will both result in inconsistent development. In order to assure consistent results, hand agitation should be performed gently, smoothly, and at regular intervals as prescribed in the PMD directions which are enclosed in each jar. The tap water used to prepare the developer solution and the age of the solution also account for the variable results experienced by astronomers. Tap water may contain dirt and chemicals which can affect the quality of negatives during the developing phase of processing. If the purity of the water in your area varies at times, as it does in my town, a tap water filter may be necessary; or the use of distilled or deionized water may be advisable when preparing the developer solution. If you have a water softener (salt), or if your water is considered "hard", distilled water should be used. Water for pre-wetting, post-soak, hypo, and washing will not suffer from the salt content, which tends to keep film emulsion from swelling. The interesting term "wetted water" refers to water treated with Kodak Photo-Flo 200 in the amount of approximately 1/16 oz. per 1 gallon of water.

Suggestions from Eastman Kodak

The author recently received a letter and the publication "Pictorial Photography with Kodak Technical Pan Film (Estar-AH Base) SO-115"(Refs.2,3) from Mr. Gordon P. Brown, Scientific & Technical Photography, Customer Technical Service, Eastman Kodak Co. Mr. Brown suggested in his letter: "You may want to try SO-115 film with Perfection Micrograin Developer (tablet form) at EI 100, forty-X enlargements are excellent". Following, for your information, is an abridged version of the above publication.

"It is normally considered good practice in black-and-white pictorial photography to process the film to a Contrast Index of 0.5 to 0.7. This contrast level is readily achieved with products such as our Pan-X, Plus-X and Tri-X Pan Films by processing in any of several well known Kodak developers, e.g., D-76, DK-50 (1:1), or HC-110 (Dilution B). When the same developers are used to process Kodak Tech. Pan Film, SO-115, it is difficult to obtain Contrast Indexes lower than 1.0 (gamma).

"As indicated in the data sheet for SO-115 Film (Ref.2), it is possible to obtain lower contrast levels with this film by using specialized formulations which must be prepared shortly before use, e.g., POTA or TEA-14 (Refs.3,4). Since the introduction of SO-115 Film in mid-1977, a number of photographers have reported favorably on their use of commercially available developers to achieve low contrast control with SO-115 Film:

1. Perfection Micrograin Dev. (1:2), 15-20 mins.
2. H & W Control 4.5 Dev., 6-8 mins.
3. Kodak Microdol-X Dev. (1:6), 7-8 mins.

"In each case, we recommend processing at 68°F and to a Contrast Index of about 0.6. We indicate a range of processing times to allow for variables such as developer activity and agitation. Experimentation should lead to processing times that yield high quality, easily printed negatives under the conditions that prevail in your darkroom. Incidentally, when evaluating SO-115 negatives visually, it is important to keep in mind that the Base - Fog density will be about half that of the more conventional films mentioned above.

"Kodak has not evaluated any of these developers in combination with the SO-115 Film. We cite them for the benefit of professionals and advanced amateurs who may wish to conduct their own tests and comparisons, recognizing that it may be more convenient to use these commercially available developers than to prepare specialized formulations with short lives. We would, however, offer some general comments.

1. The activity of these three developers may be strongly dependent upon the age of the solution and the pH of the mix water. In addition, we believe that all of the developers listed above, including the much diluted Microdol-X, have limited capacity. Freshly mixed solutions, prepared with distilled or deionized water and used on a one-time basis, should contribute to consistent results.
2. Some low contrast developers or developer/film combinations yield premature shouldering of the characteristic curve (D-Log E). This effect may result

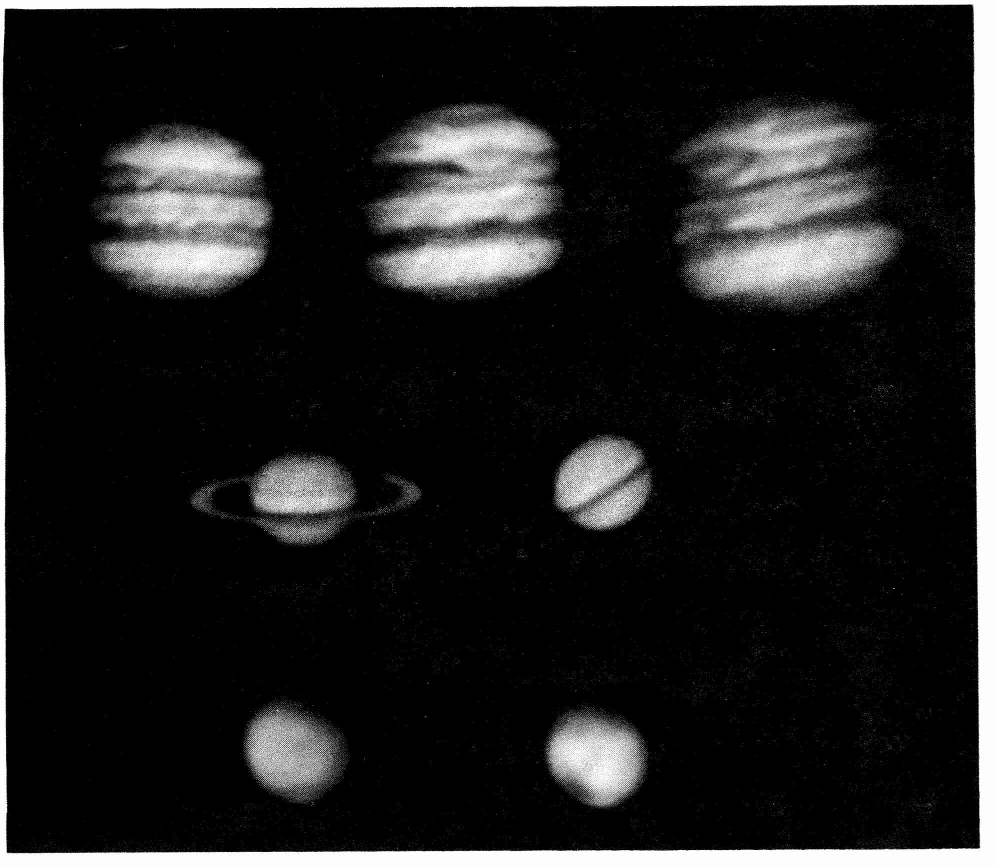

Figure 1. Photographs of Jupiter, Saturn and Mars taken by Don C. Parker of Coral Gables, Fla. with a 12.5-inch (31cm) Newt. telescope using Kodak SO-115 Film and Perfection Micrograin Developer (PMD) for 12 min. at 70°F and distilled water with gentle agitation throughout processing. Eyepiece projection was used at the telescope in order to obtain large images useful for printing. Kodak Polycontrast RC paper surface F with a No. 3 contrast filter on the enlarger were used for printing 2 to 4 inch diameter images of Jupiter and 1 inch diameter disks of Saturn and Mars. Parker's quality photos are useful for detecting new features and following seasonal changes on the planets by the ALPO Planet Section Recorders as well as analyzed by the International Jupiter Voyager Telescope Observations Program (IJVTOP) sponsored by the Meudon Observatory, France, and the Laboratory for Planetary Atmospheres, University College London, England. Observing data, top row L to R: Jupiter, 4-Oct-78, 1017 UT., CM 324°I, 102°II; 30-Nov-78, 1041 UT., CM 339°I, 042°II; 19-Jan-79, 0252 UT., CM 034°I, 078°II. Exposure 4.5 sec. @ f/103. Saturn mid row: 8-May-78, 0325 UT., 27-May-79, 0145 UT. Exposure 7 sec. @ f/69. Mars bottom row: 14-Feb-78, 0220 UT., CM 205°; 28-Feb-78; 0200 UT., CM 074°. Exposure 2 sec. @ f/103 with a disk diameter of only 12 arc seconds.

from the reduced capacity of very dilute developers. Since a reduction in highlight contrast results in the loss of image detail and exposure latitude, this should be a factor of considerable importance in judging developer performance. If a particular developer yields premature shouldering when processing in a single or small 35-mm tank, try processing in a deeper tank with twice the working solution.

3. Some low contrast developers are said to compensate in part for the loss in effective film speed which normally accompanies reduced or low contrast processing. Since films having the low granularity of SO-115 Film are inherently slower than the black-&-white films normally used, it is proper to consider speed as well as tone reproduction in evaluating these developers. It is important that the speed comparisons be made between films which have been processed to the same Contrast Index (gamma).

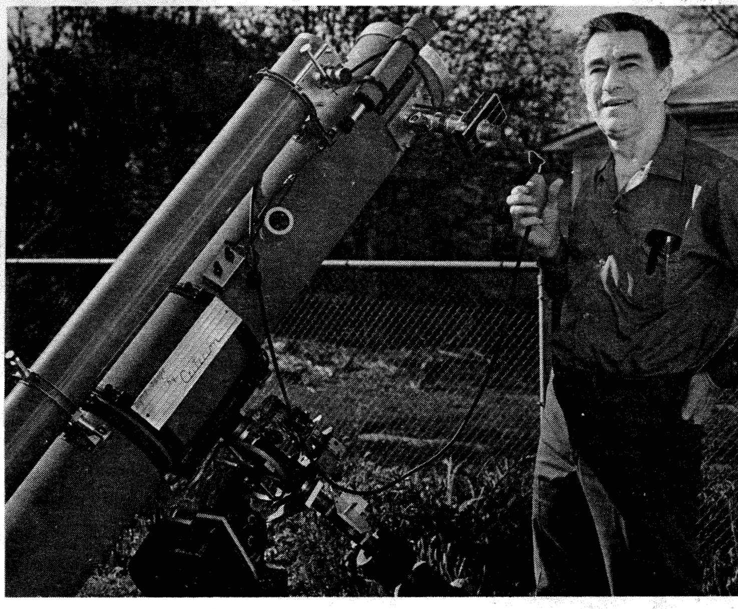

Figure 2. ALPO astrophotographer, Howard F. Zeh, of Temperance, Mich. with his reflecting 8-inch (20cm) f/8 Newtonian telescope with an 8 inch Byers RA Drive, a $4\frac{1}{4}$-inch f/13 seeing monitor reflector, and an air-bulb shutter of vintage ca. 1888. Shown below, is an Argus C-3 35mm camera with various f-ratio eyepiece projection tubes and an 8mm Clavé Plossl ocular that Mr. Zeh uses to acquire quality planet photos which he so kindly contributes to ALPO Planet Section Recorders for their measurements and analyses.

"When processed in one of the low contrast developers mentioned above, Kodak SO-115 Film provides the skilled photographer with a useful new vehicle for creating sizeable enlargements with little or no grain and with full tonal range. We are sure you will recognize the significance of other factors in exploiting the exceptional characteristics of this film for scientific and pictorial photography, e.g., quality optics, no vibration within the system, and cleanliness. Indeed, it is important to keep each of these three factors in mind at both the recording at the telescope and with the enlarger in your darkroom."

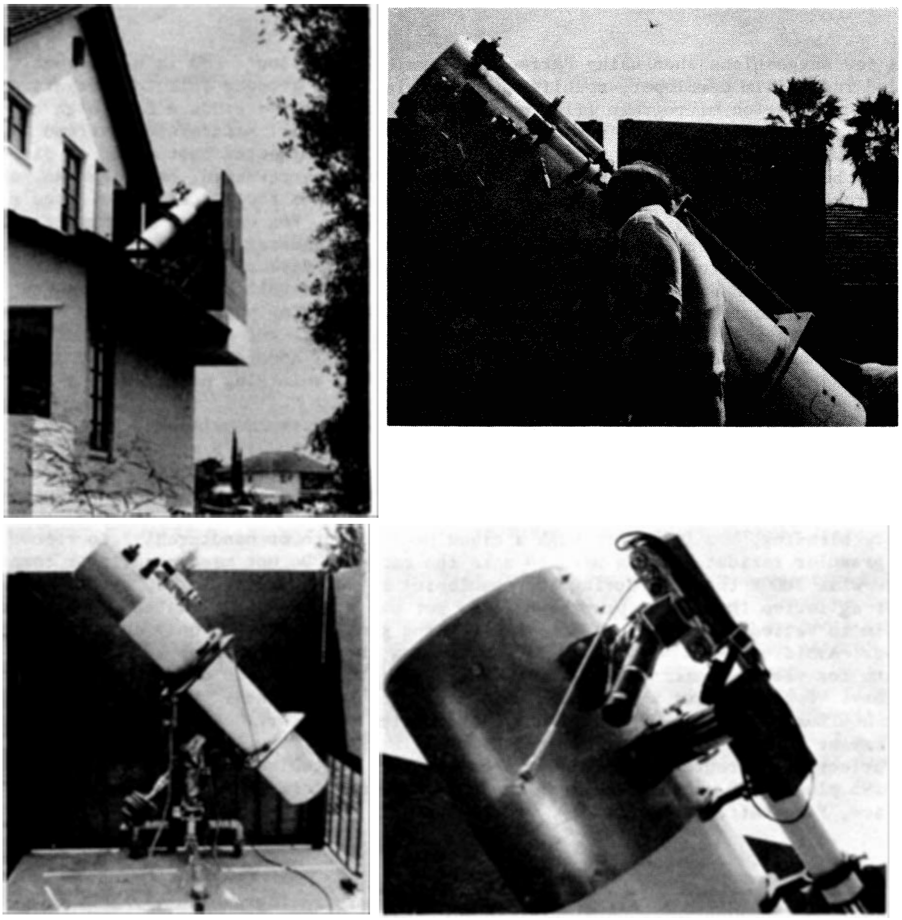

Figure 3. Several views of the 12.5-inch (31cm) f/5.5 Newtonian telescope used by Donald C. Parker, ALPO Assistant Mars Recorder, Coral Gables, Fla. The photographic telescope is located at sea-level near the ocean front on a second story patio just outside his bedroom, which is most convenient for those early morning pre-opposition observations of the planets. The usual residential interferences do not seem to prevent Dr. Parker from acquiring quality planetary images, as can be noted in his photos of Figure 1. Don is seen with his telescope at upper right, and his Nikon camera set-up is shown at lower right. Clavé Plossl eyepiece projection is used to obtain large scale images suitable for enlargement and study.

Conclusion

During the past 20 years the author has used photographic imagery for spatial and photometric measurements in planetary studies; and he is alert for new methods, chemistry, and observing techniques. Those new ideas which appear worthwhile are passed along to ALPO members as suggestions only, which may or may not improve your observing technique. If you have a film/developer combination and a darkroom/enlarger method which gives satisfactory results, by all means stay with it. Ethol UFG (1:1) developer is still a tried and true standard used by the planetary astronomer which is less finicky in use and storage than PMD. The manufacturers of UFG, Plymouth Products, are keeping pace with the new thin emulsion films and have come up with two chemistries that may be just right for extended image planet photography. If our tests are promising, we will let you know.

A few suggestions when using Perfection Developers follow: PMD is a one-shot, extended range film developer, specifically formulated to produce full tone negatives from high resolution micrograin films which characteristically produce only high contrast negatives. An increase in ASA rating is possible while still maintaining extreme fine grain and with a fair exposure range (latitude). It is suggested that a set of different exposures be taken at each observation, e.g., one image overexposed, one right on, and one underexposed. This method is especially necessary when the planet has a large range of contrasts across the disk or exhibits limb darkening. For example, the bright polar regions of Mars can best be measured and studied on the underexposed image; while the weak, shadowy details usually present centrally upon the disk show up best on the overexposed image. When properly developed, all images on the roll should have density ranges well within the contrast control provided by graded enlarging papers. Extreme overexposure results in blocked highlights, increased contrast, and deterioration of resolution; and underexposure results in loss of weak detail and reduced contrast. A properly exposed image will be perfectly matched to Grade 2 enlarging paper using a condenser enlarger.

Use only DISTILLED or DEIONIZED WATER when preparing the developer. The PMD tablets will melt completely in 5 minutes at 100°F. Hot water up to 110°F will not affect the developer chemistry. Six ounces of water at 110°F will melt up to 9 tablets. Allow tablets to melt, then stir, and add additional cool water to acquire desired quantity and temperature. Pour developer from one container to another several times to assure complete blending, and filter through a clean muslin cloth or handkerchief to remove the inert granular residue that is used to make the tablet. Do not mechanically or temperature-wise SHOCK the film during the developing phase. Use gentle and smooth and regular agitation throughout processing. Do not use a STOP BATH. Instead, post-soak the film in Wetted Water (water+Photo-Flo), using gentle agitation only once each 5 minutes. Avoid over-FIXING. A total of 2 minutes in a standard hypo-acid fixer is adequate for clearing micrograin films. A Hypo-Clear wash may be used, but is not necessary. Use plenty of WETTED-DISTILLED WATER for final rinse. Let film HANG DRY. Do not SQUEEGE, CHAMOIS, WIPE, or TOUCH the emulsion until dry. Residual streaks or spots may be removed with a silicon cloth.

Perfection Micrograin Developer may be obtained in tablet form, 7.5 gallon bottle, for $8.95 plus $1.00 postage and handling charge from Valdis Associates, 25 N. San Francisco, Flagstaff, AZ. 86001.

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SKY COLOR AND DARKNESS AT THE TOTAL SOLAR ECLIPSE, 10 JULY 1972 - PART II

By: William H. Glenn, York College of the City University of New York, Jamaica, New York 11451

Note by Editor. Part I of Mr. Glenn's paper appeared in this journal, Vol. 28, Nos. 1-2, pp. 33-35, October, 1979.

C: Prince Edward Island

In part I of this paper observations of sky color and darkness made at Cap Chat, Quebec, and Grande Anse, New Brunswick, were discussed. Southeast of these locations, thin clouds with intermittent patches of heavier cloud were generally present over Prince Edward Island; but many observers still sucessfully observed totality and the Moon's shadow in the atmosphere. Reports were received from the following:

Observers	Location
John E. Bortle Christopher Case Charles E. Scovil	1½ miles north of Blooming Point (4½ miles northeast of central line)
William H. Glenn Florence Glenn	1 mile northwest of Pownall (5½ miles southwest of central line)
Hy Roche	Stanhope Beach (on central line)
Mary Jane Taylor	Dalvay Beach (1¼ mile east of central line)
B. Franklyn Shinn Florence M. Shinn	2½ miles south of Orwell Cove Light (6 miles southwest of central line)

According to John E. Bortle, some very high thin cirrus clouds were scattered about the sky; and just before totality low altitude clouds rapidly approached from the south, obscuring about 20% of the sky. Bortle reports that the shadow was first suspected 11½ minutes before totality and was definitely seen at azimuth 335° nine minutes before second contact. At that time the shadow was very diffuse, but quite apparent. "Its color was similar to shadows cast by clouds on a humid summer day, only darker, rather grayish blue." The shadow disappeared within three minutes after totality ended, simply diffusing away toward the end of the period. Bortle's log of the minute-to-minute appearance of the shadow, based on a tape recording made during the eclipse, is so detailed that it deserves quoting in its entirety here.

Time Relative to 2nd Contact	Description
-11 min.	A strange, vague darkness is noted near the horizon both to the left and right of the Sun's azimuth, the area to the right being darker.
- 9 min.	There is a definite darkness to the north centered on azimuth 335°. Altitude is probably no greater than 15°.
- 4 min., 55 sec.	Center of shadow now at azimuth 340°. Shadow's darkness is very apparent.
- 3 min.	Shadow very dark. Azimuth almost due north. Several dozen degrees wide at the base at this time.
- 1 min., 55 sec.	Very dark in north. Shadow extends up to possibly 30° above horizon.
- 1 min., 45 sec.	Shadow appears as a shapeless darkness, rising higher in the north. At least 90° wide.
- 1 min., 5 sec.	Huge shadowy darkness due north fills most of sky in that direction.
-15 sec.	Shadow edge very diffuse, passing overhead now. Tremendous darkness of surrounding landscape.

Time Relative to 2nd Contact	Description
0 sec.	Second contact.
+26 sec.	There is a high, twilight-like band all around the horizon. It extends up to an altitude of possibly 25^{o}. Lower 5-10^{o} hazy red, upper part pinkish or salmon color. Remainder of sky dome in darkness. Color pale bluish.
+ 1 min., 2 sec.	Twilight arc in north beginning to rise higher. It continues to extend 360^{o} around the horizon.
+ 1 min., 50 sec.	In the north-northwest, below about 10^{o} altitude, the sky is pink; above this, white to an altitude of perhaps 35^{o}. There are several cirrus clouds in this area, and they are very white.
+ 2 min.	The following edge of the shadow is now half way up the northern part of the sky.
+ 2 min., 10 sec.	Third contact.
+ 2 min., 17 sec.	Following edge of the shadow is passing overhead.
+ 2 min., 40 sec.	There is a considerable darkness to the south, extending perhaps half-way up into the sky.
+ 3 min., 47 sec.	It is now not at all dark in the south, almost no evidence of shadow.

(Note: Azimuths of the shadow's center were determined by compass corrected for local magnetic declination.)

Charles E. Scovil and Christopher Case observed from the same site as John Bortle. Case reports that the change in brightness was most apparent and sudden about 30 seconds before totality, appearing like a "wave of darkening"; and he first saw the shadow, 20 seconds before totality, as a large gray mass descending very rapidly at azimuth 315 $\pm$ 10^{o}. Haze near the horizon dimmed its lower portions. Case scanned the western horizon from azimuth 0^{o} to 180^{o} about 25 seconds before totality and again 50 seconds into totality. At about 25 seconds before second contact the sky directly to either side of the shadow changed from grayish to pale red. The horizon arc glowed pale red as in a sunset to an altitude of 10-15^{o}, the lower portions being more color saturated. At 50 seconds into totality the reddishness was gone. In its place was violet-gray, which gradually blended into the background sky up to an altitude of about 25^{o}. Clouds obscured the Sun shortly after mid-totality, and no further observations were made.

Scovil also first saw the shadow about 10-15 seconds before totality, appearing directly below the Sun and extending northward about 25^{o}. The clouds went dark, and he had the impression of a very rapid advance of the shadow but could not see a distinct shape. During totality the clouds all around were orange to orange-yellow, except below the Sun where the closer clouds were gray.

William and Florence Glenn, observing from the crest of a grass-covered hill near Pownall, noticed pronounced darkening and yellowing of the landscape at 24 minutes before totality. At 16 minutes before totality scattered cirrus and altostratus clouds were present in the west, with the east and north clearer; the Sun was in thin altostratus. By 11 minutes before totality the appearance of the sky was like late afternoon. The blue sky had become steely blue, with slight yellowing of the clouds. There was a yellowish cast to the grass. At second contact the Sun was in very thin altostratus, and scattered clouds of the same type covered the rest of the sky. The shadow was first

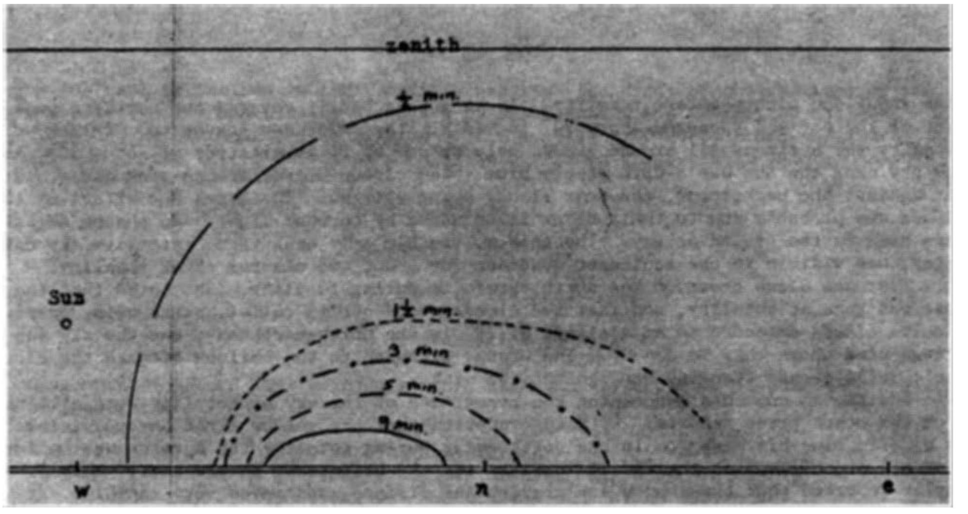

Figure 4. Drawing of shadow development before second contact. Times given are minutes before totality (John E. Bortle).

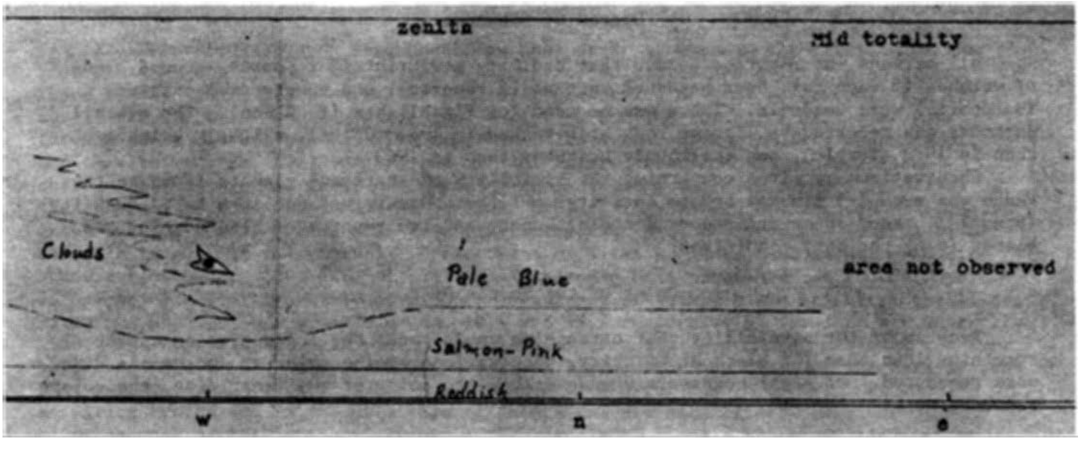

Figure 5. Sky appearance at mid-totality (John E. Bortle).

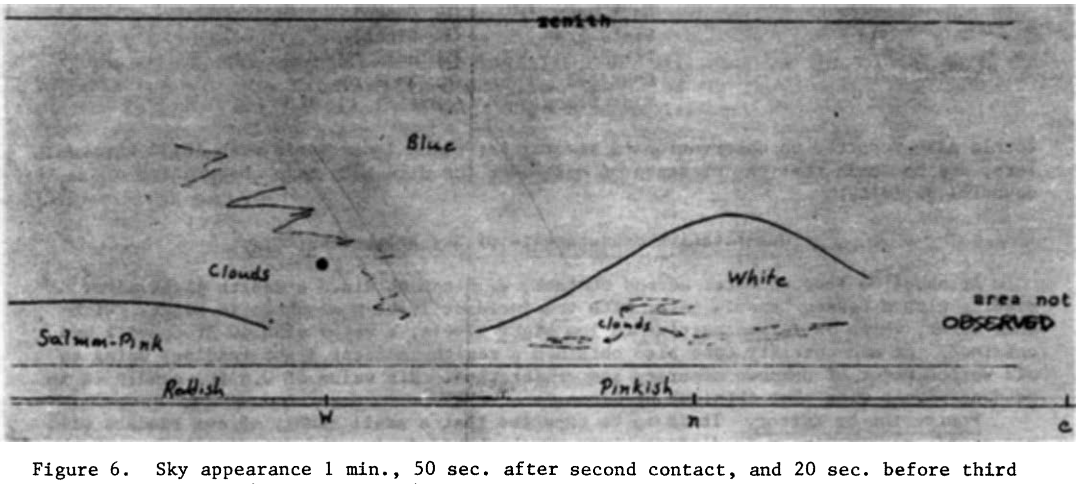

Figure 6. Sky appearance 1 min., 50 sec. after second contact, and 20 sec. before third contact (John E. Bortle).

seen about one minute before totality. As it approached it covered the northern quadrant of the sky and appeared about 90^{o} in width. The color was gray-blue. During totality the horizons all around glowed pale orange up to an altitude of about 30^{o}, and the sky near the Sun was a dark steely blue. The clouds became orange-pink and stood out against the background, the near clouds being whitish. The stand-out effect of the clouds was probably due to their being illuminated by coronal light. No shadow edges were seen on the ground or sky. The shadow, visible only as a vague extensive sky darkening, was visible in the southeast quadrant for about two minutes after totality.

Florence Glenn observed the north carefully during totality. She noted that the haze was gone at totality, and that the clouds stood out in relief, parts being gray. Cumulus clouds extended to an altitude of 10^{o} in the north-northeast, and the sky was orange-pink above this to $25-30^{o}$. The orange extended to the horizon between the clouds, the cumulus clouds standing out against the pink.

Additional comments concerning the appearance of the sky at totality were obtained from the other three reports. Hy Roche reported that the shadow first became visible as a solid blue-black region in the northwest. During totality the horizon was uniformly pink all around, and at the end of totality the sky brightened in the west. Mary J. Taylor reported that the shadow was grayish and diffuse, and moved very rapidly. It seemed to descend like a blanket, and to leave in the same manner. B. Franklyn Shinn and Florence M. Shinn described the northwestern horizon glow as soft orange up to 20^{o} altitude, with no distinct upper termination.

Degree of Darkness

All persons who reported agreed that ordinary newsprint (3 reports), second hands of watches (3 reports), hour hands of watches (2 reports), and camera dial settings (3 reports) were readable. There was no need for flashlights (F. Glenn). The overall darkness was reported as lighter than at Wivenhoe in 1963 (Shinn), slightly brighter than in 1970 (Bortle), and enormously brighter than in 1963 (Bortle).

Observations received concerning the visibility of stars and planets indicate that Venus was seen 1-2 minutes before totality, but that Mercury was not seen until totality (Scovil). Four observers reported seeing Venus, and two reported seeing nothing and blamed it on the hazy conditions.

Color of the Moon's Disc

Because of the possibility that earthshine would cause the lunar disc to appear something less than jet black at totality, observations of the color of the Moon's disc were requested. Of eight observers who described the color of the lunar disc, the colors reported were:

Silvery gray	(Case)
Slate gray-blue	(Scovil)
Steel gray	(Roche)
Dark gray	(W. Glenn)
Slate gray	(F. Glenn)
Black	(Shinn)
Charcoal	(M. Taylor)
Flat black	(Bortle)

Bortle also reported an observation of several jet-black lunar maria with 10x50 binoculars, but he feels that the presence of haze over the disc made this observation of doubtful validity.

Quantitative Measurements of Sky Brightness

At about 35 seconds after second contact, W. Glenn obtained a zenith light meter reading with a Gossen Lunasix meter with the incident light hemisphere in place. With this meter, which is very sensitive to low light levels, a value of 0.40 ft. candle was obtained. At mid-totality Case also obtained a zenith incident light reading, using an old Weston meter of unknown accuracy and calibration. His value of 0.6 ft. candle is in good agreement with that obtained by Glenn.

Postscript by Editor. It is to be expected that a small number of our readers will see total solar eclipses in distant parts of the world during the next few years. Such persons may want to include in their eclipse programs the kinds of observations of the Moon's shadow and sky appearances discussed by Mr. Glenn in his serialized article. The results should be communicated to William H. Glenn, 2411 Webb Ave., Bronx, New York 10468. We thank you. Part III of Mr. Glenn's paper is scheduled for our next issue.

PHENOMENA OF SATURN'S SATELLITES TITAN AND RHEA: 1980 JAN. 1 - SEPT. 22

By: John E. Westfall

Introduction

Observers of Saturn will be treated to a series of interesting phenomena during its 1979-80 apparition:

1979,	SEP 10	Conjunction
	OCT 27	Earth crosses ring plane (S. to N.)
1980,	MAR 03	Sun crosses ring plane (S. to N.)
	MAR 12	Earth crosses ring plane (N. to S.)
	MAR 14	Opposition
	JUL 23	Earth crosses ring plane (S. to N.)
	SEP 23	Conjunction

Besides the well-known ring phenomena that occur at or near the crossing of the ring plane by the Sun and the Earth, a variety of satellite events will also occur.[1] These events take place because the planes of the orbits of 8 of Saturn's 11 (or 12?) satellites lie near the ring plane and, thus, the Sun and the Earth will also pass through these orbital planes. The result will be a number of satellite transits of, and occultations and eclipses by, the ball of Saturn, transits of the satellites' shadows across Saturn's face, and mutual phenomena among the satellites themselves.

These satellite events are of interest because they occur only for two relatively brief periods during Saturn's 29-year orbital cycle. Many of these events will be observable in amateur instruments. Predictions of Titan's events, and mutual satellite phenomena, for Oct. 17 - Dec. 31, 1979, have already been published (JALPO, 28, Nos. 1-2, pp. 5-13). This report deals with the phenomena of Saturn's two brightest satellites, Titan and Rhea (visual magnitudes *ca.* +8.4 and +9.7 respectively) for Jan. 1 - Sept. 22, 1980. (The next article will provide predictions of mutual phenomena involving the four brightest satellites, Tethys, Dione, Rhea, and Titan, near the times of the earlier 1980 ring passage.) All such predictions are subject to error due to uncertainties in satellite orbits and in the diameters of Saturn and its satellites; observers should allow as much as 10-15 minutes leeway in the predicted times. The predictions given here were computed with an Apple-II microcomputer using data and formulae given in the 1980 *American Ephemeris and Nautical Almanac*.

Phenomena of Titan

The Saturn/Titan events predicted for Fall, 1979, will continue until Sept. 8, 1980. In Table 1, below, the Universal Times have been corrected for light-time. This table, and the following one for Rhea, use the following abbreviations: "Oc" = occultation , "Ec" = eclipse, "Tr" = transit, "Sh" = shadow, "I" = ingress, "E" = egress, "D" = disappearance, and "R" = reappearance. Table 1 predicts 100 such events, occurring in 32 sequences, separated by intervals of approximately 8 days (i.e., one-half Titan's $15\overset{d}{.}95$ orbital period).

Table 1. Phenomena of Titan, Jan. 05 - Sept. 08, 1980.

1980 Date	U.T.	Event	1980 Date	U.T.	Event	1980 Date	U.T.	Event
JAN 05	01:14	EcD	JAN 13	07:46	TrE	JAN 29	00:40	TrI
	12:49	OcR					02:15	ShE
			21	00:20	EcD		06:18	TrE
12	21:21	ShI		11:24	OcR			
13	02:34	TrI				FEB 05	23:30	EcD
	03:02	ShE	28	20:26	ShI	06	09:09	OcR

[1]For a general discussion of ring-passage events, see: Julius Benton, "Saturn's Rings--Edge-On." *Star and Sky*, Sept., 1979, 34-37.

Table 1. Phenomena of Titan, Jan. 05 - Sept. 08, 1980. (continued)

1980 Date	U.T.	Event
FEB 13	19:34	ShI
	22:31	TrI
14	01:29	ShE
	04:23	TrE
21	22:39	EcD
22	07:08	OcR
29	18:44	ShI
	20:11	TrI
MAR 01	00:40	ShE
	02:08	TrE
08	22:10	EcD
09	10:44	OcR
16	17:46	TrI
	17:57	ShI
	23:43	TrE
	23:51	ShE
24	19:56	OcD
25	03:11	EcR
APR 01	15:30	TrI
	17:15	ShI
	21:16	TrE
	23:04	ShE
09	17:30	OcD
10	02:23	EcR
17	13:17	TrI
	16:32	ShI
	19:02	TrE
	22:11	ShE
25	15:21	OcD
26	01:32	EcR

1980 Date	U.T.	Event
MAY 03	11:20	TrI
	15:33	ShI
	17:08	TrE
	21:20	ShE
11	13:59	OcD
12	00:39	EcR
19	09:43	TrI
	15:15	ShI
	15:37	TrE
	20:26	ShE
27	12:26	OcD
	18:14	OcR
	18:22	EcD
	23:46	EcR
JUN 04	08:30	TrI
	14:28	TrE
	14:38	ShI
	19:30	ShE
12	11:18	OcD
	17:25	OcR
	17:46	EcD
	22:50	EcR
20	07:56	TrI
	13:29	TrE
	14:08	ShI
	18:31	ShE
28	10:41	OcD
	16:58	OcR
	17:16	EcD
	21:56	EcR
JUL 06	07:18	TrI
	13:12	TrE

1980 Date	U.T.	Event
JUL 06	13:35	ShI
	17:28	ShE
14	10:29	OcD
	16:48	OcR
	16:49	EcD
	20:57	EcR
22	07:06	TrI
	13:06	TrE
	13:08	ShI
	16:21	ShE
30	10:37	OcD
	19:56	EcR
AUG 07	07:13	TrI
	12:43	ShI
	13:05	TrE
	14:55	ShE
15	11:07	OcD
	18:42	EcR
23	07:30	TrI
	13:29	TrE
31	11:44	OcD
	17:36	OcR
SEP 08	09:21	TrI
	12:36	TrE

Observers may have some difficulty in timing Titan's eclipse reappearances when these occur well away from the ball. As an aid to locating Titan at such times, Table 2 gives Titan's apparent distance from Saturn's center at the times of eclipse reappearance. It should be noted that Titan will be very close to the ring plane at such times.

Table 2. Apparent Distance of Titan from Saturn's Center at the Time of Eclipse Reappearance. (In units of Saturn's apparent equatorial radius, measured from Saturn's center; i.e., the limb is at distance = 1.00.)

1980 Date	U.T.	Distance
MAR 25	03:11	1.31
APR 10	02:23	1.80
26	01:32	2.22
MAY 12	00:39	2.55
27	23:46	2.70

1980 Date	U.T.	Distance
JUN 12	22:50	2.70
28	21:56	2.57
JUL 14	20:57	2.31
30	19:56	1.95
AUG 15	18:42	1.47

Phenomena of Rhea

Actually, Rhea began experiencing satellite phenomena in 1978. Those events for Jan. 1 - Sept. 22, 1980, are given in Table 3, which employs the same conventions as Table 1. Note that 354 events are predicted, occurring in 118 sequences, separated by intervals of approximately 2¼ days (i.e., one-half of Rhea's 4.52-day orbital period).

Table 3. Phenomena of Rhea, Jan. 01 - Sept. 22, 1980.

1980 Date	U.T.	Event	1980 Date	U.T.	Event	1980 Date	U.T.	Event
JAN 01	13:10	EcD	FEB 02	04:19	EcD	MAR 02	13:13	ShI
	18:43	OcR		09:26	OcR		13:36	TrI
							17:14	ShE
03	19:34	ShI	04	10:31	ShI		17:37	TrE
	20:53	TrI		11:34	TrI			
	23:06	ShE		14:28	ShE	04	19:29	EcD
04	00:52	TrE		15:35	TrE		23:49	OcR
06	01:36	EcD	06	16:47	EcD	07	01:41	ShI
	07:07	OcR		21:48	OcR		01:55	TrI
							05:42	ShE
08	08:03	ShI	08	22:59	ShI		05:57	TrE
	09:18	TrI		23:55	TrI			
	11:30	ShE	09	02:56	ShE	09	07:57	EcD
	13:16	TrE		03:56	TrE		12:09	OcR
10	14:04	EcD	11	05:15	EcD	11	14:09	ShI
	19:32	OcR		10:09	OcR		14:15	TrI
							18:10	ShE
12	20:33	ShI	13	11:26	ShI		18:16	TrE
	21:45	TrI		12:16	TrI			
	23:56	ShE		15:23	ShE	13	20:27	OcD
13	01:42	TrE		16:17	TrE	14	00:28	OcR
15	02:31	EcD	15	17:40	EcD	16	02:35	TrI
	07:56	OcR		22:30	OcR		02:36	ShI
							06:36	TrE
17	09:02	ShI	17	23:53	ShI		06:37	ShE
	10:07	TrI	18	00:36	TrI			
	12:21	ShE		03:50	ShE	18	08:47	OcD
	14:03	TrE		04:37	TrE		12:48	OcR
19	14:58	EcD	20	06:07	EcD	20	14:54	TrI
	20:20	OcR		10:50	OcR		15:04	ShI
							18:55	TrE
21	21:31	ShI	22	12:20	ShI		19:05	ShE
	22:31	TrI		12:57	TrI			
22	00:46	ShE		16:19	ShE	22	21:06	OcD
	02:26	TrE		16:58	TrE	23	01:18	EcR
24	03:25	EcD	24	18:35	EcD	25	03:14	TrI
	08:42	OcR		23:11	OcR		03:33	ShI
							07:15	TrE
26	09:36	ShI	27	00:47	ShI		07:32	ShE
	10:50	TrI		01:17	TrI			
	13:35	ShE		04:47	ShE	27	09:27	OcD
	14:51	TrE		05:18	TrE		13:46	EcR
28	15:53	EcD	29	07:03	EcD	29	15:35	TrI
	21:05	OcR		11:30	OcR		16:02	ShI
							19:35	TrE
30	22:04	ShI					19:59	ShE
	23:13	TrI						
31	02:02	ShE				MAR 31	21:47	OcD
	03:14	TrE				APR 01	02:17	EcR

Table 3. Phenomena of Rhea, Jan. 01 - Sept. 22, 1980. (continued)

1980 Date	U.T.	Event	1980 Date	U.T.	Event	1980 Date	U.T.	Event
APR 03	03:55	TrI	MAY 07	00:44	OcD	JUN 09	21:52	TrI
	04:32	ShI		05:59	EcR		23:36	ShI
	07:55	TrE				10	01:49	TrE
	08:26	ShE	09	06:51	TrI		02:53	ShE
				08:22	ShI			
05	10:07	OcD		10:51	TrE	12	04:09	OcD
	14:45	EcR		12:05	ShE		09:44	EcR
07	16:16	TrI	11	13:08	OcD	14	10:21	TrI
	17:02	ShI		18:27	EcR		12:07	ShI
	20:15	TrE					14:22	TrE
	20:51	ShE	13	19:15	TrI		15:53	ShE
				20:53	ShI			
09	22:27	OcD		23:15	TrE	16	16:38	OcD
10	03:12	EcR	14	00:31	ShE		22:12	EcR
12	04:37	TrI	16	01:34	OcD	18	22:49	TrI
	05:33	ShI		06:55	EcR	19	00:37	ShI
	08:35	TrE					02:50	TrE
	09:15	ShE	18	07:41	TrI		04:18	ShE
				09:26	ShI			
14	10:48	OcD		11:39	TrE	21	05:08	OcD
	15:41	EcR		12:54	ShE		10:40	EcR
16	17:00	TrI	20	13:54	OcD	23	11:19	TrI
	18:06	ShI		19:24	EcR		13:08	ShI
	20:56	TrE					15:19	TrE
	21:39	ShE	22	20:08	TrI		16:45	ShE
				21:59	ShI			
18	23:11	OcD	23	00:04	TrE	25	17:37	OcD
19	04:08	EcR		01:18	ShE		23:08	EcR
21	05:22	TrI	25	02:20	OcD	27	23:49	TrI
	06:40	ShI		07:53	EcR	28	01:39	ShI
	09:16	TrE					03:49	TrE
	10:01	ShE	27	08:34	TrI		05:12	ShE
				10:32	ShI			
23	11:33	OcD		12:29	TrE	30	06:07	OcD
	16:35	EcR		13:41	ShE		11:36	EcR
25	17:40	TrI	29	14:47	OcD	JUL 02	12:19	TrI
	18:50	ShI		20:21	EcR		14:08	ShI
	21:51	TrE					16:19	TrE
	22:46	ShE	MAY 31	21:01	TrI		17:38	ShE
				23:06	ShI			
27	23:56	OcD	JUN 01	00:55	TrE	04	18:35	OcD
28	05:04	EcR		02:05	ShE	05	00:04	EcR
30	06:04	TrI	03	03:14	OcD	07	00:50	TrI
	07:21	ShI		08:48	EcR		02:37	ShI
	10:04	TrE					04:50	TrE
	11:14	ShE	05	09:28	TrI		06:06	ShE
				11:38	ShI			
MAY 02	12:19	OcD		13:21	TrE	09	07:06	OcD
	17:31	EcR		14:28	ShE		12:33	EcR
04	18:27	TrI	07	15:42	OcD	11	13:20	TrI
	19:50	ShI		21:17	EcR		15:04	ShI
	22:27	TrE					17:10	TrE
	23:39	ShE					18:34	ShE

Table 3. Phenomena of Rhea, Jan. 01 - Sept. 22, 1980. (continued)

1980 Date	U.T.	Event	1980 Date	U.T.	Event	1980 Date	U.T.	Event
JUL 13	19:38	OcD	AUG 07	16:33	TrI	AUG 30	07:24	TrI
14	01:01	EcR		17:47	ShI		07:58	ShI
				20:35	TrE		11:22	TrE
16	01:52	TrI		21:29	ShE		11:59	ShE
	03:31	ShI						
	05:52	TrE	09	22:52	OcD	SEP 01	13:41	OcD
	07:04	ShE	10	03:46	EcR		18:00	EcR
18	08:09	OcD	12	05:07	TrI	03	19:59	TrI
	13:28	EcR		06:14	ShI		20:26	ShI
				09:09	TrE		23:54	TrE
20	14:23	TrI		09:59	ShE	04	00:26	ShE
	15:57	ShI						
	18:24	TrE	14	11:26	OcD	06	02:15	OcD
	19:34	ShE		16:15	EcR		06:27	EcR
22	20:42	OcD	16	17:40	TrI	08	08:36	TrI
23	01:56	EcR		18:39	ShI		08:56	ShI
				21:42	TrE		12:25	TrE
25	02:55	TrI		22:29	ShE		12:52	ShE
	04:22	ShI						
	06:57	TrE	19	00:01	OcD	10	14:50	OcD
	08:05	ShE		04:42	EcR		18:53	EcR
27	09:12	OcD	21	06:14	TrI	12	21:03	TrI
	14:23	EcR		07:04	ShI		21:37	ShI
				10:19	TrE	13	01:04	ShE
29	15:27	TrI		10:59	ShE		01:05	TrE
	16:52	ShI						
	19:29	TrE	23	12:32	OcD	15	03:26	OcD
	20:31	ShE		17:06	EcR		07:23	OcR
31	21:46	OcD	25	18:49	TrI	17	09:38	TrI
AUG 01	02:52	EcR		19:31	ShI		09:59	ShI
				22:49	TrE		13:37	ShE
03	04:00	TrI		23:30	ShE		13:39	TrE
	05:20	ShI						
	08:02	TrE	28	01:07	OcD	19	16:02	OcD
	09:00	ShE		05:34	EcR		19:55	OcR
05	10:19	OcD				21	22:12	TrI
	15:19	EcR					22:22	ShI
						22	02:09	ShE
							02:13	TrE

As with Titan, Rhea's eclipse reappearances may be difficult to time unless one knows where the statellite is likely to appear. Table 4 gives Rhea's apparent distance from Saturn's center at the times of eclipse reappearance; at such times, Rhea will be very close to the ring plane.

Table 4. Apparent Distance of Rhea from Saturn's Center at the Time of Eclipse Reappearance. (In units of Saturn's apparent equatorial radius, measured from Saturn's center; i.e., the limb is at distance = 1.00.)

1980 Date	U.T.	Distance	1980 Date	U.T.	Distance
MAR 23	01:18	1.09	APR 01	02:17	1.24
27	13:46	1.16	05	14:45	1.30
			10	03:12	1.36

Table 4. Apparent Distance of Rhea from Saturn's Center at the Time of Eclipse Reappearance. (continued)

1980 Date	U.T.	Distance	1980 Date	U.T.	Distance
APR 14	15:41	1.42	JUL 05	00:04	1.71
19	04:08	1.47	09	12:33	1.69
23	16:35	1.51	14	01:01	1.66
28	15:04	1.57	18	13:28	1.63
			23	01:56	1.59
MAY 02	17:31	1.61	27	14:23	1.55
07	05:59	1.64			
11	18:27	1.68	AUG 01	02:52	1.52
16	06:55	1.71	05	15:19	1.48
20	19:24	1.73	10	03:46	1.43
25	07:53	1.75	14	16:15	1.39
29	20:21	1.76	19	04:42	1.35
			23	17:06	1.26
JUN 03	08:48	1.77	28	05:34	1.20
07	21:17	1.78			
12	09:44	1.78	SEP 01	18:00	1.14
16	22:12	1.77	06	06:27	1.09
21	10:40	1.76	10	18:53	1.03
25	23:08	1.75			
30	11:36	1.74			

Observations and Visibility

Because of their rarity--similar events last occurred in 1966--Saturn's satellite phenomena should be of interest to many observers. Careful visual timings of satellite eclipses will help to refine their orbits. Photoelectric observations, when carefully timed, can also give us information about the diameters of Saturn and its satellites.

It is pertinent to ask what aperture instruments will be necessary to observe these events (although quality of optics, seeing conditions, and the ability of the observer also are important factors); unfortunately, the experience of past apparitions is somewhat contradictory.[2]

Quite a modest instrument (e.g., a 3-in. refractor (RR) or 4½-in. reflector (RL) should show Titan's eclipses and possibly its shadow transits as well. A 4-in. RR (or 6-in. RL) should show Titan as a dark spot during transits, and could also be used for observing occultations of it by the ball of Saturn.

Rhea will be a considerably more difficult object. A 4-in. RR, or 6-in. RL, should suffice for its eclipses. An 8-in. RL may show Rhea's shadow transits and its occultations by the ball. However, because of low contrast, larger instruments (10 in. or more) may be required to observe Rhea in transit. Some relevant (but approximate) disk and shadow data for Saturn's major satellites may give some idea of the potential for successful observation.

Table 5. Visibility Data for Saturn's Major Satellites. (At time of opposition, MAR 14, 1980. Dimensions are in arc-seconds.)

	Satellite Disk		Shadow on Ball		
			Umbra	Penumbra	
Satellite	Diam.	Surface Brightness Relative to Saturn	Diam.	Diam.	Width*
Tethys	0".16	2.1	0".12	0".20	0".08
Dione	0.19	1.4	0.14	0.24	0.10
Rhea	0.26	1.4	0.19	0.33	0.14
Titan	0.95	0.4	0.76	1.14	0.38

*This is also approximately equal to the width of Saturn's penumbra during satellite eclipses.

[2] For a summary of past experiences, see: A.F.O'D. Alexander, The Planet Saturn (London: Faber and Faber, 1962), pp. 131, 190-92, 215-16, 232-38, 242, 298, 344, 360, 397, and 417-18.

The surface brightness data are approximate, but suggest that Titan in transit should be relatively easy, and, due to its brightness, some observers may be able to see Tethys in transit as well. At any rate, large instruments will probably be required to see events for Tethys and Dione (let alone the yet smaller satellites); these events are not predicted here, although their approximate times may be deduced from the tables of eastern elongation times given in the 1980 A.E.N.A. (pp. 421-22). Certainly, though, the events involving Titan, and even Rhea, should be within the reach of many amatuers.

MUTUAL PHENOMENA OF SATURN'S BRIGHTER SATELLITES: MARCH, 1980

By: John E. Westfall

On March 12, 1980, the Earth will cross Saturn's ring plane for the second time of three such events during the 1979-80 apparition. Amongst other noteworthy events associated with a ring passage, the Earth will also pass through the planes of several satellite orbits. This last results in eclipses, transits, occultations, and shadow transits of satellites by the ball; and those events for Rhea and Titan were described in the article preceding this one. This report deals with the mutual occultations (and close passages) of Saturn's four brightest satellites--Tethys, Dione, Rhea, and Titan--which occur for the four weeks centered on the date of ring passage.

The events predicted here should be visible in telescopes of 6-8 inches aperture or greater. For close passages, or occultations, the two satellites involved will be seen to approach each other until they apparently merge into a single unresolved image which will be elongated, but whose elongation will change in amount and in direction. The brightness of this combined image will be equal to the summed brightnesses of the two satellites, but will drop somewhat during an actual occultation. This brightness drop will typically take several minutes and, visually, will only be noticed (if at all) by careful comparison of the combined image with that of an unaffected satellite or field star. Photoelectric measures will be particularly useful for timing mutual occultations, with the potential for providing information on satellites' orbits, diameters, and albedoes. Information on three stars, in Saturn's vicinity in March, 1980, for which photoelectric magnitude measures have been made, is given in Table 1.

Table 1. Photoelectric Photometry Reference Stars.

Star	R.A. (1980.2)	Dec. (1980.2)	V	(B-V)	(U-B)	Spectrum
HD 100340	$11^h31^m.9$	$+5°23'$	+10.19	-0.24	-0.94	B0
BD+3°2528	$11^h36^m.5$	$+3°23'$	+10.72	+1.55	-----	M2
BD+5°2529	$11^h40^m.8$	$+5°15'$	+ 9.60	+1.19	-----	K8

The predicted magnitudes of the combined satellite images are given in Table 2.

Table 2. Satellite Magnitudes, Alone and Combined.

Satellite.	Tethys	Dione	Rhea	Titan
Magnitude Alone.	+10.3	+10.4	+9.7	+8.4
Magnitude Combined With:				
Dione	+9.6	-----	----	----
Rhea.	+9.2	+9.2	----	----
Titan	+8.2	+8.2	+8.1	----

Table 3 gives information on 44 close approaches, including occultations, of the four brighter satellites which occur between March 2 and March 25, 1980. In this table, times are U.T. as corrected for light-time, and the satellites are listed with the one closer to Earth (the "occulter") first; "T" = Tethys, "D" = Dione, "R" = Rhea, and "Ti" = Titan. "Sep." indicates the center-to-center minimum apparent satellite separation in seconds of arc (measured parallel to Saturn's axis; positive when the first satellite is north of the second and negative if the first satellite is the southernmost). "X" is intended as an identification aid, and is the satellites' apparent distance from Saturn's center, in seconds of arc measured in the ring plane (positive indicating east and negative west). Under "Notes", "C" = conjunction (marked * when the satellite limbs will be within 0".05 and ** when they approach within 0".02), "P" = partial occultation, and "T" = total occultation (i.e., when either one satellite totally blocks the other, or is totally projected onto the other's disk). For occultations, "MD" is the estimated magnitude drop of the combined image at closest approach. Here "(ring)" means that the satellites will be near (or even projected upon) Saturn's rings.

Table 3. Mutual Phenomena of Saturn's Four Brighter Satellites, March 2 - March 25, 1980.

March, 1980, U.T. Date	Time	Sats.	Sep.	X	Notes
02^d	10:59	RT	-0".55	+23"	C
03	03:56	RD	-0.04	-56	T, MD = 0.5
	10:50	TD	-0.40	-29	C
04	15:39	DT	+0.57	+48	C
05	00:58	TR	-0.86	+16	C, (ring)
06	17:18	TD	-1.22	+41	C
	18:22	RD	-0.35	+45	C
07	13:47	RT	-0.66	-47	C
	21:06	DT	-0.98	-14	C, (ring)
08	00:08	RTi	-0.80	-79	C
	07:19	DTi	-1.12	-58	C
09	00:30	TD	-0.36	-17	C, (ring)
	03:22	TR	+0.21	-31	P--graze
	05:29	DTi	-0.43	+12	P, MD = 0.03, (ring)
	21:05	DTi	-0.23	+61	T, MD = 0.03
	23:06	DR	+0.31	+59	C
10	04:21	DT	+0.40	+42	C
11	18:50	RD	+0.32	-13	C, (ring)
12	06:14	TD	-0.87	+48	C
13	10:46	DT	-0.73	-27	C
	13:44	DR	+0.24	-42	C**
14	06:45	TR	-0.29	+40	C
15	17:48	DT	+0.46	+32	C
	19:56	RT	+0.87	+41	C
16	17:58	RD	+0.71	-60	C
	23:00	TD	+0.95	-48	C
17	04:03	TiD	+0.72	-25	C
	05:12	TiT	-0.14	-28	T, MD = 0.2
	18:11	TiR	+0.89	-71	C
18	14:16	DR	+1.02	+17	C, (ring)
19	00:19	DT	-0.56	-39	C
20	03:56	TD	-0.02	+11	T, MD = 0.4, (ring)
	08:59	RD	+0.81	+38	C
	23:16	RT	+0.29	-31	C
21	07:26	DT	+0.60	+20	C, (ring)
22	11:18	TD	+1.04	-44	C
	13:03	TR	+1.37	-47	C

Table 3. Mutual Phenomena of Saturn's Four Brighter Satellites, March 2 - March 25, 1980. (continued)

March, 1980, U.T. Date	Time	Sats.	Sep.	X	Notes
23^d	12:53	DR	+1."02	+61"	C
24	08:55	TTi	+1.83	-45	C
	11:20	DTi	+1.49	-37	C
	12:29	DT	-0.51	-46	C
25	01:39	RT	+1.28	+18	C, (ring)
	09:34	RD	+1.63	+21	C, (ring)
	17:38	TD	+0.07	+25	P, MD = 0.2

Some restrictions apply to the above table. First, some theoretical events are not given because the furthermost satellite would be eclipsed or occulted by the ball of Saturn. Second, eclipses of satellites by other satellites are not included; because the Sun passes through the ring plane on March 3rd, such events can be expected during the first half of March. Third, these ephemerides are subject to some degree of error; some close approaches may turn out to be occultations and thus should be observed. Also, actual times may vary from those in the table; and to be safe, the observer should begin to watch for a given event as much as a half-hour before the predicted time.

Of the 44 events in Table 3, the three partial occultations and the four total occultations are of particular interest, especially the two events (MAR 03^d 03:56 and MAR 20^d 03:56) where the magnitude drop is expected to be 0.5 and 0.4 magnitude, respectively. It is important to note that Saturn will be in opposition on March 14, 1980, and thus will be excellently placed for observation during this ring passage. The rings will probably be invisible (and thus will not interfere with satellite visibility) before March 3, and again after March 12, when the Sun and the Earth will be on opposite sides of the ring plane.

Finally, observers are reminded that a third ring passage, with associated satellite events, will occur on July 23, 1980. A subsequent report will provide predictions for mutual satellite events during that ring passage--the last one until 1995!

Note by Editor. We are much indebted to Dr. Westfall for his predictions of the phenomena of Saturnian satellites Titan and Rhea and of mutual phenomena of the four brightest Saturnian satellites, as given in the last two articles. In truth, such information can be available to our readers in very few other astronomical periodicals. We encourage our members to use their opportunities to attempt to observe these predicted events, both for the intrinsic worth of such observations as explained by John Westfall and for the purpose of helping to determine just what apertures are necessary to detect the different kinds of events (e.g., transits of Rhea and occultations of Tethys by Dione). Observant readers will note that many of the tabulated events cannot be observed from the United States (daytime or Saturn below horizon). Their inclusion is not accidental, however; we are seeking to give our international membership over the whole world the opportunity to participate in these rarely possible observing projects.

All observations of Saturnian satellite phenomena should be promptly reported to the ALPO Saturn Recorder, Julius Benton, at his address on the back inside cover.

A SIMPLE MODEL OF THE PLANETS JUPITER AND SATURN

By: Paul K. Mackal, ALPO Jupiter Recorder

It is easy to imagine the planets Jupiter and Saturn governed by a somewhat intricate variation of the mechanism of plate tectonics, as witnessed on the planet Earth. Only three plates need be postulated for Jupiter. An equatorial plate may be observed to subtend from the latitudes beginning with the SEB_s in the south to the NTB_s. This plate is naturally curved as Jupiter's atmosphere is, and its highest point may well be at the latitude of the equator. Due to hydrostatic pressure of liquid gases below the plate, and its faster rotation, the plate is slightly lifted with respect to the two polar plates of Jupiter. Consequently, there can be seepage of material responsible for red and blue coloration of the planet at points of maximum flexure, say at Mackal's A, B, C, D, E, F, G, and H (see Table II) in the southern hemisphere, just to the north of the SEB_s. Here the equatorial plate has been chipped by the south polar plate. In about 3 and ½ years material emitted from point B will also be emitted from B' in the northern hemisphere. Hence the 1975 NTrZ Disturbance was caused by the 1971 SEB Disturbance, just as the NTB_s eruption of 1932 was caused by the 1928 SEB Disturbance. And this is explained by the simple fact that the equatorial plate is curved and is considerably higher that the north polar plate. Without a doubt, material may pass under the equatorial plate along any line diagonal to same, and the parallel line to the north; but the shortest time line is perpendicular to the two parallel plate lines. Material will pass quickly from the equator, underneath the plate, to the crack between the two, but will take some time to rise underneath the equatorial plate at the equator. Material might also rise in the atmosphere of the SEB Z and encroach upon the SEB_n, filtering across the EZ to reproduce a tawny appearance. This material would then settle in the SEB_n, EB, and NEB_s. (It is also possible for the equatorial plate to melt away for extended periods of time, as in 1962-4, giving the usually light colored EZ a brownish or ruddy quality.) This material would then settle in the SEB_n, EB, and NEB_s.

Table I.

Zenological events of a red focal nature in the S. hemisphere.	Zenological after-effects of a blue focal nature in the N. hemisphere
1961	1964.5
1968	1971.5
1975	predicted for 1978.5

Dark material in the NTB and SEB_s would be responsible for darkening the polar regions of Jupiter to the north or the south. Once again, the dynamics of the flow of dark material would be along the plates, but this time the flow would be above and not below the plates in question. Hence, since the altitude of a polar region is quite minimal, dark material would be captured to the north or the south in relatively short periods; 4 and ½ years for the SPR and 8 years for the NPR.

To account for the seeming symmetry of the chip points on the equatorial plate, south or north of the equator, one need only postulate that fault lines or points of weakness subsist here and represent fractures in the equatorial plate. Hence, chips of the plate can be explained in spite of their great distance from each other. Without a doubt material can seep along the entire circumference of Jupiter's opening between the liquid hydrogen sea below and the ammonia, methane, and helium atmosphere above, along the latitude of the north edge of the SEB_s. However, only small amounts can seep through the narrow slits. Rather, at these openings, massive amounts of polymer material can enter the Jovian atmosphere; and this would also be true for the NTrZ.

This parsimonious explanation of Jovial dynamics is consistent with Saturn as well, with the notable exception that on the latter planet there can be only slow seepage, never fast seepage. This conclusion is based on the fact that no observation of Saturn has yet revealed anything like either the SEB Disturbance or an NTrZ eruption. Basic vent dynamics on Jupiter and Saturn are asserted to be aligned horizontally and not vertically. A shock wave might easily account for a second disturbance in the same latitude, e.g., one at F and another at G, or even one at H and another at E. No such argument could apply between B in the south and B' in the north, across equatorial latitudes.

The first astronomer to suggest vent mechanisms on Jupiter was J. C. Bartlett, Jr., an observer of Jupiter since the early 1940's. Ron Doel of the Jupiter staff of the ALPO compared events on Jupiter to hot earth geysers, in which material is squirted from the vent into the colder atmosphere above. The idea of plate tectonics originated with this author in 1975 in describing the great triple SEB Disturbance on Jupiter that year. Likewise, this author has suggested that plate tectonics on Jupiter are very like gigantic earthquakes, involving very large ice sheets.

Further information about the suspected rototion periods of the two polar plates are provided in Table II.

The rotation periods of the ice plates of Jupiter are thus deduced to be the same, through a computation of the drift line for the 1932 event in the NTB_s and the 1975 event in the NTrZ yields 0°.505/30 days, nearer $9^h\ 55^m\ 40^s.5$. An excellent estimate for all of them, computed by the author, is the average for the Red Spot, based on BAA and ALPO records from 1927 to 1972, inclusive, which is $9^h\ 55^m\ 40^s.822$. The closeness of the estimated value to the true value may well lend support to Raymond Hide's Taylor Column hypothesis of the Red Spot.

(Text continued on page 65)

INDEX TO VOLUME 27 OF THE JOURNAL OF THE ASSOCIATION
OF LUNAR AND PLANETARY OBSERVERS
(The Strolling Astronomer)

By: J. Russell Smith

(Published from December, 1977 to June, 1979)

Subject Index (References are to pages)

Author Index (references are to pages)

(Text continued from page 64).

Table II. A Uniform System of Rotation; SEB Z on Jupiter; $+0\overset{\circ}{.}32$/30 days, $9^h\ 55^m\ 41^s$.

Source	Year	Observed Long. (II)	Least Squares Long. (II)	Difference
A1	1919	221°	225°	-4°
A2	1937	285	282	+3
A3	1943B	288	301	-13
B1	1928	128	130	-2
B2	1952B	204	206	-2
B3	1955	211	214	-3
B4	1962	245	238	+7
B5	1964	245	244	+1
B6	1978A	288	304	-16
C1	1943A	20	14	+6
C2	1975C	120	122	-2
C3	1976	123	125	-2
C4	1978B	126	118	+8
D	1949	155	155	0
E1	1952A	120	125	-5
E2	1975B	208	203	+5
F1	1958	47	41	+6
F2	1971A	79	79	0
G	1971B	144	144	0
H	1975A	58	58	0

Two other rotation periods cause some confusion, however. Elmer Reese's famous three source rotation period, published in Icarus recently, yields a value in System III which has been estimated by J. L. Mitchell in an unpublished manuscript thesis (Univ. of Florida, 1974) to be $9^h\ 55^m\ 29\overset{s}{.}7$. This estimate has the distinct advantage of being based upon ALPO records of the motion of the Red Spot. This may be the rotation of the hydrogen sea underneath the tectonic plates of Jupiter. It is also very close to the decametric rotation of Jupiter. However, the subatmospheric rotation of five of the STrZ Disturbances, computed by Reese for Sky and Telescope, yields a somewhat faster rotation period of $9^h\ 55^m\ 21\overset{s}{.}208$. This value is not only inconsistent with $9^h\ 55^m\ 41^s$, but also with $9^h\ 55^m\ 29\overset{s}{.}7$.

In conclusion, it takes a simple model to explain the two giant planets; and the more complicated any model may be, the less likely it is to be general. Hence, the model proposed is offered as a highly probable one since no other model appears to be quite so simple to this author. Ostensibly, Reese's sub-atmospheric rotation of the STrZ Disturbances may be associated with the atmospheric rotations of the long-enduring S. Temp. Z. white ovals BC, DE, and FA, indicating the possible existence of yet another vent on the planet Jupiter. If so, then the surface may well have temperate plates in addition to polar plates. In the meantime, one outstanding problem yet remains; the rotation rate of the equatorial plate itself cannot be deduced from the existing observational evidence.

SATURN CENTRAL MERIDIAN EPHEMERIS: 1980

By: John E. Westfall, ALPO Associate Director

The two tables on pages 66 and 67 give the longitude of Saturn's geocentric central meridian (C.M.) for the illuminated (apparent) disk for 0^h U.T. for each day in 1980. These tables are a continuation of those previously published in ghe JALPO for 1969-79 and include corrections for phase, light-time, and the Saturnicentric longitude of the Earth.

SATURN, 1980
LONGITUDE OF CENTRAL MERIDIAN OF ILLUMINATED DISK

SYSTEM I--O HR U.T.

Day	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.
1	86.3	332.8	331.4	217.4	337.4	219.4	336.0	215.7	95.5	211.9	93.6	212.8
2	210.3	96.9	95.5	341.4	101.4	343.3	99.9	339.6	219.3	335.8	217.5	336.8
3	334.4	221.0	219.6	105.4	225.3	107.2	223.7	103.4	343.2	99.7	341.5	100.8
4	98.5	345.1	343.6	229.5	349.3	231.1	347.6	227.3	107.1	223.6	105.4	224.8
5	222.5	109.1	107.7	353.5	113.3	355.0	111.5	351.2	230.9	347.6	229.4	348.8
6	346.6	233.2	231.8	117.5	237.2	118.9	235.3	115.0	354.8	111.5	353.3	112.8
7	110.7	357.3	355.9	241.5	1.2	242.8	359.2	238.9	118.7	235.4	117.3	236.8
8	234.8	121.4	120.0	5.6	125.1	6.7	123.1	2.7	242.6	359.3	241.2	0.8
9	358.8	245.5	244.0	129.6	249.1	130.6	246.9	126.6	6.4	123.2	5.2	124.8
10	122.9	9.6	8.1	253.6	13.0	254.5	10.8	250.5	130.3	247.1	129.2	248.8
11	247.0	133.7	132.2	17.6	137.0	18.4	134.7	14.3	254.2	11.0	253.1	12.9
12	11.1	257.8	256.3	141.6	260.9	142.3	258.5	138.2	18.1	134.9	17.1	136.9
13	135.2	21.9	20.3	265.6	24.9	266.2	22.4	262.0	142.0	258.8	141.1	260.9
14	259.2	146.0	144.4	29.6	148.8	30.1	146.3	25.9	265.8	22.8	265.0	24.9
15	23.3	270.1	268.5	153.6	272.8	154.0	270.1	149.8	29.7	146.7	29.0	148.9
16	147.4	34.2	32.5	277.7	36.7	277.9	34.0	273.6	153.6	270.6	153.0	273.0
17	271.5	158.3	156.6	41.7	160.6	41.7	157.8	37.5	277.5	34.5	276.9	37.0
18	35.6	282.3	280.7	165.7	284.6	165.6	281.7	161.3	41.4	158.5	40.9	161.0
19	159.6	46.4	44.7	289.7	48.5	289.5	45.6	285.2	165.2	282.4	164.9	285.0
20	283.7	170.5	168.8	53.6	172.4	53.4	169.4	49.1	289.1	46.3	288.9	49.1
21	47.8	294.6	292.9	177.6	296.3	177.3	293.3	172.9	53.0	170.2	52.9	173.1
22	171.9	58.7	56.9	301.6	60.3	301.2	57.1	296.8	176.9	294.2	176.8	297.1
23	296.0	182.8	181.0	65.6	184.2	65.0	181.0	60.7	300.8	58.1	300.8	61.2
24	60.1	306.9	305.0	189.6	308.1	188.9	304.9	184.5	64.7	182.0	64.8	185.2
25	184.2	71.0	69.1	313.6	72.0	312.8	68.7	308.4	188.6	306.0	188.8	309.3
26	308.2	195.1	193.1	77.6	196.0	76.6	192.6	72.2	312.5	69.9	312.8	73.3
27	72.3	319.1	317.2	201.5	319.9	200.5	316.4	196.1	76.4	193.8	76.8	197.3
28	196.4	83.2	81.2	325.5	83.8	324.4	80.3	320.0	200.3	317.8	200.8	321.4
29	320.5	207.3	205.2	89.5	207.7	88.3	204.2	83.8	324.2	81.7	324.8	85.4
30	84.6		329.3	213.5	331.6	212.1	328.0	207.7	88.0	205.7	88.8	209.5
31	208.7		93.3		95.5		91.9	331.6		329.6		333.5

MOTION OF THE CENTRAL MERIDIAN

1H***35.2	9H**316.5	17H**237.8	10M****5.9	1M****0.6
2H***70.3	10H**351.7	18H**273.0	20M***11.7	2M****1.2
3H**105.5	11H***26.8	19H**308.2	30M***17.6	3M****1.8
4H**140.7	12H***62.0	20H**343.3	40M***23.4	4M****2.3
5H**175.8	13H***97.2	21H***18.5	50M***29.3	5M****2.9
6H**211.0	14H**132.3	22H***53.7		6M****3.5
7H**246.2	15H**167.5	23H***88.8		7M****4.1
8H**281.3	16H**202.7	24H**124.0		8M****4.7
				9M****5.3

Table of longitudes computed and contributed by John E. Westfall. See text on pages 65 and 68.

SATURN, 1980
LONGITUDE OF CENTRAL MERIDIAN OF ILLUMINATED DISK

SYSTEM II--O HR U.T.

Day	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.
1	28.6	3.0	153.6	127.5	7.7	337.8	214.4	182.2	150.0	26.5	356.1	235.2
2	120.6	95.1	245.7	219.6	99.6	69.7	306.3	274.1	241.9	118.4	88.0	327.2
3	212.7	187.2	337.7	311.6	191.6	161.6	38.2	5.9	333.7	210.3	180.0	59.2
4	304.8	279.3	69.8	43.6	283.6	253.5	130.0	97.8	65.6	302.2	271.9	151.2
5	36.8	11.4	161.9	135.7	15.5	345.4	221.9	189.7	157.5	34.1	3.9	243.2
6	128.9	103.5	254.0	227.7	107.5	77.3	313.8	281.5	249.4	126.0	95.8	335.2
7	221.0	195.5	346.1	319.7	199.4	169.2	45.6	13.4	341.2	217.9	187.8	67.2
8	313.1	287.6	78.1	51.8	291.4	261.1	137.5	105.3	73.1	309.8	279.8	159.2
9	45.1	19.7	170.2	143.8	23.4	353.0	229.4	197.1	165.0	41.7	11.7	251.3
10	137.2	111.8	262.3	235.8	115.3	84.9	321.2	289.0	256.9	133.7	103.7	343.3
11	229.3	203.9	354.4	327.8	207.3	176.8	53.1	20.8	348.7	225.6	195.6	75.3
12	321.3	296.0	86.4	59.8	299.2	268.7	145.0	112.7	80.6	317.5	287.6	167.3
13	53.4	28.1	178.5	151.8	31.1	0.6	236.8	204.6	172.5	49.4	19.6	259.3
14	145.5	120.2	270.6	243.8	123.1	92.5	328.7	296.4	264.4	141.3	111.5	351.3
15	237.6	212.3	2.6	335.9	215.0	184.3	60.6	28.3	356.3	233.2	203.5	83.3
16	329.7	304.4	94.7	67.9	307.0	276.2	152.4	120.1	88.1	325.1	295.5	175.4
17	61.7	36.4	186.8	159.9	38.9	8.1	244.3	212.0	180.0	57.1	27.4	267.4
18	153.8	128.5	278.8	251.9	130.8	100.0	336.2	303.9	271.9	149.0	119.4	359.4
19	245.9	220.6	10.9	343.9	222.8	191.9	68.0	35.7	3.8	240.9	211.4	91.5
20	338.0	312.7	103.0	75.9	314.7	283.8	159.9	127.6	95.7	332.8	303.4	183.5
21	70.1	44.8	195.0	167.9	46.6	15.7	251.8	219.5	187.6	64.8	35.3	275.5
22	162.1	136.9	287.1	259.8	138.6	107.5	343.6	311.3	279.5	156.7	127.3	7.5
23	254.2	229.0	19.1	351.8	230.5	199.4	75.5	43.2	11.3	248.6	219.3	99.6
24	346.3	321.1	111.2	83.8	322.4	291.3	167.3	135.1	103.2	340.6	311.3	191.6
25	78.4	53.2	203.2	175.8	54.3	23.2	259.2	226.9	195.1	72.5	43.3	283.6
26	170.5	145.2	295.3	267.8	146.3	115.0	351.1	318.8	287.0	164.4	135.3	15.7
27	262.6	237.3	27.3	359.8	238.2	206.9	82.9	50.7	18.9	256.4	227.3	107.7
28	354.7	329.4	119.4	91.7	330.1	298.8	174.8	142.5	110.8	348.3	319.2	199.8
29	86.7	61.5	211.4	183.7	62.0	30.7	266.6	234.4	202.7	80.3	51.2	291.8
30	178.8		303.5	275.7	153.9	122.6	358.5	326.3	294.6	172.2	143.2	23.8
31	270.9		35.5		245.8		90.4	58.1		264.1		115.9

MOTION OF THE CENTRAL MERIDIAN

1H***33.8	9H**304.6	17H**215.2	10M****5.6	1M****0.6
2H***67.7	10H**338.3	18H**249.0	20M***11.3	2M****1.1
3H**101.5	11H***12.7	19H**282.8	30M***16.9	3M****1.7
4H**135.3	12H***46.0	20H**316.7	40M***22.6	4M****2.3
5H**169.2	13H***79.8	21H**350.5	50M***28.2	5M****2.8
6H**203.0	14H**113.7	22H***24.3		6M****2.8
7H**236.8	15H**147.5	23H***58.2		7M****3.4
8H**270.7	16H**181.3	24H***92.0		8M****4.5
				9M****5.1

Table of longitudes computed and contributed by John E. Westfall. See text on pages 65 and 68.

"System I" assumes a sidereal rotation rate of $844^{\circ}.0$ per day (period = $10^h\ 14^m\ 13^s.08$), intended for use with features in the NEB, EZ, and SEB. "System II", intended for the remainder of the ball, has a sidereal rotation rate of $812^{\circ}.00$ per day (period = $10^h\ 38^m\ 25^s.42$). These rates are approximations only, because latitude-dependent rotation rates for Saturn are more uncertain than, say, for Jupiter; however, longitudes calculated from these tables should give conveniently small drift rates for most features. ALPO Saturn observers are urged to make central meridian timings, combined with latitude measures (or at least estimates), whenever possible so that these rotation rates, and any future C.M. tables, can be made more accurate.

To find the C.M. at any time, find the 0^h U.T. C.M. for the appropriate date and system, and then add hours and minutes corrections from the related table, "Motion of the Central Meridian", as shown in the example below.

Example: A light spot in the South Temperate Belt (STB) transits the central meridian at $01^h\ 38^m$ on March 14, 1980, U.T. (Note: The STB is in System II.)

System II C.M. at 0^h U.T., 14 Mar 1980	. .	$144^{\circ}.4$
+ Motion of the System II C.M. in:	01^h. .	035.2
	30^m. .	017.6
	08^m. .	004.7
System II C.M. at $01^h\ 38^m$, 14 Mar., 1980, U.T.		$201^{\circ}.9$ (202°)

Note that, if the calculated C. M. happens to exceed 360°, one simply subtracts 360° from the result. Also, in general, it is more realistic to round one's final longitudes to the nearest whole degree.

LUNA INCOGNITA: VISIBILITY EPHEMERIS FOR 1980

By: John E. Westfall, ALPO Lunar Recorder

Project Background

Although NASA's Orbiter and Apollo space missions succeeded in mapping almost all the Moon, their photographic coverage was incomplete for a region here called "Luna Incognita"; 270,000 square kilometers near the lunar south pole and southwest limb. In other words, the Moon is not yet completely mapped. Fortunately, most of this region can be seen from the Earth, given suitable lighting and libration.

In 1972, the ALPO Lunar Section began an observing project with the goal of producing a map of Luna Incognita. Considerable progress has been made, but much remains to be done. Consequently, high-quality drawings and photographs of this area by ALPO members are still highly needed. Other sources (observatory photographs, the "Watts limb profile charts", and Orbiter-4 and -5 and Soviet Zond-8 photographs), although helpful, do not give complete coverage.

Since the last report, ALPO members have made the following contributions:

C. Patton (6 in RL)	5 drawings
A. Porter (6 in RL)	1 drawing
J. Sabia (9 in RL; 4 in RR).	8 drawings and 3 photographs
D. Troiani (10 in RL)	2 drawings and 4 photographs
1978-79 Total . . .	16 drawings and 7 photographs
Project total . . .	19 drawings and 128 photographs.

The recent upswing in drawings is most welcome because these are capable of showing finer detail than most photographs. Naturally, high-resolution photographs are still welcome, too. Interested observers are urged to contact the writer to obtain further information, and a set of outline forms for drawings may be obtained by sending 60 cents to cover postage; the writer's address is: Dr. John E. Westfall, Department of Geography, San Francisco State University, 1600 Holloway Ave., San Francisco, CA 94132.

Observing Schedule for 1980

The table below gives those dates in 1980 when Luna Incognita will be visible from the Earth. In this table:

1. All data are for 0 hours, Universal Time (UT).
2. The "Form(s)" column indicates which of the set of outline forms is to be used for that date. "A", "B", and "C" refer to the three zones of Luna Incognita; south polar, intermediate (from Zone A to Hausen), and northern (north of Hausen), respectively. The numbers in parentheses give the form's longitude and latitude librations, respectively.
3. Asterisked (*) colongitudes indicate a low-to-medium Sun angle for Zones "B" and "C" (the Sun is always low for Zone A).

1980 UT Date	Solar Colongitude	Solar Latitude	Form(s)
JAN 08	153°.4	+1°.1	B(0°,-2°)
09	165.5	1.1	B(-2,-4)
10	177.7	1.0	B(-4,-4)
11	189.8	1.0	A(-5,-6);B&C(-4,-6)
12	202.0	1.0	A(-5,-6);B&C(-6,-6)
13	214.2	1.0	A(-5,-6);B&C(-6,-6)
14	226.4*	1.0	A(-5,-6);B&C(-6,-6)
15	238.6*	0.9	A(-5,-6);B&C(-6,-6)
FEB 04	121°.8*	+0°.4	B(0°,-2°)
05	133.9*	0.4	B(-2,-4)
06	146.0	0.4	B(-2,-4)
07	158.2	0.3	A(-5,-6);B&C(-4,-6)
08	170.4	0.3	A(-5,-6);B&C(-6,-6)
09	182.5	0.3	A(-5,-6);B&C(-6,-6)
10	194.7	0.2	A(-5,-6);B&C(-6,-6)
11	206.8	0.2	A(-5,-6);B&C(-8,-6)
12	219.0	0.2	A(-5,-6);B&C(-8,-6)
13	231.3*	0.2	A(-5,-6);B&C(-6,-6)
14	243.4*	0.2	B(-6,-4)
MAR 02	090°.4*	-0°.4	B(0°,-2°)
03	102.5*	0.4	B(0,-2)
04	114.7*	0.4	B(-2,-4)
05	126.8*	0.4	A(-5,-6);B&C(-4,-6)
06	139.0	0.5	A(-5,-6);B&C(-4,-6)
07	151.1	0.5	A(-5,-6);B&C(-6,-6)
08	163.3	0.5	A(-5,-6);B&C(-6,-6)
09	175.5	0.5	A(-5,-6);B&C(-8,-6)
10	187.6	0.6	A(-5,-6);B&C(-8,-6)
11	199.8	0.6	A(-5,-6);B&C(-8,-6)
12	212.0	0.6	B&C(-8,-4)
13	224.2	0.6	B(-6,-4)
14	236.4*	0.6	B(-6,-2)
15	248.6*	0.7	B(-4,0)
APR 01	095°.8*	-1°.1	B(-2°,-4°)
02	108.0*	1.1	A(-5,-6);B&C(-4,-6)
03	120.1*	1.1	A(-5,-6);B&C(-4,-6)
04	132.3*	1.2	A(-5,-6);B&C(-6,-6)
05	144.5	1.2	A(-5,-6);B&C(-6,-6)
06	156.6	1.2	A(-5,-6);B&C(-6,-6)
07	168.8	1.2	A(-5,-6);B&C(-8,-6)
08	181.0	1.2	B&C(-8,-4)
09	193.2	1.2	B&C(-8,-4)
10	205.4	1.2	B(-6,-2)
11	217.6	1.2	B(-6,0)
APR 29	077°.4	-1°.5	A(0°,-6°)
30	089.6*	1.5	A(-5,-6);B&C(-4,-6)

1980 UT Date	Solar Colongitude	Latitude	Form(s)
MAY 01	101°7*	-1.5	A(-5,-6);B&C(-4,-6)
02	113.9*	1.5	A(-5,-6);B&C(-4,-6)
03	126.1*	1.5	A(-5,-6);B&C(-6,-6)
04	138.3	1.5	A(-5,-6);B&C(-6,-6)
05	150.5	1.5	B(-6,-4)
06	162.7	1.5	B(-6,-4)
07	174.9	1.5	B(-6,-2)
08	187.1	1.5	B(-6,0)
09	199.3	1.5	B(-4,0)
MAY 26	047°1	-1°6	A(0°,-6°)
27	059.3	1.6	A(0,-6)
28	071.5	1.5	A(-5,-6)
29	083.7	1.5	A(-5,-6)
30	095.9*	1.5	A(-5,-6);B&C(-4,-6)
31	108.1*	1.5	A(-5,-6);B&C(-4,-6)
JUN 01	120.3*	1.5	B(-6,-4)
02	132.5*	1.5	B(-4,-4)
03	144.6	1.5	B(-4,-2)
04	156.9	1.4	B(-4,0)
05	169.1	1.4	B(-4,0)
JUN 22	017°1	-1°2	A(0°,-6°)
23	029.3	1.2	A(0,-6)
24	041.5	1.2	A(-5,-6)
25	053.7	1.2	A(-5,-6)
26	065.9	1.2	A(-5,-6)
27	078.1	1.2	A(-5,-6)
28	090.3*	1.2	A(-5,-6);B&C(-4,-6)
29	102.5*	1.1	B(-4,-4)
30	114.7*	1.1	B(-4,-2)
JUL 01	126.9*	1.1	B(-4,-2)
JUL 19	347°1	-0°7	A(0°,-6°)
20	359.3	0.6	A(0,-6)
21	011.6	0.6	A(-5,-6)
22	023.8	0.6	A(-5,-6)
23	036.0	0.6	A(-5,-6)
24	048.2	0.6	A(-5,-6)
25	060.4	0.5	A(-5,-6)
JUL 28	096°9*	-0°4	B(-4°,-2°)
29	109.1*	0.4	B(-4,0)
AUG 15	317°0	+0°1	A(0°,-6°)
16	329.2	0.1	A(0,-6)
17	341.4	0.1	A(-5,-6)
18	353.7	0.1	A(-5,-6)
19	005.9	0.1	A(-5,-6)
20	018.1	0.2	A(-5,-6)
21	030.3	0.2	A(-5,-6)
SEP 12	298°8	+0°8	A(0°,-6°)
13	311.0	0.8	A(0,-6)
14	323.3	0.8	A(-5,-6)
15	335.5	0.8	A(-5,-6)
16	347.7	0.9	A(-5,-6)
17	359.9	0.9	A(-5,-6)
18	012.1	0.9	A(-5,-6)
OCT 07	243°6*	+1°3	B(+4°,-4°)
OCT 11	292°5	+1°4	A(0°,-6°)

1980 UT Date	Solar Colongitude	Latitude	Form(s)
OCT 12	304°.7	+1°.4	A(-5°,-6°)
13	316.9	1.4	A(-5,-6)
14	329.1	1.4	A(-5,-6)
15	341.3	1.4	A(-5,-6)
NOV 03	212°.4	+1°.6	B(+4°,-4°)
04	224.6	1.6	B(+4,-4)
05	236.8*	1.6	A(0,-6);B(+2,-6)
06	249.0*	1.6	A(0,-6);B(0,-6)
NOV 10	297°.8	+1°.6	A(-5°,-6°)
11	310.0	1.6	A(-5,-6)
NOV 30	181°.0	+1°.4	B(+6°,-4°)
DEC 01	193.1	1.4	B(+4,-4)
02	205.3	1.4	A(+5,-6);B(+2,-6)
03	217.5	1.4	A(0,-6);B(+2,-6)
04	229.7*	1.4	A(0,-6);B(0,-6)
05	241.9*	1.4	A(0,-6);B(-2,-6)
DEC 27	149°.3	+0°.9	B(+6°,-4°)
28	161.4	0.9	B(+4,-4)
29	175.6	0.9	A(+5,-6);B(+4,-6)
30	185.8	0.8	A(0,-6);B(+2,-6)
31	197.9	0.8	A(0,-6);B(0,-6)

The year 1980 will be favorable for observing Luna Incognita, which will be visible on 122 dates, or one-third of the observing nights for that year. Naturally, some dates will be superior to others:

> Zone A is best seen when the Sun is southernmost in the Moon's sky so that the periods April 29 - May 4 and May 26 - 31 will be favorable for this Zone.
>
> Zones B and C are most visible when both the latitude and the longitude librations have high negative values (i.e., most southerly and westerly) and when the Sun angle is low or medium. Thus, the following periods are recommended: January 14 - 15, February 13, March 5, April 2 - 4, April 30 - May 3, May 30 - 31, and June 28.

Of course, observations made on any of the dates given in the above table will be helpful; previous observers are thanked and are urged to continue their work, while new observers are encouraged to contact the writer so that we can continue to map the last remaining unmapped portion of the Moon.

THE 1979 ALPO BUSINESS MEETING

By: John E. Westfall, Associate Director ALPO

The ALPO conducted its annual business meeting on Saturday, August 18, 1979, as part of the National Amateur Astronomy Convention held at Portland, Oregon. The meeting was called to order at 1:30 P.M., and was attended by Walter H. Haas (ALPO Director) and John E. Westfall (Associate Director), representing Association officers, together with seven other members.

The first business item was a report on membership and finances by Director Haas. The membership stood at about 730, and the June, 1979, assets at about $2000. The Association's chief expense is the publication of its Journal ("The Strolling Astronomer"), involving about $1040 per issue of approximately 800 copies. (The cost breakdown is $540 for printing, $300 for 3rd class postage, $120 for typing the contents, $30 for envelopes, and $50 for miscellaneous typing, such as the mailing list.) It is likely that these costs will increase, although means of obtaining a postal rate reduction are being explored.

Discussion then turned to future meeting sites (both for paper sessions and our concurrently-held business meetings). Our only invitation for 1980 was from the Western Amateur Astronomers (WAA), for their Tucson, Arizona, meeting on July 7-12; a unanimous vote accepted this invitation. As for 1981, two invitations were received: (1) from the WAA to meet in Orange County, California (approximate dates, August 18-21), and (2) from the Astronomical League to meet at Kutztown, Pennsylvania (Kutztown State College) on August 10-17; The consensus of the meeting was to accept the Astronomical League invitation for Kutztown. The possibility of the ALPO's holding independent meetings was also discussed; although generally desirable, it is rare that we receive an invitation for such from a local group.

As an informational item, Associate Director Westfall distributed copies for a new promotional brochure describing the ALPO and its observing Sections. One thousand copies have been printed (at a cost of approximately $100); these will be distributed at conventions, to ALPO staff, and to any interested member or non-member who requests one by sending Dr. Westfall a stamped, self-addressed long envelope.

The second item introduced by Dr. Westfall was a draft "Guide for Contributors" to the Journal, giving recommendations for correct preparation of text, tables, and illustrations. Director Haas recommended several specific revisions (e.g., regarding format and size), and the "Guide for Contributors" is being revised for future adoption and circulation.

The meeting then turned to a discussion of furthering and formalizing relations between the ALPO and the Astronomical Society of the Pacific (ASP), particularly because the latter organization has recently shown a greater interest in furthering amatuer astronomy. Mr. Frank Miller (an ASP Board member) made several points in this regard. The possibility of joint meetings (probably for 1982 and later) will be pursued. It was also suggested that ALPO Section Recorders submit articles to Mercury (an ASP publication) regarding their Section's activities. To promote greater rapport, complimentary copies of the ALPO Journal will be supplied to the ASP.

The business meeting finished with a discussion of methods to recruit new ALPO members--related to the previously-mentioned promotional brochure and ALPO-ASP cooperation. One suggestion was the authorship of articles about the ALPO and its work in other publications such as Mercury and Star and Sky. A second suggestion was for the creation of a traveling ALPO exhibit, which could be shipped to a variety of national and regional meetings.

There being no further business, the 1979 ALPO business meeting was concluded by Director Haas at 2:16 P.M.

BOOK REVIEWS

The Solar System, by John A. Wood. Prentice-Hall Inc., Englewood Cliffs, N.J., 07632. 1979. 196 pages. Illustrated. Price: hard-bound, $10.95, paperback, $6.95.

Reviewed by Walter Scott Houston

The days are long gone when a book such as Young's Manual of Astronomy could persist as a great classic textbook to satisfy the needs of several decades of students. Astronomy moves too fast today.

Perhaps in reaction, modern texts often are satisfied with the aroma of the fast food joint, blatently plastic. Now, John A. Wood has produced The Solar System, which is the nearest thing to a classic we have seen in many years. He achieves this excellence by an easy clarity of language, an abhorrence of "old chestnuts", and bright new examples and analogies which makes even his celestial mechanics sparkle.

In his acknowledgements he clues us to a portion of the reasons for this excellence; for he draws from such sensitive and original minds as Edward Anders, Owen Gingerich, and Charles Whitney, as well as others. It all adds up to a book that is eminently readable, stimulating, and warmly convincing.

The book is organized in terms of properties and processes rather than of description of the planets one by one. We have chapters on the surfaces of the planets, on their interiors, and on their atmospheres. Comets are included in the chapter on motions of the planets. To deal with the origin of the planets, there is a necessary chapter on the Sun, stars, and interstellar material, which makes the book a much fuller astronomy book than the title suggests. A glossary and a list of suggested reading, mostly from the Scientific American, are good; but the Index is most inadequate for the wealth of materials in the volume.

In several areas Wood ignores tradition and surfaces into the present. His first chapter deals in depth with the modern concept of the "model", as opposed to the older "hypothesis", and the use of the computer. "Hypothesis", he remarks, "is a pretentious and intimidating word.". It's a pity that most textbook authors have yet to find this out.

In another break with tradition, and a psychologically crucial one, Wood accepts catastrophe as a normal element in the scientific process. Thus he gives space to the "unusual" effect which gravitational forces can produce--comets may be the result of Jupiter's action on as yet unconsolidated lumps of the early planetary "soup". Large meteoroid impact can alter the axis of rotation of a major planet, even by as much as 90°; and he treats the random rain of meteorites on a planetary surface as a top priority influence. Crater formation is poured over in great detail. In fact, Wood elevates meteorites from their usual few paragraphs at a chapter's end to a prime position, with a chapter all their own. He is impressed with the amount of information a meteorite contains, and he details how we extract the data. However, he leaves unanswered the question of the origin of meteorites, closing with a tantalizing realization that "The slow rate of cooling (meteoritic structures)....requires a gravitational field ....and indicates that meteorites once resided in one or more planets." He does not identify such planets.

All of this is exciting and satisfying, but the charm of the book lies in the witty and surprising tidbits which ornament his pages:

> "The solar system consists of very little else than the sun."
>
> "If the sun were twice as massive as it is, Earth's period would be only $1/\sqrt{2}$ as long as it is; a year would pass in 258 days."
>
> "The Titus-Bode law simply expresses the closest spacing of planets in the solar system that would be dynamically stable over long periods of time."
>
> "Studies of the level of radioactivity in the meteorites [Arizona Crater] show that the impact occurred at least 2,700 years ago." (Was it then a witnessed fall? - Walter Scott Houston)
>
> "At the onset, Jupiter would have been....probably larger than the present sun."
>
> "Jupiter's internal temperature was never more than one-tenth that needed to initiate nuclear fission."

The book would make an excellent undergraduate text for a non-mathematical course. It will surprisingly sharpen the concepts of those whose astronomy was learned some time ago. It could easily inspire a sensitive high school student, and as such it belongs in public as well as school libraries.

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The Cloudy Night Book, by George A. Mumford. Sky Publishing Corporation, 49 Bay State Road, Cambridge, Mass. 02138. 1979. 115 pages with signs, symbols, and cartoons. Price $4.95. Paperback.

Reviewed by Edwin F. Bailey

When it rains or snows, observers can easily make a decision to lock up and retire for the night. Nights that are hazy and those with occasional clouds give real problems. In the pause between looks there are periods too short for concentration. Then what is one to do? Mumford has offered a beginning book with various examples of how to fill useless time with pleasant activities such as story telling, puzzles, decoding astrocrostics and memory scratching. He also suggests that new material is welcome for future editions.

If your student days are long gone, these pleasant pages will help to refresh your decaying memory. They might even point to histories which are faint tracks in your background. Since the answers are printed in the back of this paperback, you will not have to rush to the library for quick refreshers. There is a sprinkling of astro-cartoons by S. Roth that break up the letter press and perhaps the junior astronomers.

Each observatory has traditional stories about who forgot to wind the clock, replace plates, put water in the developer bottles, etc. The collected stories in this vein would easily fill a great tome. This book might begin a new division in the history of astronomy. Thanks, "Sky".

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Stars and Nebulas, by William J. Kaufmann, III. W. H. Freeman and Company, 660 Market Street, San Francisco, CA 94104. 1978. 197 pages. 104 illustrations. Price: cloth $13.00, paperback $7.00.

Reviewed by Gary A. Becker, Editor, The Reflector

I've had fun reading and discovering a new text in elementary astronomy entitled Stars and Nebulas. Written by San Diego State University physicist William J. Kaufmann, III, Stars and Nebulas was a companion of mine on a recent winter photography expedition to Maine. Sunsets come early there, and Kaufmann's book provided me with the necessary relaxation as I unwound from busy days of shooting.

The author's method of presentation is very informal. You will note that in the title "Nebulas" is not spelled with the more traditional and stuffy Latin ending. Perhaps this clue prophesies the book's most valuable asset. Stars and Nebulas is jam-packed with a story that is as old as creation, but is related in fresh new prose which makes astronomy reading truly interesting once again.

The journey begins in "Stellar Scenario," where the individual is introduced to the astronomers' vast realm, his thought processes, and his methods of observation and deduction. Kaufmann has made only one basic assumption in preparing this text--that a person can read.

Kaufmann's smooth and polished beginning gets somewhat boggled in his next chapter, "The Laws of Light." The work of Stefan and Wien, black body radiation curves, Planck's quantum theory, and the discoveries of Fraunhofer, Bunsen, Kirchhoff, Rutherford, and Bohr are too much information in the scant eleven pages of written text devoted to these subjects. However, do not despair, for the interesting material which lies ahead justifies reading "The Laws of Light" twice.

Chapter three, "The Meaning of Starlight," is right back on track with a well-presented explanation of the evolution and importance of the Hertzsprung-Russell diagram in astronomy. Binary systems are also discussed.

From this point onward, Kaufmann's true genius emerges. His ability to synthesize the first three chapters into a cohesive explanation of the life histories of stars is exceptional. "Our Sun--A Typical Star" follows. The ensuing chapers on stellar birth and maturity and the death of stars each relate extensively to preceding material. A reader cannot help but gain familiarity with the H-R diagram as the twisted pathways of evolving stars carefully unfold before him. In the final two segments of the book, pulsars, neutron stars, and black holes are discussed with equal lucidity.

Complementing the written text is a profusion of line drawings and photographs. For the most part, they add extra depth and are essential to the information being discussed. In several cases, however, they appear to lead to more confusion than they are worth. One example on page 61, which is especially poor, comes where Kaufmann assumes the reader can judge on his own the absorption line shifts in a spectroscopic binary. In some cases the photographs and diagrams could be more adequately referenced in the textual information.

Typographical errors are few but are easily noticed. Page 13 has the distance to Vega incorrectly stated as "15,600,000,000,000 miles" (actually 156 trillion miles), while on page 101, Figure 5-11, an H-R diagram of NGC 2264 is confused with Figure 5-12, a photograph of the Pleiades.

Eight colored plates grace the center section of the text. Their subject matter is of the garden (Hale Observatory) variety, but their reproductive quality is quite good. Textbooks and magazine articles are also listed for further reading at the end of the last chapter. Twelve monthly star charts, reprinted from The Griffith Observer, are reproduced in a separate unnumbered section. They neither support the content emphasis of the book, nor are they really suited for fieldwork because of their small size and lack of detail. This extra space could have been more adequately utilized to expand the content of Chapter Two, "The Laws of Light." The book's layout and print size are very pleasing to the eye, and its index is quite complete. The cover in the paper edition is rather thin and bendable for the book's $7.00 purchase price.

Stars and Nebulas is a very readable, enjoyable, and exciting book. In our modern media-oriented society, science writers must seek new avenues of approach in order to coax individuals into reading. Kaufmann's friendly writing style, combined with the ample use of good visual illustrations, appears to offer the necessary ingredients for providing the essential story in an exciting cosmic adventure novel. Stars and Nebulas is the first book of a trilogy on astronomy being written by William Kaufmann for a lay audience. Forthcoming volumes are Planets and Moons and Galaxies and Quasars. I shall eagerly await their release.

ASTRO-NORTHWEST '79

By: Don Machholz

Over 200 amateur astronomers and enthusiasts attended this conference, held on the University of Portland campus in Portland, Oregon. Conducted by the Western Amateur Astronomers, the Astronomical League, and our very own Association of Lunar and Planetary Observers and sponsored by the Portland Astronomical Society, it took place on Aug. 16-19, 1979. Papers were presented, awards were given, tours were taken, and a good time was had by all.

The Paper Sessions

There were three days of paper sessions, where many studies, reports, and reviews were read and illustrated. First, the convention was opened by the Presidents of the organizations: Walter Haas of the ALPO, Bob Young of the Astronomical League, and Frank Miller of the WAA. Then papers were presented. Ken Miller of the Seattle Science Center gave a talk on public star parties and the importance of keeping them geared to the general public. The rest of the first morning (Thursday) was spent on the Feb. 26, 1979, total solar eclipse. Apparently not everyone had cloudy skies-as evidenced by some of the fine photos and slides shown.

That afternoon, Hank Pander, an artist whose paintings recently appeared in Sky and Telescope, talked on some of his artwork and his travels to some of America's observatories. Cliff Holmes showed some slides of the 1979 Riverside Telescope Makers Convention, which draws more than just the telescope makers, and encouraged early registration for the 1980 convention to be held on the Memorial Day Weekend. There may be over 1,000 people at this next one.

Del Wiseman demonstrated his "replicator", a box-like screen projecting miniature planets, stars, clusters, and galaxies. When they are seen through a telescope from a given distance, this device provides views of these objects which can be used for training and/or pleasure. The "replicator" was later used at a rained-out star party. Robert Young of the A.L. then threw some light on the ever-present light-pollution problem, illustrating mis-aimed and over-watted outdoor lighting. Bob Amos, now residing in Oregon, talked about his astronomical experiences during his six-year stay in Australia. The talk was augmented with a wide variety of slides. The last talk of the day was by Don Machholz of the San Jose Astronomical Association. He discussed the "Messier Marathon", an attempt to observe as many of the 110 Messier objects in one night as possible. Earlier this year Gerry Rattley and he each saw 108 of the objects in one night.

Friday morning saw a talk by Don Machholz on the discovery of Comet Machholz (1978L) on Sept. 12, 1978. Dan Lester of the Lick Observatory gave an interesting and detailed talk on star formation. Ralph Turner brought a model of Phobos (one of Mars' two moons) which he constructed from 25 Mariner photos. The model can be used better to determine the volume and density of this small moon. Ben Casados of the Jet Propulsion Lab demonstrated the Voyager flybys of Jupiter and its moons, and talked about what lies beyond.

After lunch, B. E. Meyer (of the company of the same name) demonstrated some image intensifiers. They are used to make faint objects appear thousands of times brighter. Some models will soon be available to the amateur astronomer for a base price of around $1,000. Dave Chandler talked of naked-eye astronomy and some of the distortion problems that are corrected on the "Planisphere", advertised on the back cover of this Journal. Howard Thomas discussed his computer program to help one more easily align the telescope axis with the North Pole. Alan Gorski of the Tacoma (Washington) Astronomical Society spoke of the construction of the Pittinger-Grilay Observatory, now housing a 6", f/15 refractor, and used by the Tacoma group. Alan also discussed the contrast enhancement of slides by re-photographing them.

After a short break, John Westfall of the ALPO read a paper by Alain Porter and Derek Wallentinsen about asteroid rotation. This is a field lacking needed attention by both amateur and professional astronomers. Those interested in working on this project may wish to contact Derek - his address is in the back of this Journal.

Larry Mahon of the Portland area talked on both his blink comparator, developed several years ago, and on a 30.5" telescope he has been planning on building in central Oregon. John Westfall talked about image analyzers and their use in measuring the position of solar system objects from slides or negatives. Then Steve Edburg talked about spectroscopic equipment - the main problem appears to be that of acquiring a good diffraction grating.

Figure 7.
Amateur astronomers at the 1979 National Amateur Astronomy Convention, gathering outside the principal meeting place--Buckley Center Auditorium on the campus of the University of Portland, Portland, Oregon. Figures 7-11 are photographs taken and contributed by John E. Westfall.

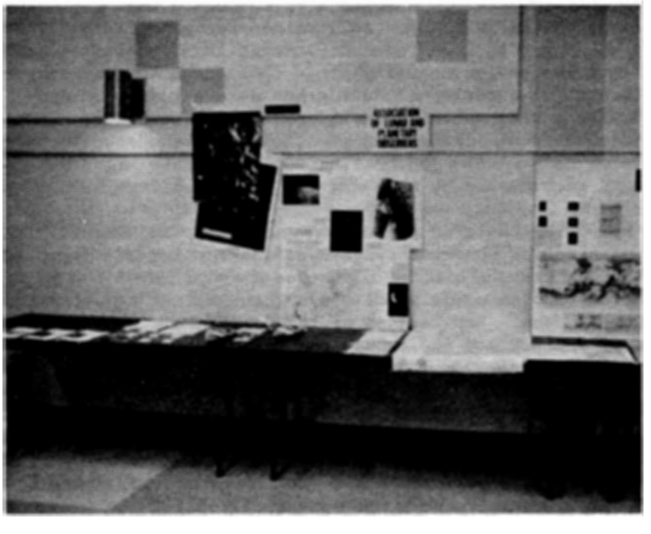

Figure 8.
The ALPO Exhibit at the National Astronomy Convention, containing materials submitted by the Mars, Jupiter, Saturn, and Lunar Sections, together with free copies of the new ALPO brochure. Exhibit collected and arranged by John E. Westfall.

Saturday, the last full day of the convention, contained only one paper session, this one being held in the morning. Sandy Mikalow described the "Northwest Astro-Net", a shortwave radio program heard weekly. On the 80-meter band it's at 3.925 MHz on Sunday nights at 10 P.M., Pacific Time. On the 40-meter band it's at 7.29 MHz on Wednesday nights at 8 P.M. Next, the Honorable George Joseph, a judge in the Portland area, talked on astronomy in ancient Egypt. Seeing how the Egyptians were more interested in the practical than in the theory, Mr. Joseph suggested that they probably did not develop astronomy to such a high degree as is generally attributed to them.

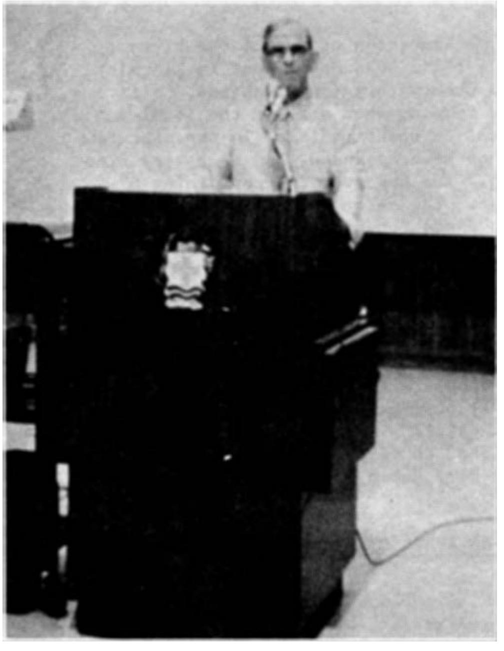

Figure 9. ALPO Director Walter H. Haas welcoming attendants at the opening session of the 1979 National Amateur Astronomy Convention.

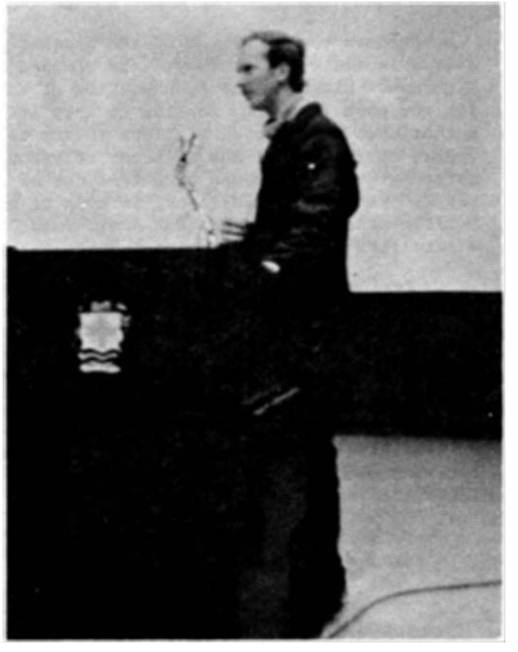

Figure 10. Don Machholz, an active ALPO observer, delivering an illustrated talk describing his technique of comet searching and his discovery of Comet Machholz 1978L.

Figure 11. John Sanford, an advanced astrophotographer, describing techniques of high-resolution planetary photography.

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Walter Haas, President of the ALPO, talked on the rotational period of an equatorial white spot on Saturn. Using observations made by several amateur astronomers in Spring, 1978, Mr. Haas found that the period ranged from $10^h\ 16^m$ to $10^h\ 23^m$. More observations are needed for this study. Walter Haas then read a paper by Richard Baum of England, describing some 1908 observations of very faint dusky rings of Saturn other than the recognized Rings A, B, and C. John Sanford gave a talk on planetary photography. John's photos have appeared in dozens of publications. To finish the session, a slide show and taped-talk were given explaining the Ancient City Astronomy Club's Herschel Project. Some 400 objects will be in the catalog, and it is nearing completion at this time.

The Banquet

On Friday evening, a well-attended banquet was held. The keynote speaker was Jim Bosley, a television meteorologist who is rather popular in the Portland area. He entertained us with stories of some of his experiences with his job, and included the reading of some of his fan mail.

Perhaps the highlight of the banquet was the presentation of two of the highest awards in amateur astronomy. The coveted WAA Bruce Blair Gold Medal went to Kingsley Wightman. Kingsley has been working at the Chabot Observatory (near Oakland, Calif.) for the past 15 years, working to keep it open and running when some of the local authorities have wanted to close it due to oversight or underfunding. In the past few years, operations at the adjacent telescope workshop have expanded, and some very fine astronomical instruments have come out of the shop. The Observatory, containing 8" and 20" refractor telescopes, is open to the public. The Astronomical Society of the Pacific presented its Amateur Achievement Award to James McMahon. Last year he discovered a satellite of the minor planet Herculina.

Other Notes

Conventions of this size usually have one or more star parties. This one was no exception. The star party was held on the evening of Saturday, Aug. 18, at Trillion Lake, some 60 miles east of Portland. Nearly 100 people either took the chartered bus or drove to the site. Clouds and rain prevented sky observation, but several telescopes were set up and pointed towards Del Wiseman's replicator.

Bus tours were also available to those who wished to visit the attractions of the Portland area and the Oregon-Washington area. The half dozen tours were conducted by Adventure Trails of Portland.

OBSERVING MARS VIII - THE 1979-80 APHELIC APPARITION

By: C. F. Capen and D. C. Parker, M.D., ALPO Mars Recorders

Abstract

The 1979-80 Martian apparition geometric characteristics, seasonal aspects, and observational phenomena which are especially important to the study of the Martian problem are discussed. Useful graphs, charts, and a calendar of seasonal events are presented for the telescopic observer of Mars. The future of observational programs is considered.

Introduction

Mars is a dynamic world with many Earth-like characteristics: four seasons, global climates, changeable weather, windy seasons, storm clouds, annual polar ice caps, and a large assortment of geomorphological surface features. Because Mars has a very active atmosphere, it exhibits many exciting changes both on the surface and in the atmosphere which can be observed through color filters with moderate-size telescopes.

The ALPO Mars Section's observing program is an international cooperative effort by astronomers located around the world, thus allowing a synoptic surveillance of all Martian longitudes during one or two rotations of the Earth. The Mars Section Recorders coordinate and instruct observers in using similar observing techniques, color filters, and methods of reporting their data. Obtaining a homogeneous set of data aids greatly in its final interpretation and analysis. Visual observations, photographs, and photometry of Mars are contributed monthly to the Mars Section by individual astronomers, astronomical societies' observing groups, by members of professional observatories, and by international organizations, e.g.: the Société Astronomique de France, the Oriental Astronomical Association, and the British Astronomical Association. A news letter "Martian Chronicle '80" is available to active observers who send the Mars Recorder 6 to 8 self-addressed and stamped envelopes. Standard ALPO Mars observing report forms are available at cost and postage for $2.75. A Mars Observing Kit containing useful reprints, graphs, CM computing tables, nomenclature, charts, color filter and photographic techniques, and helpful instructions is also available at cost for $4.75 pp. Various Mars Charts from the Lowell Observatory, useful for reference and for plotting Martian phenomena, can be obtained for $2.50 pp. Informative, reference, and interesting books about Mars and observing methods are often available. Contact Recorder C. Capen for current lists.

1979-80 Apparition Characteristics

An apparition of a planet is defined as the total duration of useful observability from Earth, before, during, and after opposition. For Mars, an apparition lasts about 10 to 12 months, less than half the 26-month interval between successive oppositions.

This interval is also known as the synodic period of Mars. Refer to Figure 12. Due to the unusually long Martian apparition of about 1 terrestrial year, it is possible to observe Mars throughout 2 Martian seasons. There is about 1 Martian season overlap and 1 season advance between consecutive apparitions, as indicated in Figure 12. The 1979-80 Martian apparition is an epoch of northern hemisphere spring and summer, or southern hemisphere autumn and winter. This apparition is indeed aphelic since opposition occurs only 1 degree beyond aphelion. Mars reaches opposition on Feb. 25, 1980, just 2 days after aphelion, with an apparent disk diameter of 13.8 arcsec. at a distance of 63 million miles from Earth. The disk diameter is just 0.5 arcsec. less than that reached last apparition on Jan. 22, 1978. Not since 1948 has Mars had such a small disk at the time of opposition.

Figure 14, the 1979-80 Graphic Ephemeris For Mars, indicates that useful visual observations can be made for over 8 months, from November, 1979, until mid-July, 1980, while the Martian disk is larger than 6 arcsec. Quality planetary photography is possible when the apparent disk diameter exceeds 10 arcsec., from January until late April, 1980. Successful photography of the small Martian disk is possible only when employing eyepiece projection or a Barlow lens that will give a negative image at least 3mm to 4mm in diameter. The larger the image, the better for printing enlargment photos to a minimum size of 1 inch in diameter, which is necessary for study, measurement, and reproducing for use as illustrations in J.ALPO Mars Reports. The Graphic Ephemeris For Mars shows that the subearth D_e (Mars' tilt) and subsolar D_s points are coincident along the 22°N. parallel during the first week in February, 1980, just before opposition, while the apparent disk is near its maximum diameter. This aspect makes possible specular reflection observations of brightened ice-fog and frost areas and improves local contrasts in nearby latitudes. Further, the subearth dashed line tells us that the northern polar and tropical regions of Mars are favorably tilted toward the observer during the entire apparition. It is noted that another point of coincidence between the subearth and subsolar curves occurs later in May, when the Martian disk is rapidly shrinking in size but when observing is a bit more pleasant. It is most informative and interesting to compare the 1977-78 Graphic Ephemeris For Mars published in "Observing Mars VII - The 1977-78 Aphelic Apparition" (Ref. 1.) to the current 1979-80 Graphic Ephemeris For Mars for the seasonal shift (L_s) of the point of opposition and the points of coincidences between D_e and D_s.

Observational Phenomena

This autumn, winter, and spring the planet Mars is again favorably placed in the sky, well north of the celestial equator, giving improved "seeing" to observers located in the northern hemisphere of the Earth. The Martian atmosphere becomes most dynamic in northern late spring and early summer. Since this apparition is centered on the time of the Martian year when white water clouds and limb hazes become the salient features on the observed disk, your Mars Section Recorders with to emphasize a systematic color filter patrol of the Martian atmosphere. Although the apparent disk of Mars is small, refracting telescopes with 3- to 5-inch apertures or reflectors with 6- to 8-inch apertures can be used visually to study and record the location and seasonal occurrence of these atmospheric features with the aid of high transmission filters. Skilled planetary photographers have obtained good pictures of Mars with instruments as small as 8-inches in aperture by using large f-ratios of f/100 to f/200 and fine grain pan films. It is most important to obtain multi-color black and white photos of the white condensates in blue-light vs. yellow or red-light. Martian images with large tonal range are possible with fine grain hi-contrast pan films processed using mild developers, e.g., UFG or PMD. Refer to Refs. 2 and 3. Professional color and color filter black and white photos are possible with 12-inch and larger telescopes operating at large f-rations in order to obtain large image sizes.

Polar Regions: The North Polar Cap (NPC) is the salient polar feature since the north pole of Mars is tilted toward the Earth during the entire apparition and the NPC is bright and large during Martian spring. Dr. Parker announced that the polar cloud hood dissipated the first week of Oct., 1979, at about $5^{o}L_s$, or Mar. 26 Martian Date. Thus, the rapidly shrinking cap can be observed and measured micrometrically during the first part of the apparition. As predicted over a decade ago by Capen and Capen, Ref. 4, the NPC is a thin mantle of CO_2 crystals deposited over a small, thick H_2O ice cap. The larger CO_2 portion of the cap sublimates away rapidly in mid-spring. When the edge of the dense water ice cap is exposed in late spring, the retreat of the cap is observed to become slow. The release of moisture causes a temporary hood

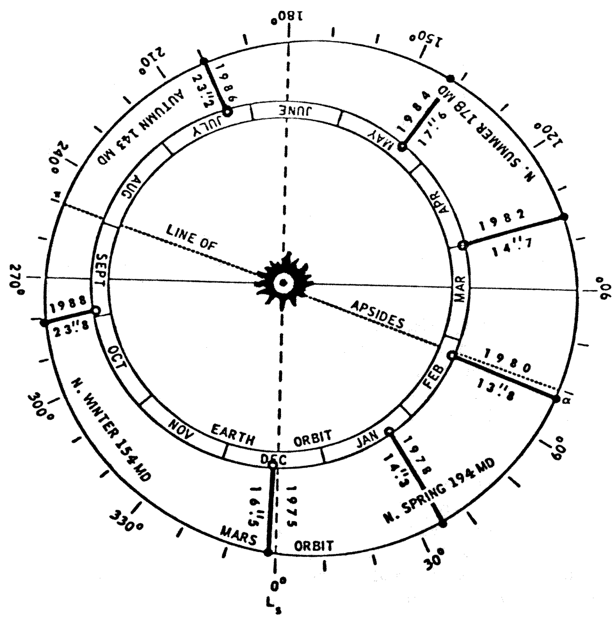

Figure 12. Heliocentric orbital chart showing oppositions of Mars over the interval 1975-88, the maximum apparent angular diameter of Mars for each apparition, and the relative seasons for Earth and Mars. The quantity L_S is the areocentric longitude of the Sun so selected as to be zero degrees at the vernal equinox of the north hemisphere of Mars. Thus L_S is a measure of the Martian seasonal date.

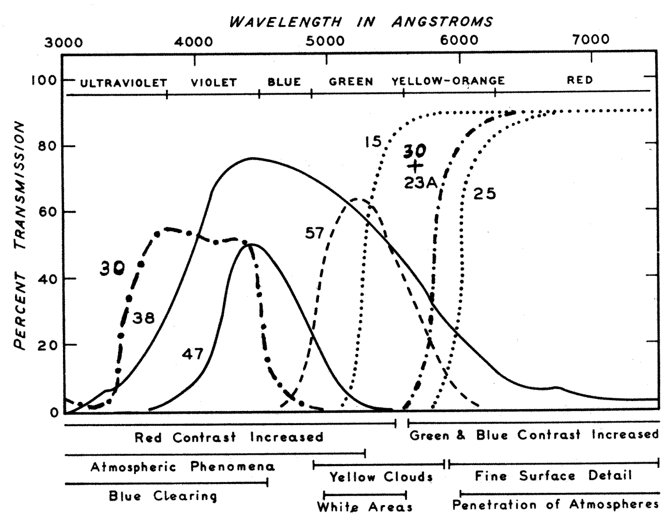

Figure 13. Spectral transmission curves of some Eastman Kodak Wratten Filters widely used for planetary observation. The wavelength regions appropriate for specialized purposes are indicated by horizontal bars below the graph. The W30 filter, magenta in color, transmits in both the violet-blue and the orange-red regions as shown by the heavy dash-dot curve. The orange-red portion coincides with the W23A filter.

of clouds to form over the cap, which in turn stops the retreat of the cap. Some measurements of the cap diameter indicate that the NPC actually increases slightly in diameter at this time when Mars is near aphelion. These temporary arctic clouds occur during the period known to planetary astronomers as the "Aphelic Chill". ALPO observers should be alert to the symptoms of the Aphelic Chill in late Feb., 1980, because little is known about the occurrence and seasonal behavior of the Martian arctic at this time of its year. Only a small ice cap remnant should be left by the Martian northern summer solstice in mid-April, 1980.

Mariner 9 photography confirmed the existence of the dark collar about the NPC which classical astronomers had been observing for a century. C. Sagan, et.al., Ref. 5, explain the polar collar as due to temperature differential winds blowing off the north

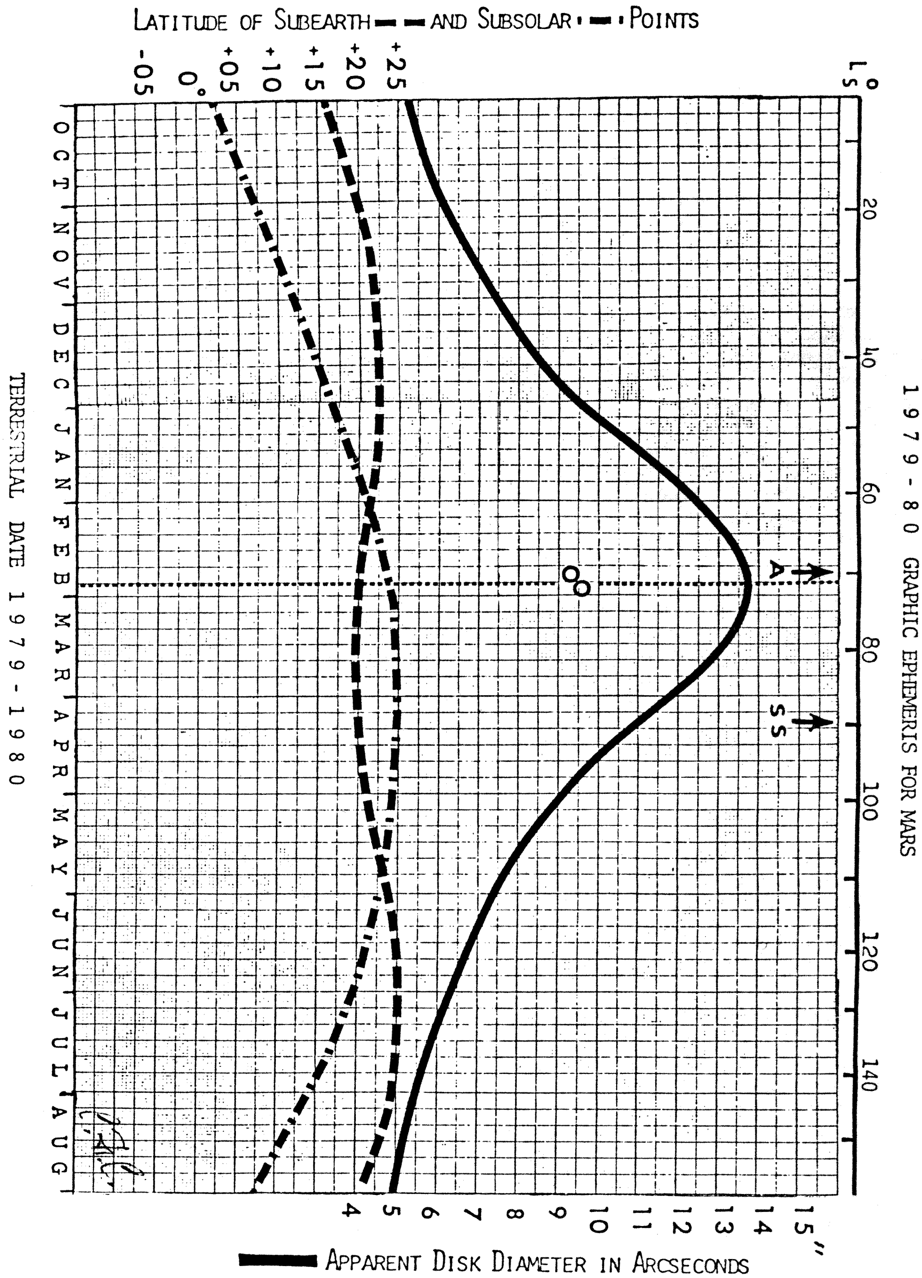

Figure 14. A Graphic Ephermis for the 1979-80 Apparition of Mars showing the apparent disc diameter (solid curve) in arcseconds, the latitude of the subearth point or the apparent tilt (dashed curve) in areocentric degrees, and the latitude of the subsolar point or seasonal altitude of the Sun as seen on Mars (dash-dot curve) in areocentric degrees. The areocentric longitude L_s of the Sun shown along the right edge of the graph defines the Martian seasonal date. The value of L_s is 0^o at the vernal equinox, 70^o when Mars is at aphelion (A), and 90^o at the summer solstice (SS) of the northern hemisphere. Graph prepared by Mars Recorder C. F. Capen for the ALPO 1980 Mars Observing Kit.

cap which removes a thin, bright surface layer of dust from dark base rock. The darkening and the broadening of the polar collar can be observed from early Dec., 1979, until late Feb., 1980.

The South Polar Cap (SPC) will be forming beneath an extensive dull, gray, polar hood of CO_2 clouds. Unlike the NPC, the SPC is chiefly composed of CO_2 frost. According to recent Viking spacecraft results the H_2O content of the southern hemisphere is controlled by water traps, or sinks, which are located in the basins Hellas, Argyre, and possibly other similar low areas yet unrecognized. These unknown topographic low places that collect H_2O ice during the chill of Martian late autumn and winter can possibly be located with terrestrial telescopes, and then checked against elevation topo charts of Mars. Consequently, any brightenings seen in the Hellas, Argyre, and other places should be emphatically reported to the ALPO Mars Recorders.

Martian Meteorology: The Martian atmosphere is most dynamic exhibiting many types of salient condensates which are easily observed with color filters through terrestrial telescopes. The white clouds consisting of water droplets, limb hazes of CO_2 and dust, yellow dust storms, and surface ice-fogs have been of increasing interest in the last decade. Past ALPO observations of the white clouds and bright ice-fog patches show that their occurrence is coupled with the seasonal thawing and condensation of the polar caps. Your Mars Recorders wish to emphasize the importance of blue filter vs. red or yellow filter observations of these atmospheric features. Refer to Figure 13.

Orographic clouds begin condensing as local noon approaches mountains and volcanoes due to up-lifting of water vapor laden air. By early afternoon they become bright, white, individual clouds seen best in blue light. They continue to expand and to brighten and coalesce with each other toward sunset, when they can be seen best on the limb in violet and ultraviolet light, indicating that they must also expand upward by convection. They do not appear to keep the same form or to last throughout the chill of night because they are not seen again in the twilight of morning. The formation of these clouds is definitely linked to the elevation topography shown on the USGS Mars Atlas charts and to special meteorological conditions of the Martian atmosphere of late spring and summer. The Mars Recorders have found the orographic H_2O clouds to be restricted to the Martian tropical zone from -10^{o} to $+40^{o}$ latitude. Refer to Figure 15 and the front cover chart.

Less understood are dense, whitish clouds of limited extent which recur seasonally and regionally and persist for many days. They exhibit day-to-day growth and displacement within a region, appearing white in their early stages, and are seen best through blue and blue-green filters. Their color can change, becoming prominent in green light, and sometimes they are visible in yellow wavelengths. This has led the senior Mars Recorder to suspect that the localized clouds may be combinations of white water clouds and yellow dust clouds. Observational information is indeed needed to learn how many clouds of this type exist and where they are located. This information can only be obtained during the next three aphelic apparitions.

A thorough historical discussion and a modern presentation of these condensates are given in Ref. 1 and are well illustrated in Figure 15, a Topographic/albedo chart of Mars, which shows the appearances and locations of the Martian clouds with respect to the local topography.

Certain light albedo areas exhibit temporary bright, white spots, which are probably seasonal in nature because they are often observed at a time when a polar cap is rapidly thawing near its summer solstice. These bright patches have been identified by Viking Orbiters as surface frosts and dense fogs near the surface, analogous to our terrestrial polar ice-fogs known as "white-outs". Frosts show up best through green or yellow filters, and ice-fogs through magenta or blue-green filters. These bright patches are thought by C. Capen to be topographically controlled. If this supposition proves to be correct for many of the bright spots, their occurrences and especially their locations will be useful for improving the topo-elevation maps of Mars. Dr. R. Wells points out the various possible errors of the contour lines in the northern hemisphere on the modern charts of Mars in his new book, Geophysics of Mars, Ref. 6. A list of active bright areas and their coordinates and a schematic map of Mars showing whitened areas detected in northern spring-summer during the 1960 decade are presented in Ref. 1.

Surface Features: The light and dark albedo features on Mars underwent drastic changes during the 1973 apparition, Ref. 7. It is interesting to note that these major albedo changes occurred about six Martian months after the great dust storm of 1971 abated. They showed little further modification during the following 1975-76 apparition in the northern autumn and winter seasons. These surface changes unrelated to known dust cloud activity are indeed puzzling. The Daedalia-Claritas darkening located within

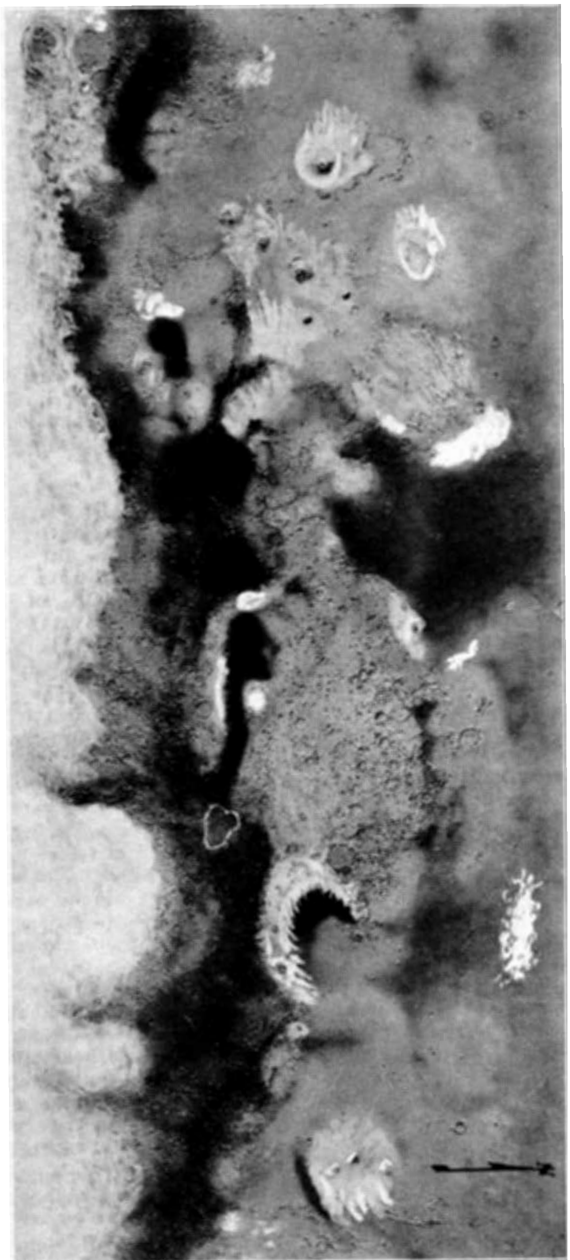

Figure 15. A topo-relief map of Mars (Lowell Observatory base map) showing common northern hemisphere summer orogenic white clouds and ice-fogs relative to topographic features. The locations of the clouds and fogs were derived from measurements of ALPO 1965, 1967, and 1969 photographs and visual observations in green, blue, violet, and ultra-violet light. Telescopic inverted view with South along the left edge. Map prepared and contributed by C. F. Capen and V. W. Capen.

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the Eye-of-Mars (100°-130°W, 29°S) was the major secular change recorded in the 1970's. It showed slight weakening and boundary modification during the 1977-78 apparition. Also during the last apparition, ALPO astronomers reported a darkening streak running from NE to SW across Aetheria to Alcyonius (225°-255°W, 42°N). This dark albedo feature was found on 1978 Viking Orbiter photography; consequently, this region should be observed closely at this current apparition. The following list of albedo features should be carefully observed throughout the 1979-80 apparition for their visibility, shape, and changes: visibility and shape of Sabaeus-Meridiani Sinus (350°W, 5°S); regular seasonal darkening in Bosporus (63°W, 43°S); size and shape of Solis Lacus (85°W, 26°S); visibility of Cerberus along the SE edge of the Elysium shield volcano (210°W, 15°N); brightening of Hellas Basin (290°W, 35°S); and seasonal broadening and darkening of Syrtis Major, especially on the west slope of the Libya basin (290°W, 10°N). Refer to the front cover Mercator chart of Mars with nomenclature prepared by the staff of the Lowell Observatory.

Future Observation Programs

The Mariner Mars 6, 7, and 9 Missions, Viking Orbiters, and Viking Landers have given us much useful close-up information about Mars; and they have identified or confirmed most of the telescopic observed features and Martian meteorological phenomena. More importantly, these space missions have outlined areas for useful research on past acquired observational data on record in numerous historical volumes published in several countries, in the I.A.U. Planetary Research Centers located at Lowell Observatory, Flagstaff, AZ, U.S.A. and Paris Observatory, Meudon, France, and in the archives of the British Astronomical Society, the Oriental Astronomical Association, and the Association of Lunar and Planetary Observers. Some examples of questions yet unanswered are: Are the polar climates static, or are they changing over long intervals of time? The seasonal condition of a polar region affects the equatorial regions. Measurements of the NPC during the last two decades indicate that the shrinking rate is variable and that the size may be slowly changing. Can surface wind directions be inferred from cloud formations? Are certain equatorial H_2O clouds seasonal? If so, can their appearances and locations be predicted? What causes the secular (long-term) gross, dark albedo features observed on the surface? Are their locations topographically controlled or caused from unseasonal wind regimes? Have these areas been affected in the past history of Mars? These are some of the major questions which may be answered by future observational programs of the dynamic and dichotomic Red Planet.

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GOLDEN ANNIVERSARY OF A DISTANT PLANET

The year 1980 marks the fiftieth anniversary of the discovery of Pluto, the most distant known planet in the Solar System. A Pluto Meeting is being held at New Mexico State University on February 17, 18, and 19, 1980, to commemorate this milestone in astronomy and to honor the discoverer, Dr. Clyde W. Tombaugh. The meeting is sponsored by the Department of Astronomy, New Mexico State University, Box 4500, Las Cruces, NM 88003. Readers can write to this address for detailed information. The meeting will open with an informal reception on the evening of Sunday, February 17, at the Holiday Inn de Las Cruces. There will be morning and afternoon paper sessions on February 18; these will cover current Pluto research and historical aspects of the discovery. The speakers will be Solar System specialists and friends of Clyde Tombaugh. A banquet will be held on the evening of February 18. A final paper session is scheduled for the forenoon of Tuesday, February 19. Your attendance is most cordially invited.

Apart from the technical aspects of the Pluto Meeting, many devotees of astronomy would surely enjoy this opportunity to meet Dr. Tombaugh and to hear from the discoverer himself how a most perservering search culminated in the discovery of a new planet.

The Proceedings of the meeting will be published in Icarus. A booklet of abstracts of papers is being planned for distribution at the meeting. Subjects treated will include photometric and spectrophotometric observations of Pluto, the discovery of satellite Charon, another search for a satellite of Pluto, the mass and composition of Pluto, and the tidal history of Pluto's satellite system.

There will be tours to the New Mexico State University and Sacramento Peak observatories.

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