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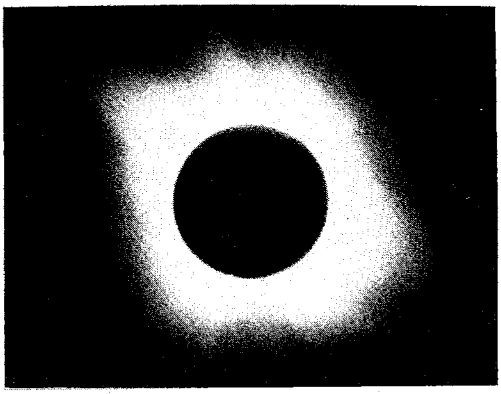

The total solar eclipse of July 11, 1991, as seen from La Paz, Baja California Sur, Mexico; the site of the 41st A.L.P.O. Convention. Photographed by John Westfall with a 400-mm f/6.3 lens and Ektachrome 100 Film. *(Top)* Totality, showing coronal streamers with celestial north approximately at top. 1/8-second exposure. *(Bottom)* "Third Contact"—the end of totality, with celestial west approximately at top. 1/1000-second exposure. The "Diamond Ring" in the upper left is caused by the solar photosphere reappearing; to its right is a large prominence, while the bright strip to the left of the emerging photosphere is the chromosphere. Additional prominences can be seen at the bottom.

THE ASSOCIATION OF LUNAR AND PLANETARY OBSERVERS
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ASSOCIATION OF LUNAR & PLANETARY OBSERVERS
A L P O
Founded in 1947

In This Issue

A QUINQUENNIAL OBSERVATIONAL REPORT OF THE A.L.P.O. REMOTE PLANETS SECTION FOR THE YEARS 1985-1989

By: Richard G. Hodgson, Previous A.L.P.O. Remote Planets Recorder

Note by Editor: Although Mr. Hodgson is past Recorder of the Remote Planets Section, he has kindly submitted this summary of the observations received by him for 1985-1989.

We believe that his comments remain pertinent. However, the visibility of detail on the Remote Planets with small apertures has long been debated. Many veteran observers share Mr. Hodgson's rather negative conclusions. On the other hand, many others believe that small telescopes can be used reliably to detect detail on Uranus and Neptune. Even the latter would agree, however, that long experience, outstanding eyesight, excellent optics, and extremely good atmospheric conditions are necessary to achieve usable results.

Interested readers should also refer to the short article by the present Remote Planets Recorder, Mr. Richard W. Schmude, Jr., in our previous issue, "Uranus, Neptune, and Pluto: Contributions that A.L.P.O. Members Can Make" (J.A.L.P.O., 35, No. 2, June, 1991, pp. 67-68 [2]). Also, we plan to publish in the next issue an updated Remote Planets report by Mr. Schmude.

ACKNOWLEDGING THE PAST AND FACING THE FUTURE

It has been some years since an observational report of the A.L.P.O. Remote Planets Section has been published, so it appears desirable to this writer that our members be informed about what has been done in the past five years. We wish that we had a number of attractive disk drawings of Uranus showing subtle (yet real!) details made by large-aperture telescopes (such as 60-100-cm Dobsonians). One might also wish for some studies of the magnitudes of the satellites of Uranus and Neptune. Alas, such is not the case, as no really large apertures were used for the observations reported here—let this be a challenge to those who have access to large telescopes.

However, the writer wishes to thank all those who have submitted observations of the remote planets, even if they were made with modest equipment. It is good to know that these planets are not forgotten even if, for northern observers, Uranus and Neptune have been almost lost in the haze of the southern horizon as they come to opposition during the northern summer. Perhaps this circumstance helps in part to explain why there have been so few observations of Uranus and Neptune in the 1980's—many of us in northern latitudes are struggling with the subtle effects of light pollution at our observing sites, and the low altitudes of these objects in the sky have hampered high-quality observations. Another deterrent to the observation of Uranus, and especially of Neptune, is the difficulty in finding these planets amid the rich star fields of the southern Milky Way. Even the writer would be lost in these regions without good finder charts, such as are published annually by *Sky & Telescope*, the *Handbook of the British Astronomical Association*, and the *Observer's Handbook* of the Royal Astronomical Society of Canada.

Fortunately this situation is now changing. Both Uranus and Neptune are beginning to move northward, a circumstance which will continue for the next four and seven decades, respectively. These planets' oppositions locations are moving into the northern autumn evening sky, which for many of us is the best observing season. So now is the time to begin, if one needs reasons to begin a Remote Planets observing program!

OBSERVERS, EQUIPMENT, AND OBSERVATIONS

The persons who submitted reports of their observations of the Remote Planets for the years 1985-1989 are listed below in *Table 1*. This table shows that there were few ob-

Table 1. A.L.P.O. Remote Planets Observers, 1985-1989.

Observer and Location	Telescope Aperture & Type	No. of Observations (Year) Uranus	Neptune	Pluto
Francis Graham & Thomas Mohney Pittsburgh, PA, U.S.A.	41-cm reflector	-	1 (1989)	-
Richard G. Hodgson Sioux Center, IA, U.S.A.	32- & 44.5-cm reflectors	3 (1989)	7 (1989)	-
Frank J. Melillo North Valley Stream, NY, U.S.A.	20-cm Schmidt-Cassegrain	2 (1985)	2 (1985)	2 (1985)
Cristófor Tobal Vilanova i la Geltrú, Spain	10.2-cm refractor & 22-cm reflector	3 (1986) 4 (1987) 5 (1988)	- 1 (1987) 1 (1988)	- - -

servers and few observations, and that most observations were made with small apertures—in most cases too small for the type of observation attempted. It must also be said that none of these observations, including my own, really served to advance astronomical knowledge, except perhaps to indicate the possibility (and difficulty!) of seeing some of the Remote Planets and their brightest satellites in spite of their southerly declination and the light pollution present at many of our observing sites.

DISCUSSION OF OBSERVATIONS

The first observation is a drawing of Neptune by Francis Graham and Thomas Mohney, made with a 41-cm f/4.5 Newtonian reflector at 475X. It shows a black circular sky field with a tiny pale-blue featureless disk of Neptune, 4 mm in diameter. Artistically, it is realistic—a pale-blue disk in a sea of blackness. It shows what I often see when I look at Neptune. It is noteworthy that no surface detail is shown, even with an instrument large by amateur standards.

Frank J. Melillo provided a series of photographs made with his Celestron 8-inch (20-cm) telescope. They represent a fine piece of work. In the case of Pluto, two photographs show the planet close to +8.5-magnitude star SAO 120446 in Virgo; first on 1985 MAY 08, 03h 30m U.T., and the second on 1985 MAY 11, at 03h 30m U.T. Each involved a 20-minute exposure on hypered Kodak 2415 Film. Pluto is clearly visible, and moved significantly in the field in the three-day interval.

It is exciting to know that one can photograph Pluto with a "C-8." Mr. Melillo's photographs are all the more impressive when one realizes that they were taken in a moderately light-polluted area on the outskirts of New York City.

The same observer has also very kindly contributed two photographs each of Uranus and Neptune, showing them on 1985 JUN 15 and JUN 21. He also provided photographs of the star fields later, with Uranus and Neptune absent. On the Uranus photograph of 1985 JUN 15, the satellites Oberon, Titania, and Umbriel are visible. On the photograph of Uranus taken on 1985 JUN 21, the same three satellites are shown. Mr. Melillo wonders if the image of Ariel lies tangent to the edge of the enlarged image of Uranus in the latter photograph, but this is uncertain.

In the photograph of Neptune on 1985 JUN 15, Triton is visible on the edge of Neptune's enlarged image. Triton appears again on the 1985 JUN 21 photograph, nearly at western elongation. The capture of the satellites of Uranus and Neptune is a superb piece of work for a 20-cm aperture telescope! *[Somewhat similar photographs of Neptune and Triton on 1989 JUN 30 and JUL 01 by Mr. Melillo appear on p. 181 of our October, 1989, issue; J.A.L.P.O., 33, Nos. 11-12. Ed.]*

Another set of observations was provided by Christófor Tobal of Vilanova i la Geltrú, Spain, consisting of 12 disk drawings of Uranus and Neptune. With them is a three-page report in Spanish. He is to be commended for his obvious enthusiasm for observation and the careful documentation of what he has seen. Made during 1986-1988, the drawings are executed upon Spanish-language observing forms, and all disks are drawn with a 64-mm diameter. Such a drawing size might be appropriate for Jupiter, where there is a wealth of detail to be seen, but I think that a smaller size would be more appropriate for Uranus and Neptune.

During 1986 and 1987, Mr. Tobal's observed solely with a 10.2-cm f/15 Unitron refractor. In 1988 he used a larger 22-cm Newtonian reflector. These sizes of telescope give this writer a second reason for caution. The apertures may suffice to give generalized color impressions of Uranus and Neptune, although color observations with refractors can involve problems of chromatic aberration, but I think them insufficient to resolve spots and streaks in those remote atmospheres.

On some of his drawings of Uranus, and on both drawings of Neptune, Mr. Tobal is quite restrained and depicts only a modest amount of detail; small color variations on the disks and the extent of limb darkening. On several other drawings of Uranus, however, he has drawn nearly linear structures which cut across the planet somewhat off-center. These linear structures are hard to explain because we are dealing with cloud-tops and not with some major system of faults or chasms on a solid surface. Also, most, but not all, of these lines cannot be latitude features such as the dark belts of Jupiter or Saturn, for they do not correspond to Uranus' orientation in 1986-88.

The greenish color of Uranus, tinged with blue, and the blue color of Neptune that Tobal reports is, I believe, quite accurate. This impression is supported by the comments of many others, as well as by Voyager-2 images. However, I personally doubt the linear structures shown in some of the drawings of Uranus. I do not doubt that Mr. Tobal drew what he saw; but as he was working near the limits of resolution, I wonder if these features are not instrumental or psychological in nature.

On this matter, I speak from vivid experience. In the Spring of 1961, I made a series of observations of Uranus with a 10.2-cm f/15 Unitron refractor; the precise type of instrument that Mr. Tobal used. In 1961, Uranus was near Regulus, at a much more favorable declination for Northern-Hemisphere observers. Reviewing my records of that series of observations, I see that at 214X I repeatedly drew a pale yellowish-green disk that showed some limb darkening, but nothing more. Unitron makes a great product, but a 10.2-cm aperture can only resolve to 1.1 arc-seconds. As the disk of Uranus is at most just 3.9 arc-seconds in diameter, unless the laws of optics are repealed, I do not see how some of the details noted with the 10.2-cm refractor can be real. [It is conceivable that these are distorted impressions of real features, subjectively interpreted. Ed.]

The drawings that Mr. Tobal made with the 22-cm reflector deserve more serious attention because the larger aperture should allow better resolution. In these drawings, the dark "brown" lines are now curved, suggesting one or two latitude-oriented belts. From 1988 JUN 6-JUN 21, five disk drawings were made that show curved brown belts, but there is no strong consistency among them, and it is difficult to believe that Uranus' cloud structure could change so radically in a few days' time. Possibly these markings were too faint for proper resolution. Years ago when I was Mercury Recorder, I saw rather similar drawings in the Mercury Section files. How different that planet appeared when it was finally photographed close-up from space! [Naturally, bearing in mind the great difference in resolution, the earthbased observers may still have recorded a pattern of detail which was real for them. Ed.]

While I sincerely commend Mr. Tobal for his interest and zeal for observing Uranus and Neptune, I hope that he (and all of us) can have the opportunity to use much larger apertures in the future!

Finally, I can now point the gun at myself. My 1989 observations of Uranus and Neptune were made as Voyager 2 was approaching its Neptune flyby. My chief instruments were a 32-cm f/5.9 Newtonian equatorial reflector and a 44.5-cm f/4.68 Newtonian Dobsonian. Both were used mainly with magnifications under 200X; I do not like "fuzzy" over-magnification. Both disks were searched for details on each observing night, but no features were seen unambiguously, so no disk drawings were made. Also, Uranus' satellites Titania and Oberon were glimpsed on two nights.

I made a special effort to see Neptune's satellite Triton. With the 44.5-cm reflector, it was seen with difficulty on 1989 AUG 22, and with greater difficulty, on AUG 24. On the latter night, some of my observing was interrupted in order to obtain updates on the Voyager-2 fly-by! It should not have been so hard for an instrument of that size to see Triton under good conditions; the town lights and the southerly declination were the major problems, and the sky was not truly black.

There is nothing scientifically noteworthy in these observations of mine except the renewed realization that Uranus and Neptune are not easy targets; and of course the personal satisfaction of seeing Triton on the same day that Voyager 2 passed by it!

WHAT HAS BEEN LEARNED?

What are we to learn from the 1985-1989 observations?

First, it is clear that really credible disk drawings require large apertures in order to have adequate resolution, and they must be made under exceptionally good seeing conditions. These realities cannot be ignored. *Disk drawings of Uranus require an aperture of 40 cm to be credible, and 60 or 70 cm is the minimum for Neptune.* If possible, exceed these minima! The more aperture the better.

Second, really dark skies are needed to observe the brighter satellites of Uranus and Neptune. I live in the small town of Sioux Center, with a population of 5,000, but even here there are sodium-vapor lights which give an increasing sky glow. In the past decade, I have lost about 1 magnitude in limiting magnitude despite a change of observing site which was supposed to give a darker sky. For satellite studies we need to consider large apertures which are also portable, such as Dobsonians, or retiring to a dark desert area where there are no neighboring towns. This dilemma is frustrating.

TWO PROJECTS UPON WHICH TO FOCUS

In the future, two projects need attention. First, it would be particularly useful to monitor the disk of Uranus to see if there is any clear, unambiguous evidence for the reëstablishment of a bright-zone, dark-belt pattern as the planet gradually approaches an equatorial presentation toward the Sun in the early 21st Century. We see such a pattern on Jupiter and Saturn, and Voyager-2 saw a similar pattern on Neptune. There are reasons to believe that this may happen; but we need to document its reality, and the approximate year that such a pattern becomes apparent, if indeed it does.

The second project is further studies of the brightness of the satellites of Uranus; in terms of both relative brightness in relation to each other, and of absolute brightness in relation to stars of known magnitude in variable star fields through which Uranus might pass. [The Remote Planets also occasionally pass through the fields of the Hubble Space Telescope "Guide Star Catalog," as described in reference **[1]**. Ed.] Triton might also be checked for variability, although this would be much more difficult to assess, and the present southerly Tritonicentric declination of its subsolar point may minimize such variations in the next few decades. [See also the possible projects described in reference **[2]**. Small apertures *can* give scientifically-valuable results for the Remote Planets; e.g., for photoelectric photometry of Uranus and Neptune. Ed.]

In closing, I wish to thank all those who have submitted observations, and to invite all with access to large apertures to give attention to the Remote Planets and to report their observations to the Section. [The address of the new Recorder, Mr. Schmude, is given on the inside back cover.] We hope that henceforth the Remote Planets Section will be able to publish annual observational reports. Let us also hope that many observers with large apertures will also contribute!

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THE LUNAR SELECTED AREAS PROGRAM (SAP): HOW TO GET STARTED

By: Julius L. Benton, Jr., A.L.P.O. Lunar Selected Areas Program Recorder

BACKGROUND

Over two decades ago, the Lunar Transient Phenomena (LTP) Patrol was introduced as a new program for the A.L.P.O. Lunar Section. A major emphasis of this effort was visually to monitor supposed variations of the lunar surface which were brief or ephemeral, usually lasting from a few seconds to the order of thirty minutes, and quite unpredictable. In addition to such transient events, observers were asked to record intensity estimates of lunar features that were suspected of "seasonal" or long-term phenomena. Thus commenced the intensive study of such carefully selected features as Aristarchus and Herodotus, Alphonsus, Eratosthenes, and Kepler, to name a few. As the observational data base grew and reports were published, new areas were added to the program, such as Atlas, Ross D, Colombo, and others.

By 1971, the A.L.P.O. Lunar Recorders decided to divide our observational pursuits into a bona fide and separate LTP Survey and to form a Selected Areas Program (SAP) to deal rigorously and more effectively with the long-term phenomena that were being reported. Both programs experienced promising observational results for the next few years.

In the 20 years since 1971, the LTP Survey and the Selected Areas Program diverged. Also, observers began to lose interest in visual lunar work in the wake of extensive photography of our satellite by the Lunar Orbiter space probes and then firsthand explorations by the Apollo astronauts. The question of whether lunar observations by amateur astronomers had any remaining value was heard more frequently. This question has been frequently addressed in the literature over the past two decades, and there are those even today who still believe that little can be done by the earthbased visual lunar observer that is of any real value to science.

If one spends a little time examining where the emphases of the LTP Survey and the Selected Areas Program really lie, it should be clear that both programs are meaningful and have enormous potential. The nature of the observational work of these programs involves prolonged monitoring of the Moon and is quite removed from the brief periods of study by manned and unmanned spacecraft. It is through the patient and persistent efforts of visual observers that what appears to be variable phenomena occurring at the Moon's surface can be thoroughly and regularly monitored visually and photographically. The results of new studies can certainly supplement the findings of the past LTP Survey and Selected Areas Programs, as well as adding to the knowledge of the Moon that was gathered by spacecraft.

Today, although the LTP Patrol and SAP continue to be regular A.L.P.O. programs, a very limited observer response continues, reflecting a widespread apathy of the amateur astronomical community toward studies of the Moon. We hope that this brief description of what the A.L.P.O. Lunar Selected Areas Program is all about will entice individuals to turn their telescopes toward the Moon. Because the LTP Survey is now a program separate from the SAP, we make no attempt here to discuss the former, except to say that both programs are more effective from the standpoint of comparative data exchange if observers in both programs use similar methods and monitor some of the same lunar areas.

SAP OBSERVATIONAL PROGRAMS

Unlike the LTP Survey, the Selected Areas Program monitors regular and cyclical long-term variations over the course of several lunations, for specifically designated lunar areas. In general, the SAP tries carefully to investigate the following possible phenomena for each feature chosen:

1. **Tonal and/or Color Variations.** Watch for any change in tone or color, or in the size and shape of an area of distinctive tone or color, which is not related to varying illumination. Such phenomena do not exactly repeat from lunation to lunation. Features most subject to such behavior are radial bands, dark patches, and nimbi or haloes.

2. **Shape and Size Changes.** Pay careful attention to any change in the apparent morphology of an area that is not traceable to changes in lighting or libration.

3. **Shadow Anomalies.** Watch for any deviation of a shadow from absolute black, or any shadow with an anomalous shape or color, especially if not traceable to changes in lighting conditions.

4. **Appearance or Disappearance of Features.** Although any such events are extremely controversial and rare, we should monitor any feature that is suspected of being present during an observing session but which is found to be absent on earlier maps or photographs. Naturally, we should also note areas that were shown on earlier maps or photographs that are not readily apparent today.

5. **Eclipse-Induced Changes.** We also seek observations of any of the above phenomena that might in any way be associated with an eclipse of the Moon.

Most of the phenomena listed above are related to anomalous changes in morphology, tone, or hue, which cannot be explained by changes in sun angle or libration, and which do not repeat in any systematic way from lunation to lunation. Searching for such phenomena is one of the chief goals of the SAP. However, before we can do this, we must establish the normal aspects of features under all conditions of illumination, particularly the normal brightness or albedo of features at all phase angles. [The *phase angle* is the angle between the Sun and the observer as seen from the feature itself. It is approximately 180° at New Moon and 0° at Full Moon. Ed.]

In order to be consistent, the SAP uses some of the same methods that were pioneered years ago by former Recorders, although substantial changes have taken place in the SAP functions. For example, several areas that had been selected in the past, such as Plato and Alphonsus, have received extensive observations. Other areas, although part of the SAP, never had the attention that they deserved. In the past, observers freely chose the areas that they were to monitor, but this policy resulted in limited coverage of important regions. Therefore, in order that all SAP areas receive sufficient attention, areas are now assigned to individual observers. However, some choice is still possible for those who truly wish to monitor a specific feature.

After considerable thought and consultation with other lunar colleagues, including those in the LTP Survey, we have decided to concentrate on the following areas for now:

Alphonsus	Copernicus	Plato
Tycho	Aristarchus-Herodotus	

These features are all easy to find and are important for long-term intensive study. We have made outline charts and forms for these areas, which are available to those who express an interest in the SAP. Features will be assigned so that a team of observers will follow each area regularly. If an observer wishes to study areas in addition to the one assigned, contact this SAP Recorder for outline forms.

Remember that our standard procedure is to monitor visually all of the assigned Selected Areas as objectively as possible. We follow a regular observing schedule over many lunations, using systematic procedures. Although telescope aperture is not of prime importance, excellent optics are required in order to capture lunar detail on the threshold of visibility. Of course, larger apertures will reveal more detail, given favorable seeing conditions. Observers should become well acquainted with the characteristics and the capabilities of their telescopes. They should understand what scattered light and reflections, irradiation, and aberrations caused by the eye, the instrument, and the atmosphere can do to images and how to recognize such spurious effects.

OBSERVATIONAL PROCEDURES BRIEFLY NOTED

The general observing procedures of the SAP are as follows:

1. Concentrate on one, or at most two, features throughout any given lunation. Place each observation on the form provided by the SAP.

2. For observations of the same feature, use the same telescope, range of magnifications, filters, and so forth.

3. Keep careful records of the Universal Time and date of observations, the colongitude range, the eyepiece field orientation, and any other pertinent information. There is space on the SAP forms for this information, and the SAP literature includes methods of computing colongitude the lunar longitude of the sunrise terminator].

4. Observe the Moon at altitudes greater than about 25° so that most of the effects of atmospheric dispersion and differential refraction are at a minimum.

5. Carefully appraise the seeing in the vicinity of the Moon, using the standard A.L.P.O. Seeing Scale of 0.0 (poorest) to 10.0 (steady, perfect seeing). Quantify the transparency in terms of the magnitude of the faintest star that can be seen by the naked eye at the time of observation. Note the sky clarity as well because the brightness of the Moon will affect the visibility of stars. Monitor seeing and transparency changes during the period of observation.

6. The SAP provides a reference outline chart for each selected lunar feature, with several points chosen to help in the standardization of observations. We have assigned letters to these points, as shown in *Figure 1* (p. 102), in order to reference albedo estimates as follows:

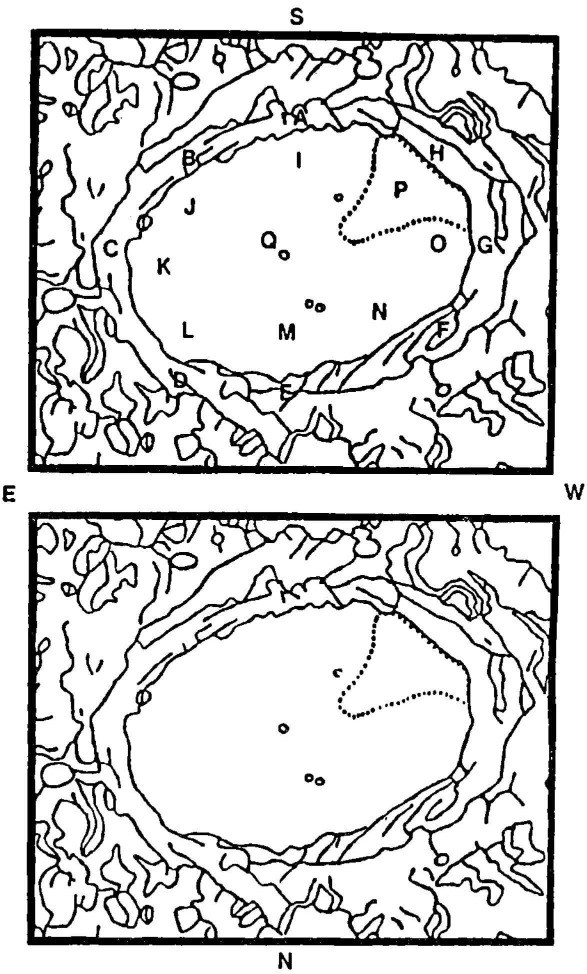
A. A letter has been designated for each cardinal point (i.e., N, E, S, or W in the I.A.U. sense, where Mare Crisium is near the *east* limb) on the inner walls of craters or on the exterior sides of mountains and domes.
B. A letter has been assigned to the summit(s) of central peaks, if they exist, or to the summits of lunar mountains.
C. Several points have been established on the floors of craters and in surrounding terrain.

It is very important to use consistently the same points in a feature over time for assigning albedo values. The point assigned should always remain the same for all observations of the same feature. If the observer adds points of reference to the diagram, they should be noted carefully and should never be letters that are already used on the form.

7. *Table 1* (p. 103) presents Elger's Scale of Albedo Values, with a few examples for Full phase (0° phase angle). [Note: "Elger's" Scale is based on one originally developed by Schröter. Ed.] Observers should initially familiarize themselves at Full Moon with all the steps and examples in Elger's Scale and make a permanent reference gray scale. This can be done very easily by using selectively exposed film, graded pencil shadings, a good photographic grey-scale wedge, or

A.L.P.O. LUNAR SELECTED AREAS PROGRAM: VISUAL OBSERVATIONAL DATA SHEET

PLATO



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B			
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E			
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S			

Date (UT)________
Observer________
Address________

Telephone ( ) -
Telescope________

Magnification(s)________

Seeing________
Transparency________
Time (UT) Start________
Time (UT) End________
Colong. (start)________
Colong. (end)________
Altitude of Moon________

General Observational Notes:

Figure 1. Sample lunar Selected Areas Program observing form, showing Plato and vicinity.

some similar means to match each step of the scale in integrated light (no filter). Once this reference chart has been calibrated at the telescope, it becomes the reference standard for estimating the albedos of the features being observed. Match the albedo of each point in the feature to the nearest grey-scale swathe. Always use the same telescope and magnitude for routine observing that you used for setting up the grey scale.

8. One of the outline charts on each form (see *Figure 1* above) is to be used for drawing the feature observed, and you should attempt to represent as accurately as possible what the feature looked like at the time and date of observation.

9.You can enhance your albedo estimates by following up with color observations, using filters such as the Kodak Wratten series that have precisely-known transmission characteristics. If you make color-filter observations, start at Full Moon, noting the appearance of Elger's representative features in different wavelengths of light, setting up a grey scale for each filter to be used. Always precede such observations with integrated-light observations.

Table 1. Elger's Albedo Reference Scale With Examples.

Numerical Value	Lunar Features as Examples (high sun angle except for 0.0)
0.0	Black Shadows
1.0	Darkest parts of Grimaldi, Riccioli
1.5	Interiors of Billy, Boscovich, Zupus
2.0	Floors of Endymion, Le Monnier, Julius Caesar, Crüger, Fourier A
2.5	Interiors of Azout, Vitruvius, Pitatus, Hippalus, Marius
3.0	Interiors of Taruntius, Plinius, Theophilus, Parrot, Flamsteed, Mercator
3.5	Interiors of Hansen, Archimedes, Mersenius
4.0	Interiors of Manilius, Ptolemaeus, Guericke
4.5	Surface around Aristillus; Sinus Medii
5.0	Walls of Arago, Lansberg, Bullialdus; surfaces around Kepler, Archimedes
5.5	Walls of Picard and Timocharis; rays of Copernicus
6.0	Walls of Macrobius, Kant, Bessel, Flamsteed, Mösting
6.5	Walls of Langrenus, Thaetetus; LaHire
7.0	Theon, Ariadaeus, Bode B, Kepler, Wichmann
7.5	Ukert, Hortensius, Euclides
8.0	Walls of Godin, Bode, Copernicus
8.5	Walls of Proclus, Bode A, Hipparchus C
9.0	Censorinus, Dionysius, Mösting A, Mersenius B and C
9.5	Interior of Aristarchus, La Perouse Δ
10.0	Central Peak of Aristarchus

Always accompany your observations with brief but complete descriptive notes. Describe such phenomena as features visible under high or low Sun angles, the nature and extent of any associated bright rays or bands , and the general morphological aspect of the area of study. Give details about any anomalous or unusual aspects that you see.

You can find complete details on observing methods and techniques in the *A.L.P.O. Lunar Selected Areas Program Manual*, which is available from this Recorder (address on inside back cover) as part of the "Lunar SAP Kit." If you wish to participate in a truly enjoyable opportunity to make useful contributions to our knowledge about the Moon, please contact me for further information.

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PRACTICAL LUNAR PHOTOELECTRIC PHOTOMETRY

By: Charles A. Kapral © 1991

ABSTRACT

This report describes a lunar photoelectric photometry project that consisted of measuring the brightness of four lunar features through relative photometry with a solid-state photometer. It explains the selection criteria used and the observing procedures, with a worked example at the end of the paper.

INTRODUCTION

Lunar photoelectric photometry, as described in this report, is the measurement of the brightness of a lunar site, compared to the known brightness of a comparison site. The equipment that I used was a 10-inch (25-cm) f/10 Meade 2120 Schmidt-Cassegrain telescope with an OPTEC SSP-3 solid-state photometer equipped with standard **V** (visual) and **B** (blue) broad-band filters. These were used with a 4-inch (10-cm) extension tube and a 3X Barlow Lens to obtain a 30 km-diameter scan area on the Moon.

SITE SELECTION

Comparison sites were selected from the "Shorthill List" in Appendix C of the A.L.P.O. *Lunar Photoelectric Photometry Handbook* (Westfall, 1984), using the primary sites if at all possible, these being the better-defined sites with relatively small uncertainties in their photometric properties. Several of the potential comparison sites are also Lunar Transient Phenomena (LTP) sites, and should be avoided, because using them would be like trying to obtain a variable star's light curve by using another variable as the comparison star! Because it is not always possible to avoid such sites, two comparison sites were selected in the hope that only one of them, at most, would display transient activity. The comparison sites used for this example are circled in *Figure 2* (p. 105) and were:

D27 Site. A primary site located in Mare Crisium about one-third of the way between Cape Agarum and Picard at lunar coordinates: ξ = +0.8169, η = +0.2349; longitude = 57°.18 E, latitude = 13°.58 N. The albedo is 0.0640, with local colongitudes: sunrise = 302°.8, noon = 032°.8, sunset = 122°.8. [Note that directions in this paper follow the IAU convention, with Mare Crisium near the *east* limb and Plato near the *north* limb. Note also that the albedos for the two comparison sites apply to the **B** band. Ed.]

C88 Site. A primary site located in the crater Taruntius at lunar coordinates: ξ = +0.7209, η = +0.0973; longitude = 46°.42 E, latitude = 05°.58 N. The albedo is 0.0874, with local colongitudes: sunrise = 313°.6, noon = 043°.6, sunset = 133°.6.

I initially planned to use the crater Proclus as my only study site, because its brightness curve is well-established. However, experience has now shown that it is more efficient to measure several neighboring sites at the same time, because the same comparison site measurements may be used for all. Therefore, additional sites were chosen using these selection criteria:

1. All sites should be close together.

2. The area should be easily identifiable throughout a lunation.

3. Local known albedo variations in the 30-km scan areas should be small.

4. The sites should be reasonably flat with a minimum of local relief, eliminating local local shading.

5. There should be no high features immediately east or west of the sites, eliminating external shading.

6. The comparison sites should be at approximately the same longitude as the study sites, to insure that they are visible during the entire time that the study sites are visible.

7. The "site set" should be located so that it can be observed throughout a lunation; e.g., in the lunar Eastern Hemisphere if you work a first shift, or the Western Hemisphere if you work a second shift, unless you don't mind getting up in the middle of the night to make an hour or two of observations.

The four study sites were chosen using Dinsmore Alter's *Lunar Atlas* (1964); NASA SP-206, *Lunar Orbiter Photographic Atlas of the Moon* (Bowker & Hughes, 1971); and the "Lunar Quadrant Maps" prepared by D.W.G Arthur and his associates (1963, 1964, 1965, 1966). The study sites are circled in *Figure 2* (p. 105) and are described as follows:

Cape Agarum. A well-known LTP site, Cape Agarum is strongly affected by lunar librations, so care must be used when making measurements. Its coordinates are: ξ = +0.8800, η = +0.2350; longitude = 65° E, latitude = 14° N. Local colongitudes are: sunrise = 295°, noon = 025°, sunset = 115°.

Proclus. A bright crater on the east edge of Palus Somnii, 28.0 km in diameter, with a sharply-defined rim. Proclus is an upland crater with no central peak, and is the center of a bright ray system with a darker fan extending into Palus Somnii. Its coordinates are: ξ = +0.7020, η = +0.2776; longitude =

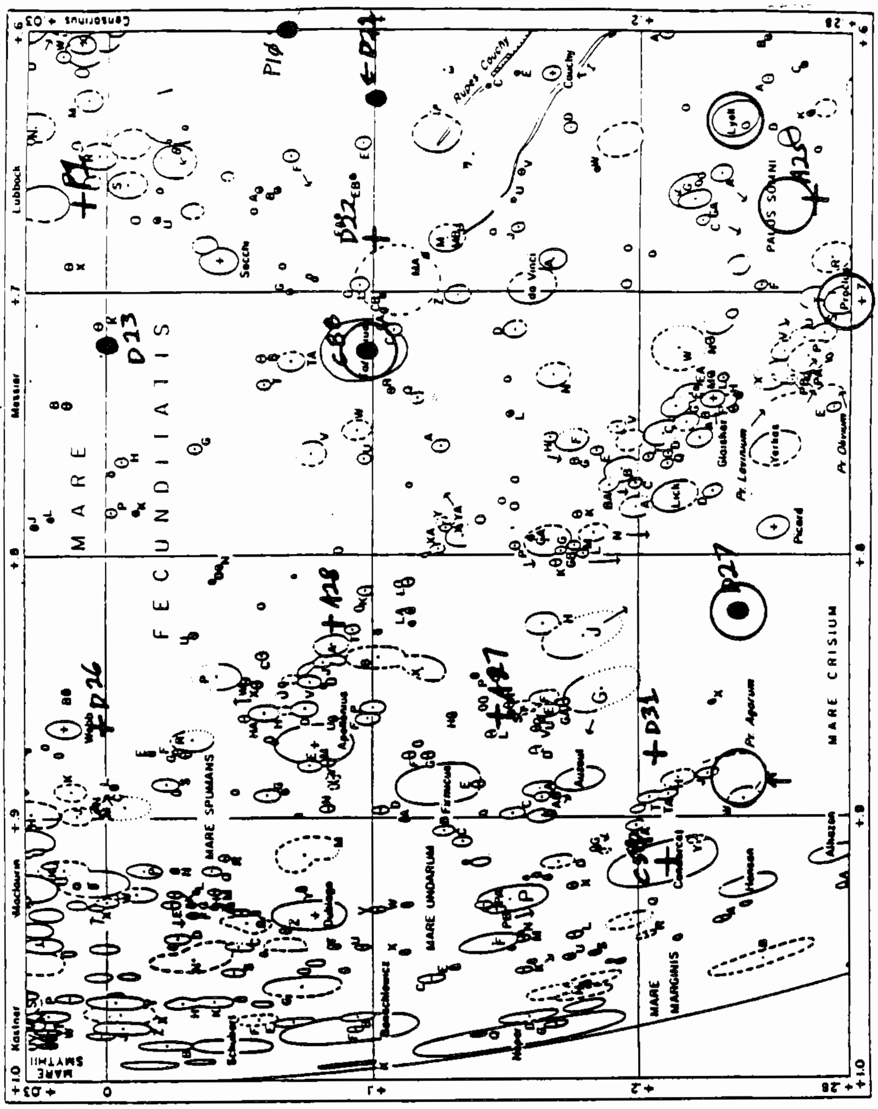

Figure 2. Outline chart of the photometric sites described in the text. Rotate this page 90° clockwise for proper orientation; making lunar south at top and east (IAU) to the left. Base from Arthur (1963).

46°.9 E, latitude = 16°.1 N. Local colongitudes are: sunrise = 313°.1, noon = 043°.1, sunset = 133°.1.

Palus Somnii. The site in this *mare* is midway between Proclus and Lyell, at coordinates: ξ = +0.6684, η = +0.2563; longitude = 43°.75 E, latitude = 14°.85 N. Local colongitudes are: sunrise = 316°.25, noon = 046°.25, sunset = 136°.25.

Lyell. A 32.2-km crater on the west side of Palus Somnii. Lyell has a broken rim with a flooded interior and no central peak. This pre-*mare* crater overlaps both *mare* and uplands. Its coordinates are: ξ = +0.6330, η = +0.2360; longitude = 40°6 E, latitude = 13°.6 N. Local colongitudes are: sunrise = 319°.4, noon = 049°.4, sunset = 139°.4.

The Observing Session

The observing sequence was: SKY – COMPARISON SITE 1 – COMPARISON SITE 2 – CAPE AGARUM – PROCLUS – PALUS SOMNII – LYELL – COMPARISON SITE 1 – COMPARISON SITE 2 – SKY. A minimum of four sets of measures was taken during each observing session. The sky reading was taken by placing the east limb of the Moon immediately outside the telescope's field of view, and then making the measurement. A V-filter measure was recorded, followed by a B-filter measure, for each sky and site. The transparency was determined by recording the faintest star visible near the zenith. A typical observing session lasted approximately 1.25 hours. A voice-actuated tape recorder was found to be handy for notes, but taping the measurements results in a long and tedious transcription process and is *not* recommended. See *Figure 3* (p. 107) for the results of the observing session of 1990 AUG 04.

DATA REDUCTION

To save time and reduce the chance of error, data reduction should be performed on a computer. A program is being developed to perform the complete data reduction process. A fully-worked example is given on *Figures 4-6* (pp. 108-110). As a first step in the reduction process, the observer should determine his observing site's terrestrial latitude and longitude and the lunar latitude and longitude of each comparison and study site. [Space precludes giving the mathematical details of the reduction process here. Mr. Kapral has kindly offered to send a copy of the reduction formulae and algorithms to any person who supplies him with a stamped self-addressed envelope. His address is: 6601 Hana Road, Edison, NJ 08817. Ed.]

MULTIBAND PHOTOMETRY

Multiband photometry is the measurement of the brightness of a site in more than one spectral band. The use of **B**, **V**, and **R** (red) wide-band filters is especially useful for the detection of short- and long-term LTP color changes. The previous observing sequence must be modified for multiband photometry in order to include the measurement of a "standard," and an "extinction," star. A standard star is required in order to define a known magnitude with which you can determine the apparent magnitude of the site. Standard star magnitudes are based on the Johnson and Morgan definition of the **UBV** system.

The extinction star is used to determine the first-order atmospheric extinction coefficient. This is the loss of light due to its attenuation when traveling through the changing air mass. The extinction is determined by using a least-squares analysis of the air mass-versus-magnitude function. A list of standard and extinction stars is given in Henden and Kaitchuck (1982).

A possible observing sequence for multiband lunar photometry could be: SKY – STANDARD STAR – EXTINCTION STAR–COMPARISON SITE 1 – COMPARISON SITE 2 – SITE 1 – SITE 2 – SITE 3 – SITE 4 – COMPARISON SITE 1 – COMPARISON SITE 2 – STANDARD STAR – EXTINCTION STAR – SKY.

The readings are used to determine the "magnitude" of each site. These "magnitudes" are not equivalent to stellar magnitudes because the sites are extended sources, representing the photometer's scan area projected onto the Moon. This distinction is irrelevant because only the color difference(e.g., **B-V**) is of interest. The determination of the color index of a site may be averaged over an observing session unless one suspected a rapid [but not too rapid!] LTP color change, in which case the color index should be reduced for each sequence.

OBJECTIVES

The short-term objective of this project is to establish sound working procedures, easily implemented by any amateur astronomer who has a photoelectric photometer. This is to encourage more amateur astronomers to become involved in serious, worthwhile lunar studies.

The long-term objectives are to: (1) derive the brightness curves for sites which have not yet been well studied; and (2) monitor LTP sites for changes in their brightness curves.

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Note by Editor: Now that photoelectric photometers are relatively inexpensive and available to many amateurs, we hope that our readers will consider a lunar photometry program. The *Handbook* listed above (Westfall, 1984) is available from our Lunar Photometry Recorder, Mr. Francis Graham, whose address is given in the inside back cover. Note also the applicability of such photometry to the study of lunar Selected Areas, as described in the previous article.

(Note continued on p. 108)

LUNAR PHOTOMETRY OBSERVATION FORM

DATE: 8/4/90 SEEING: 6 TRANSPARENCY: 5
COMPARISON 1: D27 COMPARISON 2: C88

SET	OBJECT	TIME (UT)	V READING	B READING	COMMENTS
	SKY	01:58	187	53	
	C1	02:00	1981	599	
	C2	02:02	2542	782	
	Cape Agarum	02:04	2711	843	
1	Proclus	02:06	4549	1409	
	Palus Somnii	02:08	2890	903	
	Lyell	02:12	2303	762	
	C1	02:14	2064	646	
	C2	02:15	2696	839	
	SKY	02:16	198	58	
	C1	02:17	2143	654	
	C2	02:19	2626	819	
	Cape Agarum	02:20	2822	849	
2	Proclus	02:22	4836	1486	
	Palus Somnii	02:24	2921	943	
	Lyell	02:25	2552	755	
	C1	02:27	2101	674	
	C2	02:29	2740	855	
	SKY	02:30	194	58	
	C1	02:33	2181	681	
	C2	02:35	2732	875	
	Cape Agarum	02:36	2996	950	
3	Proclus	02:38	4505	1610	
	Palus Somnii	02:40	3049	961	
	Lyell	02:42	2676	786	
	C1	02:44	2228	710	
	C2	02:46	2835	894	
	SKY	02:47	212	61	
	C1	02:48	2214	709	
	C2	02:50	2790	880	
	Cape Agarum	02:52	3036	957	
4	Proclus	02:55	4932	1677	
	Palus Somnii	02:56	3171	1015	
	Lyell	02:59	2747	840	
	C1	03:02	2269	704	
	C2	03:04	2847	876	
	SKY	03:06	173	58	
	C1				
	C2				
	Cape Agarum				
5	Proclus				
	Palus Somnii				
	Lyell				
	C1				
	C2				
	SKY				

Figure 3. Sample set of lunar photometric observations by Charles A. Kapral, 1990 AUG 04.

LUNAR PHOTOMETRY DATA REDUCTION FORM - FORM 1

DATE: 8/4/90 AVERAGE SKY (V): 196 AVERAGE SKY (B): 59

SET	OBJECT	TIME (UT)	(V-SKY)	(B-SKY)	V	B
AVG SKY	C1	02:00	1789	543	1830	566
V=191	C2	02:02	2350	726	2427	754
B=56	Cape Agarum	02:04	2519	787	2519	787
1	Proclus	02:06	4357	1353	4357	1353
	Palus Somnii	02:08	2698	847	2698	847
	Lyell	02:12	2111	706	2111	706
	C1	02:14	1872	590	—	—
	C2	02:15	2504	783	—	—
AVG SKY	C1	02:17	1947	596	1926	606
V=196	C2	02:19	2430	761	2487	779
B=58	Cape Agarum	02:20	2626	791	2626	791
2	Proclus	02:22	4640	1428	4640	1428
	Palus Somnii	02:24	2725	865	2725	865
	Lyell	02:25	2356	697	2356	697
	C1	02:27	1905	616	—	—
	C2	02:29	2544	797	—	—
AVG SKY	C1	02:33	1978	621	2002	636
V=203	C2	02:35	2529	815	2580	824
B=60	Cape Agarum	02:36	2793	890	2793	890
3	Proclus	02:38	4302	1550	4302	1550
	Palus Somnii	02:40	2846	901	2846	901
	Lyell	02:42	2473	726	2473	726
	C1	02:44	2025	650	—	—
	C2	02:46	2632	834	—	—
AVG SKY	C1	02:48	2022	649	2050	646
V=192	C2	02:50	2598	820	2626	818
B=60	Cape Agarum	02:52	2844	897	2844	897
4	Proclus	02:55	4740	1617	4740	1617
	Palus Somnii	02:56	2979	955	2979	955
	Lyell	02:59	2555	780	2555	780
	C1	03:02	2077	644	—	—
	C2	03:04	2655	816	—	—
	C1					
	C2					
	Cape Agarum					
	Proclus					
5	Palus Somnii					
	Lyell					
	C1					
	C2					

AVERAGED READINGS

OBJECT	V	B
C1	1952	614
C2	2530	794
Cape Agarum	2696	841
Proclus	4570	1487
Palus Somnii	2812	892
Lyell	2374	727

Figure 4. Initial reduction of sample set of lunar photometric observations by Charles A. Kapral, 1990 AUG 04. Subtraction of sky brightness and averaging of four sets of measurements.

We also note that the photometry of the Moon, and indeed the bright planets, is relatively unaffected by the light pollution found at urban and even suburban observing sites. Such problems preclude many other forms of observation, increasing the appeal of a program such as the one described in the above article.

LUNAR PHOTOMETRY DATA REDUCTION FORM - FORM 2

DATE: 8/4/90 FILTER: V

SET	U.T.	OBJECT	R'	ALT.	SUN CLNG.	SUN B-SUN	EARTH L-EAR	EARTH B-ear	A.MAS CORR	R"
1	02:00	C1	1830	21.85	64.12	-0.08	-3.21	3.85	2.6715	48
	02:02	C2	2427	21.95	64.2	-0.08	-3.21	3.84	2.6606	64
	02:04	Cape Agarum	2579	22.05	64.2	-0.08	-3.22	3.84	2.6493	66
	02:06	Proclus	4357	22.14	64.2	-0.08	-3.23	3.84	2.6385	11
	02:08	Palus Somnii	2698	22.24	64.24	-0.08	-3.23	3.85	2.62813	70
	02:12	Lyell	2111	22.42	64.24	-0.08	-3.26	3.85	2.60807	55
2	02:17	C1	1946	22.63	64.28	-0.08	-3.27	3.84	2.5857	50
	02:19	C2	2487	22.7	64.32	-0.08	-3.28	3.84	2.5778	64
	02:20	Cape Agarum	2626	22.74	64.32	-0.08	-3.28	3.84	2.57379	67
	02:22	Proclus	4640	22.81	64.32	-0.08	-3.29	3.84	2.5657	119
	02:24	Palus Somnii	2725	22.89	64.36	-0.08	-3.3	3.83	2.55824	69
	02:25	Lyell	2356	22.92	64.36	-0.08	-3.31	3.83	2.55472	60
3	02:33	C1	2002	23.16	64.45	-0.08	-3.33	3.83	2.5295	506
	02:35	C2	2580	23.22	64.49	-0.08	-3.34	3.82	2.5238	65
	02:36	Cape Agarum	2793	23.25	64.49	-0.08	-3.34	3.82	2.52119	704
	02:38	Proclus	4302	23.3	64.49	-0.08	-3.35	3.82	2.5159	108
	02:40	Palus Somnii	2846	23.34	64.49	-0.08	-3.36	3.82	2.5132	714
	02:42	Lyell	2473	23.39	64.53	-0.08	-3.36	3.82	2.50700	620
4	02:48	C1	2050	23.5	64.57	-0.08	-3.39	3.81	2.4954	57
	02:50	C2	2626	23.53	64.57	-0.08	-3.40	3.81	2.4925	65
	02:52	Cape Agarum	2844	23.56	64.65	-0.08	-3.41	3.81	2.48938	708
	02:55	Proclus	4740	23.6	64.65	-0.08	-3.42	3.80	2.4856	112
	02:56	Palus Somnii	2979	23.61	64.65	-0.08	-3.42	3.80	2.48469	740
	02:59	Lyell	2555	23.64	64.65	-0.08	-3.44	3.80	2.48193	634
5		C1								
		C2								
		Cape Agarum								
		Proclus								
		Palus Somnii								
		Lyell								

OBJECT	MEAN CLNG.	MEAN B-SUN	MEAN L-EAR	MEAN B-EAR	SUN ALT.	EARTH ALT.	P.A g	BRGT FUNC	PHOT FUNC
C1	64.36	-0.08	-3.33	3.83	55.91	29.55	-29.21	-58.82	0.5763
C2	64.40	-0.08	-3.31	3.83	68.46	40.42	-29.15	-49.04	0.5654
Cape Agarum	64.42	-0.08	-3.31	3.83	48.8	21.98	-29.13	-66.81	0.5846
Proclus	64.42	-0.08	-3.32	3.82	63.46	39.19	-29.14	-48.09	0.5641
Palus Somnii	64.44	-0.08	-3.33	3.82	66.63	42.36	-29.13	-45.11	0.5596
Lyell	64.44	-0.08	-3.34	3.82	69.77	45.56	-29.14	-42.15	0.55418

Observer's Longitude: +74°.4125
Latitude : +40°.53425

Figure 5. Further reduction of sample set of lunar photometric observations by Charles A. Kapral, 1990 AUG 04. Calculation of lighting and libration parameters, air mass, brightness corrected for extinction and averaging of four sets of measurements.

LUNAR PHOTOMETRY DATA REDUCTION FORM - FORM 3

DATE: 8/4/90 FILTER: V

A(0) = 0.0640 L(0)*A(0) = 0.036889

L = L(0)*A(0)*R"/R"(0) A = L/PHOT FUNC

R"(0) = COMPARISON 1

SET	R"(0)	OBJECT	R"	L	A	OBJECT	R"	L	A
1	4889	Cape Agarum	6674	0.05036	0.086128	Proclus	11496	0.08674	0.1553
2	5032		6759	0.04955	0.084746		11905	0.08727	0.1546
3	5064		7042	0.05130	0.087736		10823	0.07884	0.139
4	5116		7080	0.05105	0.087313		11782	0.08495	0.1505
5									

Mean g = -29.13 N = 4 Mean g = -29.14 N = 4

Mean A = 0.086481 Mean A = 0.149690

SET	R"(0)	OBJECT	R"	L	A	OBJECT	R"	L	A
1	4889	Palus Somnii	7091	0.05350	0.095606	Lyell	5506	0.04154	0.0749
2	5032		6971	0.05110	0.091317		6019	0.04412	0.0796
3	5064		7147	0.05206	0.093031		6200	0.04516	0.08149
4	5116		7402	0.05337	0.095371		6341	0.04572	0.0825
5									

Mean g = -29.13 N = 4 Mean g = -29.14 N = 4

Mean A = 0.093831 Mean A = 0.079646

A(0) = 0.0874 L(0)*A(0) = 0.049419

R"(0) = COMPARISON 2

SET	R"(0)	OBJECT	R"	L	A	OBJECT	R"	L	A
1	6457	Cape Agarum	6674	0.05108	0.087364	Proclus	11496	0.08799	0.15595
2	6411		6759	0.05210	0.089111		11905	0.09177	0.16266
3	6511		7042	0.05345	0.091416		10823	0.08248	0.14560
4	6545		7080	0.05346	0.091432		11782	0.08896	0.15788
5									

Mean g = -29.13 N = 4 Mean g = -29.14 N = 4

Mean A = 0.089831 Mean A = 0.155478

SET	R"(0)	OBJECT	R"	L	A	OBJECT	R"	L	A
1	6457	Palus Somnii	7091	0.05427	0.096977	Lyell	5506	0.04214	0.0760
2	6411		6971	0.05374	0.096020		6019	0.04640	0.0837
3	6511		7147	0.05425	0.096933		6200	0.04706	0.08491
4	6545		7402	0.05589	0.099870		6341	0.04788	0.0863
5									

Mean g = -29.13 N = 4 Mean g = -29.14 N = 4

Mean A = 0.097450 Mean A = 0.082767

Figure 6. Final reduction of sample set of lunar photometric observations by Charles A. Kapral, 1990 AUG 04. Determination of site illuminance (L) and albedo, and averaging of four sets of measurements.

OBSERVATIONS OF JUPITER DURING THE 1989-90 APPARITION

By: Richard W. Schmude, Jr., A.L.P.O. Remote Planets Recorder

ABSTRACT

This report presents the results of visual observations and the micrometer measurement of the latitudes of several Jovian features. The visual observations confirm the darkening of the Red Spot and Equatorial Zone as well as the fading of the South Equatorial Belt. In addition, several smaller changes occurred during the first four months of 1990; including changes in the detail near and within the Great Red Spot, the emergence of a distinct North Temperate Belt, and a southward shift of the northern border of the North Equatorial Belt. Micrometer measurements of the Great Red Spot suggest that it has an area of $2.4{\pm}0.5 \times 10^8$ km^2, meaning that it has not changed significantly in size since the 1960's.

INTRODUCTION

The 1989-90 Apparition of Jupiter began with Jupiter's conjunction with the Sun on 1989 JUN 09, included its opposition to the Sun on 1989 DEC 27, and ended with conjunction on 1990 JUL 15 (Universal Time is used throughout this report). In Fall, 1989, when Jupiter became visible in the morning sky, it became clear that three major changes had occurred on Jupiter during the period when it was unobservable: the almost-total disappearance of the South Equatorial Belt (SEB); the darkening of the Equatorial Zone (EZ); and the darkening of the Great Red Spot (GRS). Further changes occurred during the first four months of 1990: a decrease in the number of large festoons on the southern edge of the North Equatorial Belt (NEB); a southward shift in the northern border of the NEB; and the development of a distinct North Temperate Belt (NTB). These changes remained in effect for the rest of the 1989-90 Apparition. The set of strip maps, described below, shows the atmospheric features of Jupiter. In addition, micrometer measurements of the latitudes of the most distinct belts were made. The observations described here were made with the facilities at Texas A&M University Observatory.

STRIP MAPS

Three strip maps of Jupiter were made on the Cylindrical Equal-Area Projection, covering all longitudes of the planet, and are shown together on *Figure 7* (p. 112). The maps were constructed on 1989 DEC 06 and 10, 1989 DEC 21, and 1990 MAY 07-09. They are based on "System II" longitudes (assuming a period of rotation of 9h 55m 41s), which applies to the temperate latitudes of Jupiter, except for the south edge of the NTB. However, the EZ and adjoining edges of the NEB and SEB rotate according to "System I," with a period of 9h 50m 30s. Given the time interval involved in the construction of the first and the last maps, the positions of features in the System I region on those two maps are thus only averages. [1]

The Southern Hemisphere of Jupiter was dominated by two features during the 1989-90 Apparition; the Great Red Spot and the South South Temperate Belt (SSTB). The SSTB was identified from its latitude.[2] This feature had a complex structure and appeared to be joined to a more southerly belt during December, 1989. The dark feature on the SSTB just to the south of the GRS during December, 1989, had an appearance similar to one that I observed in this same belt during 1987 [3]; however, I did not observe such a feature during the 1988-89 Apparition. Also, on 1989 DEC 21. a bright circular area lay immediately north of the SSTB at λII = 235° (System II longitude 235°), as shown in *Figure 7*.

Fragments of the South Temperate Belt (STB) were visible during December, 1989, but had faded by May, 1990. The STB was also either very faint or absent during the 1988-89 Apparition. [4]

Fragments of the SEB were only faintly visible during late 1989. Most of these fragments were near 10° S latitude, corresponding to the northern half of the SEB. By May, 1990, there were even fewer visible fragments of the SEB. One feature of the SEB, however, was quite distinct; lying north of the GRS, centered near λII = 000°. On 1990 MAY 06, I was able to make micrometer measurements of this feature, which indicated that it was centered at a zenocentric latitude of -10°.7, or a zenographic latitude of -12°.2. [The *zenocentric* latitude of a feature is the angle, at Jupiter's center, between it and Jupiter's equator; the *zenographic* latitude is the angle between "overhead" at the feature and the equatorial plane. Ed.]

During December, 1989, two faint belts were visible that corresponded to the northern and southern components of the SEB. These features are also visible in CCD (Charge-Coupled Device) images of Jupiter [5, 6] and in a drawing made by Graham on 1989 AUG 21. [7] These faint bands were less distinct in May, 1990, thus suggesting that the SEB was continuing to fade during the first third of 1990. Eicher suggests that the mixing of bright material with the darker clouds of the SEB may have caused the fading of this belt. [8] This hypothesis, along with the fact that the fading began at a longitude of λII = 138°, suggests that the large bright oval and sur-

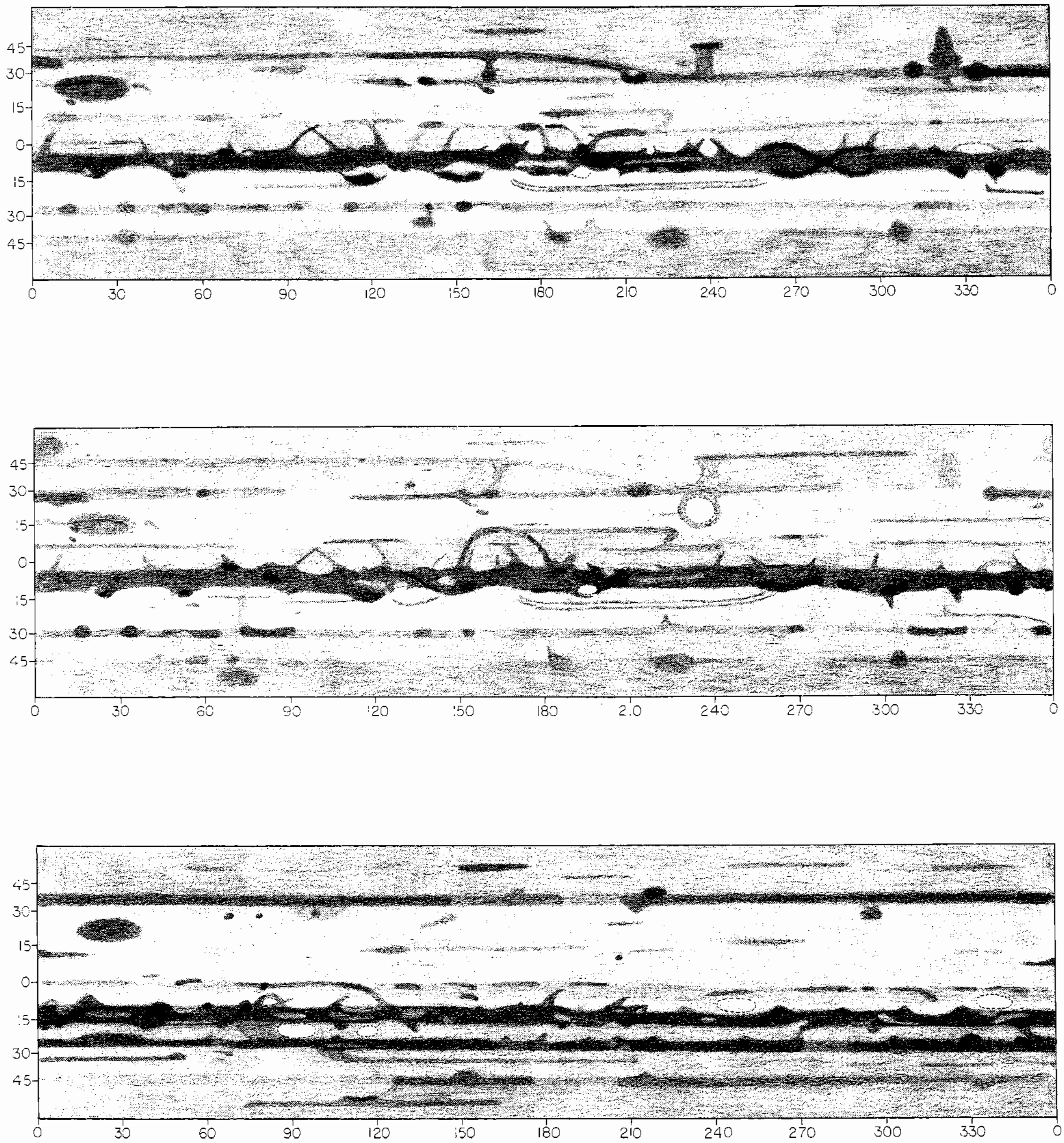

Figure 7. Strip charts of Jupiter during the 1989-90 Apparition, prepared by Richard W. Schmude, Jr. using the 35.6-cm telescope at Texas A&M University at 325×. These charts are on the Cylindrical Equal-Area Projection, with south at the top, with zenocentric latitudes indicated on the left edge, and with System II longitudes along the bottom. From top to bottom, the charts cover the dates of: 1989 DEC 6 and 10; 1989 DEC 21; and 1990 MAY 07-09.

rounding areas seen by the writer in February, 1989 **[4]**, at λII = 125°, may have triggered the fading of the SEB.

The equatorial region continued to contain a large amount of detail, as it had done in 1988-89. The Equatorial Band (EB) was fragmentary. In some cases, its fragments appeared to be connected to festoons associated with the NEB. One important change from 1988-89, however, was the darkening of the EZ that occurred during 1989. During the 1988-89 Apparition, the EZ was as bright as any other zone on Jupiter; but in December, 1989, and May, 1990, most of this area was darker than several of the equatorial and temperate zones. In fact, it was darker than some areas previously covered by the SEB, which had been the darkest belt on Jupiter during

February, 1989. This change is also discussed by di Cicco and may be related to the fading of the SEB. [9] During May, 1990, the brightest portion of the EZ bordered the NEB. Micrometer measures of the fragments of the EB were made on two dates, indicating that the center of the EB was at zenographic latitude -1°.6 (see *Table 1*).

The NEB had up to a dozen large festoons in December, 1989. One of them, centered at λ_{II} = 150° on 1989 DEC 21, extended over 15,000 km southward, as shown in the middle map in *Figure 7*. This festoon and others nearby possibly may have been created by the large eruption that occurred in this belt during mid-October, 1989. [10] This feature may also have been imaged by Laques and his colleagues. [5, 6] Between December, 1989, and May, 1990, however, the number of large festoons on the south edge of the NEB dropped sharply. The NEB usually had irregular borders and at times contained bright filaments. During May, 1990, this belt spanned 7° of zenographic latitude; less than the 10° it had spanned in 1989. It appears that most of the changes in this area occurred during the first third of 1990, as can be seen by comparing the central and bottom maps in *Figure 7*, and from the fact that the CCD images of Jupiter made in January, 1990, indicate that the NEB then spanned 9° of zenographic latitude. A movement of 20 km/day would account for the 2° difference between January and May, 1990.

Although the NTB had been faint in December, 1989, it had become prominent by May, 1990, as shown in *Figure 7*. Furthermore, this feature was faint in the CCD images made by Laques and his co-workers in January, 1990. [5, 6] This feature was also either very weak or absent during the 1988-89 Apparition. My micrometer measurements in 1989-90 indicate a zenographic latitude of +25°.1 for the center of the NTB. I estimated that this belt was about two-thirds as wide as the NEB during May, 1990, giving the NTB a width of between 4° and 5°.

At times, up to three belts were visible north of the NTB. The North North Temperate Belt (NNTB) was prominent near λ_{II} = 020°, but was weak or absent at other longitudes. The NNNTB and "N^5TB" (NNNNNTB) were also visible at some longitudes. (I have assigned these two names to these two features based on their measured latitudes, as given in *Table 1* [p. 114] and the convention suggested by Rogers. [2].) My micrometer measures give zenographic latitudes of +39° for the NNTB and +46° for the NNNTB, which are consistent with previous measurements. [1, 2, 11] On 1990 MAY 07, I visually estimated that the N^5TB lay exactly midway between the NNNTB and the northern limb, implying a zenographic latitude of +60°.4 for the center of this feature. This latitude marginally agrees with that suggested for the N^5TB by Rogers, +56°. [2]

The GRS also underwent changes during 1989 and early 1990. For one thing, it darkened considerably. Furthermore, during December, 1989, it contained a fine dark line, a portion of which appears to be present in the CCD images taken in January, 1990. In addition, I observed a bright speck inside the GRS during December, 1989, as shown in *Figure 7*. Finally, a small hook-shaped feature, extending about 2000 km north-south and 9000 km east-west, was immediately west (jovian) of the GRS in December, 1989, as shown in *Figure 7*. This feature also appears in the CCD images made by Laques and his co-workers on 1990 JAN 06. [5] However, none of the above features was visible in May, 1990.

Micrometer measurements of the GRS were made when it was on the Central Meridian on 1990 MAY 06, giving this feature an east-west length of 28,700±1900 km and a north-south width of 10,800±1900 km. Assuming an elliptical shape, this results in an area of $2.4 \pm 0.5 \times 10^8$ km^2. Central-meridian transit timings of the preceding and following edges of the GRS in December, 1999, imply an east-west length of 25°.5±3°; at zenographic latitude -22°, this corresponds to a length of 29,400±3500 km. I also measured the length of the GRS from CCD images of Jupiter [5, 6] and obtained an east-west length of 30,000±2000 km and a north-south extent of 13,000±2000 km, which gives an area of $3.1 \pm 0.5 \times 10^8$ km^2. Although statistically there is no significant difference between the CCD and the micrometer measurements of the GRS, there is the possibility that the GRS has decreased in area during the first four months of 1990. It is apparent, though, that the length of this feature has not decreased much for the last 24 years; in 1966 it was 23° in length [12], which is not very different from its length in 1990. Investigating possible changes in the size of the GRS, I also measured this feature as extending 29,500±2000 km east-west and 13,300±2000 km north-south from a photograph taken by J. Russell Smith on 1963 SEP 22 [11], giving an area of $3.1 \pm 0.5 \times 10^8$ km^2, which is not much larger than the 1990 area. Also, the area of the GRS in 1990 was about two-thirds that of the Red Spot Hollow (RSH) in 1989. [4]

Micrometer measurements show that the GRS was centered at a zenographic latitude of -22°, which is close to the value of -22°.4 measured by Akutsu from photographs taken in August, 1985. [13] It is important to note that, during 1985, the RSH was visible, but not the GRS; thus Akutsu's measurements of the RSH, along with the GRS measurements listed in *Table 1*, indicate that the centers of the GRS and the larger RSH coincide in latitude. The 1990 zenographic latitude of the GRS also agrees well with the mean value of -21°.8 that it had between 1908 and 1930. [1]

SUMMARY OF MICROMETER MEASUREMENTS

Table 1 (p. 114) summarizes the micrometer measurements of Jupiter's main belts and other features made during May, 1990. Below each latitude value is given the System I or System II longitude of the Central Meridian when the measurement was made. Each latitude is the mean of five measurements, with the uncertainty expressed as the standard deviation of the measurements. The uncertainties quoted for the mean zenocentric, and derived zenographic, latitudes are my estimates of the overall uncertainties of the measurements.

The mean zenographic latitude of the NTB between 1908-1947 is just under +28° [1], which suggests that the NTB in May, 1990, was slightly south of where it normally lies. The NNTB in May, 1990, was slightly under 2° north of the mean value reported in Peek. [1] The southern edge of the NEB during 1990 was very close to the mean value reported during 1908-1947, but the northern edge was almost 3° south of the mean value given in Peek. [1] Furthermore, the NEBn was 4°.0 south of where it was measured to lie in February, 1989; such a change, however, is not unreasonable. [14] According to the trends discussed by Mackal, latitudinal displacements of several degrees occur for the NEBn every four years on the average. [14]

During 1989-90, the only distinct belt in Jupiter's Southern Hemisphere was a feature lying at zenographic latitude -39°. This feature is probably the SSTB because the mean zenographic latitude of the SSTB reported in Peek is -41°.7, whereas the mean value for the STB is -28°.9. [1] On two dates, I was able to measure the latitude of the fragments of the EB, giving a mean zenographic latitude of -1°.6.

The feature designated as "Ac" is the dark band lying just north of the GRS. This feature was centered at -12°.2 zenographic latitude and is thus probably part of the SEB.

CONCLUSIONS

As observed by the writer, three major changes occurred on Jupiter between February and December, 1989: the fading of the SEB; the darkening of the GRS; and the darkening of the EZ.

Between December, 1989, and May, 1990, four further changes occurred: A decrease in the number of large festoons on the NEBs; changes in the detail within and around the GRS; the development of a dark and prominent NTB; and a southward shift of the northern edge of the NEB.

Besides these changes, the GRS may have diminished in area between January and May, 1990. The micrometer measurements in *Table 1* suggest that the latitudes of the visible belts were similar to those reported in Peek [1] and in Wend [11]. The NEB had a mean width of 7° in latitude during May, 1990, which is 25 percent less than its mean 1908-1947 width.

Table 1. Zenocentric Latitudes of Selected Features of Jupiter, Derived from Micrometer Measurements During the 1989-90 Apparition.

(Longitudes, given in parentheses, are in System II; except for System I in the EBc, italicized. "c" refers to the center of a feature; "n" to its north component, and "s" to its south component.)

Feature	1990 Date: MAY 04 ° °	MAY 06 ° °	MAY 07 ° °	MAY 08 ° °	MAY 09 ° °	Mean Latitude: Zenocentric ° °	Zenographic ° °
N5TBc (visual estimate)	---	---	+56.9±1.6 (152°)	---	---	**+56.9±4.0**	**+60.4±4.0**
NNNTBc	---	---	+42.1±0.8 (152°)	---	+41.0±0.3 (115°)	**+41.6±3.0**	**+45.5±3.0**
NNTBc	---	+34.9±0.7 (026°)	---	---	---	**+34.9±2.0**	**+38.7±2.0**
NTBc	+23.6±0.9 (088°)	+23.5±0.8 (023°)	+21.6±0.5 (155°)	+20.8±0.3 (311°)	+21.4±1.1 (112°)	**+22.2±2.0**	**+25.1±2.0**
NEBn	+13.0±0.6 (074°)	---	+13.2±0.7 (163°)	+14.2±0.5 (313°)	+11.5±0.2 (118°)	**+13.0±1.5**	**+14.8±1.5**
NEBs	+7.0±0.7 (067°)	---	+7.8±0.3 (162°)	+7.5±0.8 (317°)	+4.8±0.9 (120°)	**+6.8±1.5**	**+7.8±1.5**
EBc	---	---	-2.1±0.6 *(276°)*	---	-0.7±0.7 *(239°)*	**-1.4±1.5**	**-1.6±1.5**
Ac	---	-10.7±0.4 (010°)	---	---	---	**-10.7±1.5**	**-12.2±1.5**
GRSc	-19.7±1.2 (079°)	-18.2±0.3 (005°)	---	---	---	**-19.0±1.5**	**-21.6±1.5**
SSTBc	---	-35.0±0.6 (014°)	---	---	-35.4±0.8 (110°)	**-35.2±2.0**	**-39.0±2.0**

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THE SOLAR MAGNETIC FIELD

By: Frank J. Melillo

[Our readers have probably noted the excellent H-α photographs by Mr. Melillo that have been published in this Journal. Here he describes the significance, and the joy, of such observations. Ed.]

Magnetism plays an important role in the appearance of the Universe, being found in spiral galaxies, stars, and interstellar matter. It is also found closer to home; in our star, the Sun, where we can study the magnetic field in great detail, which may help us to understand magnetic fields elsewhere.

Actually, a magnetic field itself is an invisible force field which has the properties of strength and direction that affect charged particles. The Sun's gases consist of charged ionized plasma that is moved by the magnetic field.

Particularly at this present time of high solar activity, we can study the movement of the Sun's plasma. To do this, I use a Daystar © H-α 0.6 Å-bandpass filter to view hydrogen at a wavelength of 6563Å with a C-8 20-cm f/10 telescope. For photography, I use a Praktica LB camera with Kodak TP2415 black-and-white film. Visually, the filter reveals many twisting fibrils, filaments, and other chromospheric features.

I am frequently amazed by the visual evidence of the magnetic field of the Sun in H-α light. An example is active regions, which correspond to sunspot groups in white light. One form of feature seen is fibrils, which occur around active regions with a strong magnetic field. Farther from the spots, where the field is weaker, one can see spicules, which are jets of gas that cluster at the edge of the supergranular cells.

Particularly interesting are sunspot pairs, where the two spots are of opposite magnetic polarity; one positive and one negative. Here, the pattern of magnetic lines is similar to that produced in iron filings by a bar magnet.

Occasionally, the magnetic field becomes so complex, and with such a strong gradient, that it may trigger solar flares. One theory for solar flares is that the magnetic field explodes and snaps like a rubber band. If the motion is fast enough, you can watch it in real time!

The Sun is an excellent object of study for those with light-polluted night skies. In H-α light, the Sun offers many features that can otherwise be observed only during a total solar eclipse! The Sun changes its face every day and from one day to another; it never looks the same.

From my own observations with a H-α filter, I can watch the development of the magnetic field. For example, a region may be very complex and trigger flares. On the other hand, it may subside. Such observations are important to professional solar astronomers as they become more aware that magnetism plays a vital role in controlling the Sun's activity. Much remains to be discovered. Also, besides the scientific value of such observations, I enjoy watching the beauty of the amazing phenomena of our Sun for their own sake.

THE 1988-89 WESTERN (MORNING) APPARITION OF THE PLANET VENUS: VISUAL AND PHOTOGRAPHIC OBSERVATIONS

By: Julius L. Benton, Jr., A.L.P.O. Venus Recorder

ABSTRACT

This report summarizes visual and photographic observations of Venus for the 1988-89 Western (Morning) Apparition, based on data submitted by A.L.P.O. Venus Section observers in the United States and several other countries, including the instrumentation and sources of data used in obtaining those observations. Comparative studies deal with observers, instruments, and visual and photographic data. The report includes illustrations and a statistical analysis of the categories of features in the atmosphere of Venus, including cusps, cusp-caps, and cusp-bands, seen or suspected at visual wavelengths, both in integrated light and with color filters. Terminator irregularities and the apparent phase are discussed, together with the cooperative A.L.P.O.-Pioneer Venus Orbiter Ashen Light Monitoring Program.

INTRODUCTION

Observers submitted a meaningful collection of visual and photographic observations of Venus during the 1988-89 Western (Morning) Apparition. The geocentric parameters of that apparition are given in *Table 1* below.

A total of 299 observations consisting of visual drawings and photographs taken at visual wavelengths was received for the 1988-89 Apparition. *Figure 8* (p. 117) illustrates the distribution of observations for each month during that apparition.

Table 1. Geocentric Data in Universal Time (UT) for the 1988-89 Western (Morning) Apparition of Venus. [U.S. Naval Observatory, 1987, 1988]

		d	h
Inferior Conjunction..........................	1988 JUN	13	00
Greatest Brilliancy (-4.5)..................	JUL	19	18
Greatest Elongation West (46°).......	AUG	22	12
Superior Conjunction.......................	1989 APR	04	23
Apparent Diameter (observed range)	57".56 (1988 JUN 15)- 11".55 (1988 DEC 14)		
Dichotomy (predicted)....................	1988 AUG	22	02

Observational coverage was very good, with individuals initiating their programs early in the apparition. Because of the Ashen-Light program, there was a need to observe up until the time Venus reached Superior Conjunction, but no reports were submitted for observations after mid-December, 1988. The "observing season," or observational period, was from 1988 JUN 15 to DEC 14, with the maximum emphasis during the months of July-September (80.9 percent of the total observations). As in previous apparitions, the greatest observational activity during 1988-89 was near the period of greatest brilliancy and greatest elongation from the Sun.

Twelve individuals submitted visual and photographic observations of Venus during the 1988-89 Apparition. These observers are listed in *Table 2* (p. 117), with their observing sites, number of observations, and instruments used.

Figure 9 (p. 118) shows the international nature of the observers and the observations for this apparition. One-half of the observers were located outside the United States, and those individuals submitted four-fifths of the observations. Indeed, one person, D. Neichoy of Göttingen, Germany, contributed over two-thirds of the observations received!

The types of telescope used are depicted in *Figure 10* (p. 118). [Note the rather unusual popularity of Schmidt-Cassegrain telescopes for this apparition. More normally, "classical" designs such as the Newtonian and the refractor predominate. Ed.] In terms of aperture, 92 percent of the observations were made with telescopes of 15.2-cm (6.0-in) aperture or greater; only 8 percent were made with small telescopes under 15.2 cm.

In terms of atmospheric conditions, the mean Seeing was 4.0, or "fair," on the standard A.L.P.O. Scale that ranges from 0.0 for worst to 10.0 for perfect. The mean Transparency, expressed as the limiting stellar magnitude, was about +4.0 for those observations made when Venus was in a fairly dark sky, and thus at a relatively low altitude.

This Recorder expresses his sincere gratitude to all the dedicated colleagues mentioned in this report who carried out observations for the A.L.P.O. Venus Section. Observers everywhere are cordially invited to join, or to continue, with us in future observing seasons. We are continuing efforts to encourage and coordinate intensified and more comprehensive coverage of Venus in coming apparitions. We are cooperating with such groups as the

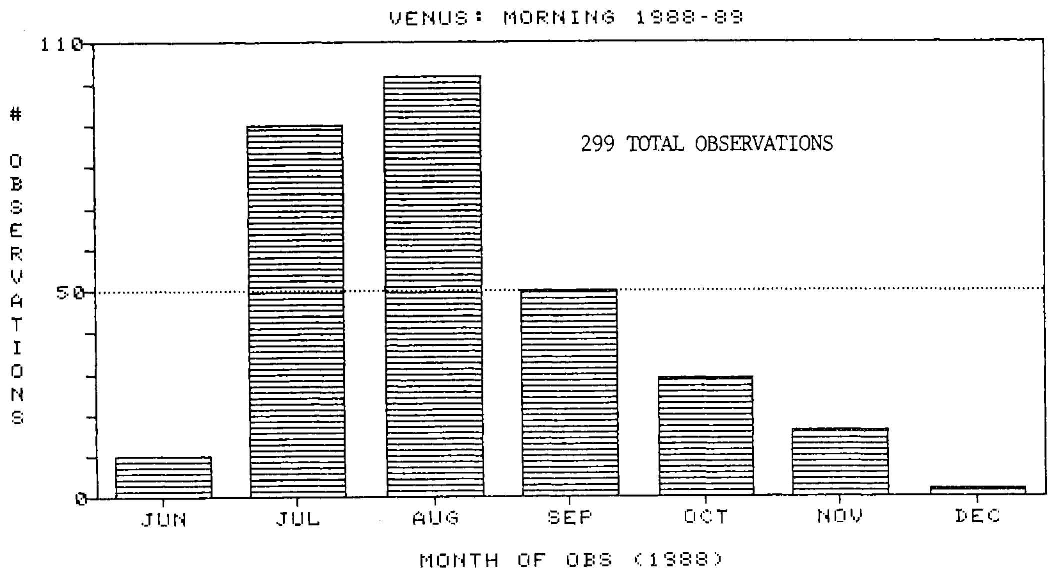


Figure 8. Number of observations contributed to the A.L.P.O. Venus Section by month during the 1988-89 Western (Morning) Apparition.

British Astronomical Association, the Royal Astronomical Society of Canada, the Vereinigung der Sternfreunde in Germany, and with similar organizations in Belgium, France, Hungary, and Spain.

Observations of Venusian Atmospheric Details

As noted in previous Venus reports that have appeared in this Journal [Benton, 1989, 1989a], the methods for conducting visual studies of the somewhat vague, elusive "markings" in the atmosphere of Venus have been outlined in the appropriate Venus Section publications. [Benton 1973, 1987] We recommend that observers new to the study of Venus consult these sources as well as previous apparition reports.

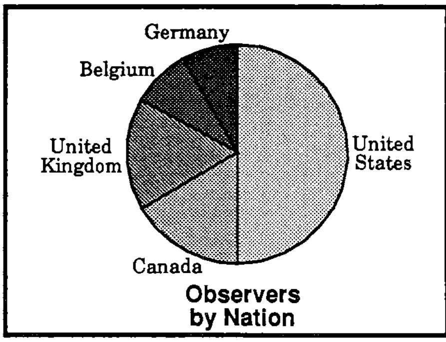
All the observations used for this report were at visual wavelengths. A few samples of these drawings appear in this report (see *Figures 11-17*, pp. 122-123) in order to aid the reader in interpreting the phenomena reported or suspected on Venus in 1988-89.

The visual and photographic data for the 1988-89 Apparition represented almost all of the categories of dusky and bright markings on Venus, as covered in the literature cited

Table 2. Participants in the A.L.P.O. Venus Observing Program during the 1988-89 Western (Morning) Apparition.

Observer	Observing Site	Number of Observations	Telescope(s) Used
Benton, J.L.	Wilmington Island, GA	17	15.2-cm (6.0-in) Refractor
Graham, D.L.	Brompton-on-Swale, U.K.	23	15.2-cm (6.0-in) Refractor
Haas, W.H.	Las Cruces, NM	3	15.2-cm (6.0-in) Newtonian
			20.3-cm (8.0-in) Newtonian
			31.8-cm (12.5-in) Newtonian
Heath, A.W.	Nottingham, U.K.	3	30.5-cm (12.0-in) Newtonian
Mac Dougal, C.	Tampa, FL	3	15.2-cm (6.0-in) Refractor
Melillo, F.J.	Franklin Square, NY	2	20.3-cm (8.0-in) Sch.-Cass.
Neichoy, D.	Göttingen, Germany	204	20.3-cm (8.0-in) Sch.-Cass.
Nowak, G.T.	Essex Junction, VT	2	22.9-cm (9.0-in) Refractor
Robotham, R.	Willowdale, ONT, Canada	2	15.2-cm (6.0-in) Newtonian
Van den Eijnde, P.	Antwerp, Belgium	5	20.8-cm (8.2-in) Newtonian
Viens, J.-F.	Quebec, Canada	19	11.5-cm (4.5-in) Newtonian
Westfall, J.E.	San Francisco, CA	16	9.0-cm (3.5-in) Maksutov
			25.4-cm (10.0-in) Cassegrain
			35.6-cm (14.0-in) Sch.-Cass.

Total Number of Observations........................299



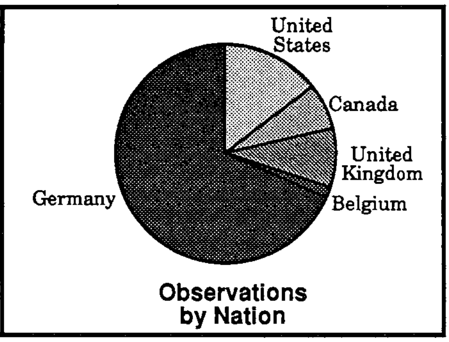


Figure 9. Distribution of observers and observations by nationality, 1988-89 Western (morning) Apparition of Venus.

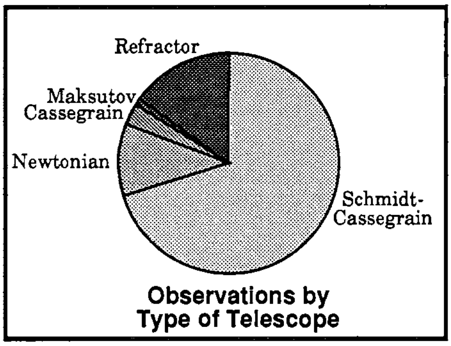


Figure 10. Distribution of observations by optical design of telescope, 1988-89 Western (morning) Apparition of Venus.

above. [Benton 1973, 1987, 1989, 1989a] *Table 3* (p. 119) summarizes the frequency by which the specific forms of markings were reported; note that many observations showed more than one type of marking, so that totals over 100 percent are possible. Undoubtedly, there is a subjective element in the reporting of the vague and elusive markings of Venus which must affect the values in the table. Nonetheless, our tentative conclusions based on these data appear reasonable.

The dusky markings of Venus' atmosphere are quite elusive, both to the novice and to the experienced observer. It is usually thought that ultraviolet (UV) photographs of Venus are preferred in order to bring out any possible dusky features. We certainly do seek UV photographs because many features' appearances in UV are different than in visual wavelengths, particularly radial dusky patterns. However, it is interesting that during 1988-89 only slightly more than one-quarter of the drawings and other visual observations of Venus showed the planet as devoid of shadings or markings of any kind, unlike the result in many of the past apparitions. However, nearly all the photographs submitted showed a completely blank disk even though visual observers reported banded, irregular, amorphous, and radial dusky markings. One important factor here is that observers have been utilizing more standardized, systematic techniques with polarizing and color filters in recent years.

Most of the dusky markings that were reported were in the category of "Amorphous Dusky Markings," reported in 75.6 percent of the observations. Other dusky atmospheric features were distributed almost evenly between the categories of "Banded Dusky Markings" (46.8 percent) and "Irregular Dusky Markings" (46.5 percent), and only 2.0 percent of the observations reported "Radial Dusky Markings" in 1988-89.

Except for the cusp regions, bright areas or mottlings were infrequently observed for the 1988-89 Apparition. At visual wavelengths, a small number of drawings, and even fewer photographs, showed these bright spots or regions on Venus.

Color-filter techniques were effectively and systematically applied to Venus during the Western (morning) Apparition of 1988-89. These gave very promising results when compared with integrated-light observations. The usage of Wratten and Schott color filters, as well as variable-density polarizing filters, enhanced the visibility of atmospheric features on Venus, and the resulting data proved most useful.

Terminator shading was very prominent in this apparition. There was the usual tendency for the terminator shading to lighten (i.e., assume a higher intensity value) as one proceeded from the terminator toward the illuminated limb of the planet. Sometimes this gradation ended in the bright limb band, and usually this terminator shading extended from one cusp region to the other. Unlike the drawings, only a small fraction of the photographs submitted in 1988-89 suggested terminator shading.

CUSPS, CUSP-CAPS, AND CUSP-BANDS

The most contrasting and conspicuous features sometimes seen in the atmosphere of Venus are found at or near the planet's cusps, usually when the phase coefficient **k** [the fraction of the disk that is illuminated] lies between 0.1 and 0.8. These cusp-caps are occasionally bounded by dark, often diffuse, peripheral cusp-bands. *Table 4* (p. 119) gives visibility statistics for Venus' cusp features in 1988-89. When the northern and southern

Table 3. Frequency of Occurrence of Types of Markings during the 1988-89 Western (Morning) Apparition of Venus.

Marking Category	Percent. of Observations
Radial Dusky Markings	2.0 %
Banded Dusky Markings.	46.8
Irregular Dusky Markings	46.5
Amorphous Dusky Markings	75.6
Terminator Shading	94.9
No Dusky Markings Seen or Suspected	27.9
Bright Spots or Regions (exclusive of Cusps)	6.0

1. The geometric phase **k** ranged from 0.003 (1988 JUN 15) to 0.893 (1988 DEC 14).

2. Assuming that Venus' bright illuminated hemisphere (all areas devoid of any shading or other obvious markings) was typically assigned a relative numerical intensity of 8.4-9.0 (using the A.L.P.O. scale ranging from 0.0 for pure black to 10.0 for pure white) in 1988-89, the mean assigned intensity for the first five items above in integrated light (no filter) was about 7.5-8.0. The last category had an assigned intensity value of 9.0 during this apparition.

3. The scale of conspicuousness, ranging from 0.0 for definitely not seen to 10.0 for certainly seen, was used rather effectively in 1988-89, when the mean conspicuousness rating for the first five items and the last item was 5.0, indicating that all the features lay somewhere between vague suspicions and strong indications.

cusp-caps were recorded, they were often seen at the same time and usually were equal in size and brightness. In those instances where the cusp-caps were different, it was usually the southern one that was the larger and brighter. The cusp-caps were frequently bordered by dusky cusp-bands. In nearly one-half of the observations, neither cusp-cap was reported; and, for slightly more than half the time, neither cusp-band was seen. There were a few instances when the northern cusp-cap was the brighter and larger of the two; but this was rare, and the north cap was then bordered by an inconspicuous cusp-band.

Extension of the Cusps

Over three-quarters of the observations showed no cusp extensions beyond the 180° expected from simple geometry, in integrated light and with color filters. However, from 1988 July to mid-August, several observers recorded extensions of both cusps ranging from 2° to 40° on the average. There were, though, several instances when the reported extensions of both cusps met, forming a halo encircling the entire dark hemisphere of Venus; a truly beautiful spectacle. These cusp extensions were depicted on drawings, enhanced by color-filter techniques, but were wholly invisible on any photographs submitted. As expected, cusp extensions are extremely difficult to capture on film, being considerably fainter than the sunlit portions of the disk.

The Bright Limb Band

In 1988-89, 45.5 percent of the observations submitted referred to a bright band on the sunlit limb of Venus. This feature usually extended from cusp to cusp, was narrow along the limb, and was mostly uniform in intensity throughout its length. The mean numerical intensity assigned to this band was 9.5-9.7. Its visibility was greatly enhanced by the use of selected color filters and polarizers.

Table 4. Frequency of Occurrence of Cusp-Caps and Cusp-Bands during the 1988-89 Western (Morning) Apparition of Venus.*

Marking Category/Condition	Percent. Obser.
Cusp-Caps:	
No Cusp-Caps Visible	49.5 %
Both Cusp-Caps Visible	48.5
North Cusp-Cap Alone Visible	0.3
South Cusp-Cap Alone Visible	1.7
Either or Both Cusp-Caps Vis.	50.5
North Cusp-Cap the Brighter	1.0 %
Cusp-Caps of Equal Brightness	42.8
South Cusp-Cap the Brighter	4.7
North Cusp-Cap the Larger	1.0 %
Cusp-Caps of Equal Size	36.8
South Cusp-Cap the Larger	10.7

Marking Category/Condition	Percent Obser.
Cusp-Bands:	
No Cusp-Bands Visible	54.5 %
Both Cusp-Bands Visible	42.8
North Cusp-Band Alone Visible	0.7
South Cusp-Band Alone Visible	2.0
Either or Both Cusp-Bands Vis.	45.5

* The mean assigned intensity for the cusp-caps was about 9.5 and about 7.8 for the cusp-bands. The percentages above do not always add up to 100. Particularly, when only one cusp-cap was visible, it was not possible to make comparisons of size and brightness.

TERMINATOR IRREGULARITIES

The terminator of Venus is the geometric curve that separates the sunlit and dark hemispheres. Most of the observations (93.7 percent) made during 1988-89 reported obvious terminator irregularities. Amorphous and irregular dusky shadings, and to a lesser extent banded and radial dusky shadings, merged with the terminator shading and with possible reported deformities along the otherwise geometrically regular terminator. As with other observations this apparition, successful filter techniques probably enhanced the visibility of any terminator irregularities and associated dusky atmospheric features. [The phenomenon of *irradiation* may cause bright features near the terminator to become apparent bulges; and dark features, apparent hollows. Ed.]

ESTIMATES OF DICHOTOMY

The "Schröter Effect" on Venus, a discrepancy between the predicted and the observed dates of dichotomy (half-phase), was reported in 1988-89. The predicted half-phase occurs when **k** = 0.500, and the phase angle **i** between the Sun and the Earth as seen from Venus equals 90°. The observed *minus* predicted discrepancies for 1988-89 are given in *Table 5* (below).

THE ASHEN LIGHT

The Ashen Light, first reported by the Italian observer G. Riccioli in 1643, is an exceedingly elusive, faint illumination of the dark hemisphere of Venus. It resembles Earthshine on the dark portion of the Moon, but it cannot have the same origin. It is often argued that Venus must be viewed against a dark sky in order to detect the Ashen Light, but Venus is low in the sky at such times and suffers from poor seeing and glare in contrast with the dark sky background.

The A.L.P.O. Venus Section, in conjunction with several other astronomical associations throughout the world, actively participated in a very intensive effort to study the Ashen Light in cooperation with Pioneer Venus scientists. The Pioneer Venus Orbiter (PVO) has been circling Venus since 1978 in a near-polar orbit. The spacecraft contains an instrument package which observes Venus' atmospheric features, monitors Sun-Venus interactions, and samples the interplanetary medium near the planet. However, the PVO cannot directly observe the Ashen Light at optical (visual) wavelengths, and this is the reason why PVO studies have been complemented by visual work by A.L.P.O. and other Venus observers all over the globe.

The PVO data, which are still being studied and compared with the earthbased observations, have already yielded some interesting, if somewhat tentative, results. PVO scientists have expressed a heartened but cautious reaction to the findings so far. [Phillips, 1989]

The monitoring of Venus by A.L.P.O. and other observers around the world began with the 1987-88 Eastern (evening) Apparition. This has continued into the 1988-89 Western Apparition that is covered by this report, in an effort to provide an almost-uninterrupted survey of the planet with equal representation of observations from eastern and western apparitions. When the final results of the PVO program become available to this writer, he will submit a report on them to this Journal.

For now, it is important to consider the 1988-89 A.L.P.O. observations by themselves. *Table 6* (p. 121) summarizes the positive and negative observations of this phenomenon by D. Neichoy. Our other observers made negative sightings only, even though they observed on almost every day within the time span covered by *Table 6*. Mr. Neichoy was alone in reporting any positive sightings of the Ashen Light. His observations also have the merit of being made with the same instrument, magnification, and filters. Variations in these factors made comparisons among the entire group of observers very difficult.

On several occasions, Mr. Neichoy suspected the Ashen Light with color filters, but not with integrated light. In particular, the RG610 and W25 Filters (both red) often enhanced the visibility of this phenomenon.

Except for the daylight observation of 1991 AUG 14, all of Mr. Neichoy's observations were made during twilight. This was also true for most of the remaining observers, although a few observations were made under dark skies.

CONCLUSIONS

Limited atmospheric activity was reported for Venus in the 1988-89 Apparition. It is important to compare these results with those of previous morning observing seasons, as well

Table 5. Observed versus Predicted Dichotomy of Venus: 1988-89 Western (Morning) Apparition.

Quantity		Observer: J.L. Benton	A. Heath	J.F. Viens	J. Westfall
Date (1988 AUG):	Observed (O)	24.3 d	30.2 d	27.5 d	23.4 d
	Predicted (P)	22.1	22.1	22.1	22.1
	Difference (O - P)	+2.2	+8.1	+5.4	+1.3
Phase Coefficient:	Observed (O)	0.500	0.500	0.500	0.500
	Predicted (P)	0.512	0.543	0.529	0.507
	Difference (O - P)	-0.012	-0.043	-0.029	-0.007

as with evening apparitions of the planet. One important aspect of this observing season was the cooperation among the A.L.P.O., various other astronomical organizations around the world, and the Pioneer Venus Orbiter program for monitoring the Ashen Light. Analysis of the wealth of information gathered by all these sources during this apparition and the eastern (evening) apparition that preceded it should provide interesting reading in later reports.

Continuous monitoring of the planet by diligent participants over many years remains our main program, and we invite interested readers to join us in our pursuits to gather reliable information about Venus.

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Table 6. A.L.P.O. Venus Section Ashen-Light Observations by D. Neichoy: 1988-89 Western (Morning) Apparition.

Notes: All observations below were made with a 20.3-cm (8.0-in) Schmidt-Cassegrain telescope at 225×. Filters are as follows: BG3 = blue, GG10 = yellow, IL = integrated light, OG550 = green, RG610 = red, UG3 = yellow, W15 = yellow, W25 = red, W35 = magenta, W47 = violet. "S/T" refers to Seeing and Transparency in the standard 0-10 and 0-5 A.L.P.O. Scales, respectively. "AL" is the Ashen-Light visibility, as follows: NS = nothing seen or suspected, S = suspected, StS = strongly suspected, VStS = very strongly suspected.

Date & UT	Filter	S/T	AL
1988			
JUL 13			
04h03m	IL	2/2	NS
04 11	W47	2/2	NS
04 18	GG10	3/2	NS
04 26	RG610	2/2	NS
04 39	W15	2/2	NS
04 55	W25	2/2	S
JUL 25			
03h34m	IL	2/3	NS
03 42	W47	2/3	NS
03 52	RG610	2/3	NS
03 58	GG10	2/3	NS
04 09	W15	2/3	NS
04 20	W25	2/3	S
04 27	OG550	2/3	NS
04 38	W35	2/3	NS
04 43	UG3	2/3	NS
04 47	BG3	2/3	NS
JUL 26			
03h22m	IL	2/3	NS
03 29	IL	2/2	NS
03 36	W47	2/2	NS
03 45	W47	2/2	NS
03 52	RG610	2/2	VStS
03 59	BG3	2/2	S
04 11	W15	2/3	NS
04 19	GG10	2/3	NS
04 34	W25	2/3	NS
04 39	GG10	2/3	NS
04 45	W25	2/3	NS
AUG 01			
03h38m	IL	2/2	StS
03 44	IL	2/2	S
03 50	W47	2/2	S
03 57	RG610	2/2	StS
04 05	W15	2/2	NS
04 10	W25	2/2	NS
04 16	GG10	3/2	NS
AUG 02			
03h55m	IL	2/2	StS
04 05	IL	2/2	NS
04 12	W47	2/2	NS
04 19	W15	2/3	NS
04 25	W25	2/3	NS
AUG 04			
02h56m	IL	2/3	NS
03 03	W47	2/3	S
03 10	W35	2/2	NS
03 17	RG610	2/3	StS
03 26	GG10	2/2	S
03 35	W25	2/2	S
03 50	W15	2/2	S
AUG 07			
01h54m	IL	2/3	NS
01 58	W47	2/3	NS
02 02	RG610	2/3	VStS
02 08	W25	3/2	VStS
02 15	W35	2/2	StS
02 22	GG10	2/3	S
AUG 08			
03h40m	IL	2/3	S
03 47	W47	2/3	NS
AUG 08			
03h56m	W15	2/3	S
04 10	W25	2/3	StS
04 19	GG10	2/3	StS
04 30	RG610	2/2	NS
AUG 14			
07h14m	IL	2/2	NS
07 23	W47	2/3	NS
07 46	RG610	2/3	NS
07 54	UG3	2/2	NS
08 03	W15	2/2	StS
08 11	BG3	2/2	NS
08 21	W25	2/3	NS
09 00	GG10	2/2	NS
AUG 15			
03h11m	IL	2/2	S
03 19	W47	2/2	S
03 28	W25	2/2	S
03 38	W15	2/3	NS
03 46	UG3	2/3	S
03 56	GG10	2/3	NS
AUG 17			
03h31m	IL	2/2	StS
03 35	W47	2/3	NS
03 41	RG610	2/3	NS
03 55	W15	2/3	NS
SEP 07			
03h59m	IL	2/3	S
04 05	GG10	2/3	NS
04 15	W47	2/2	NS
04 19	RG610	2/2	NS
04 28	W15	3/3	NS

Notes: Figures 11-17 are oriented with celestial south at the top and the preceding direction to the left (simple inverted views). For *Figures 11-14*, seeing is given in the standard A.L.P.O. scale of 0 (worst) - 10 (perfect). Transparency is the limiting naked-eye stellar magnitude for *Figures 11* and *13*, and in the 0 (worst) - 5 (best) scale for *Figures 12* and *14*.

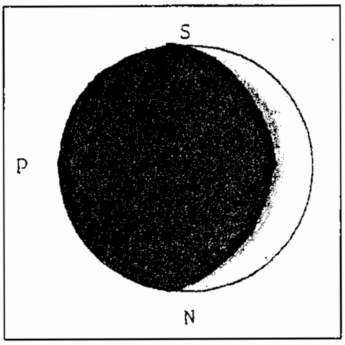

Figure 11 (left). Drawing of Venus by Frank J. Melillo. 1988 JUL 04, 09h20m - 09h35m UT. 20.3-cm (8.0-in) Schmidt-Cassegrain, 220×. W80A (blue) and W47 (violet) Filters. Seeing = 9, Transparency = +3.5 (twilight sky). Phase, **k** = 0.132. Diameter = 47".2.

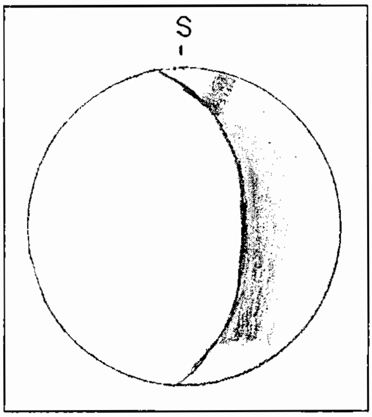

Figure 12 (right). Drawing of Venus by Rob Robotham. 1988 JUL 20, 09h50m - 10h00m UT. 15.2-cm (6.0-in) Newtonian, 160×. Integrated light (no filters). Seeing = 4-7, Transparency = 3-5 (light sky). Phase, **k** = 0.278. Diameter = 36".6.

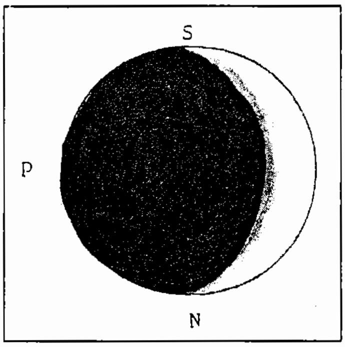

Figure 13 (left). Drawing of Venus by Frank J. Melillo. 1988 JUL 26, 09h20m - 09h30m UT. 20.3-cm (8.0-in) Schmidt-Cassegrain, 220×. W80A (blue) and W47 (violet) Filters. Seeing = 7, Transparency = +3.5 (twilight sky). Phase, **k** = 0.326. Diameter = 33".4.

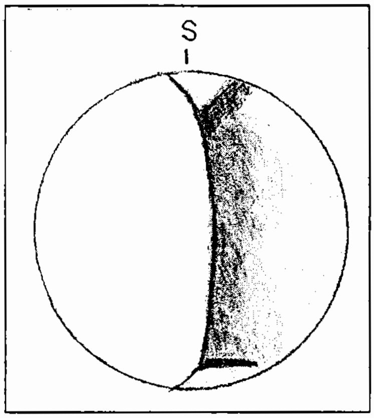

Figure 14 (right). Drawing of Venus by Rob Robotham. 1988 AUG 13, 10h12m - 10h50m UT. 15.2-cm (6.0-in) Newtonian, 203×. Integrated light (no filters). Seeing = 7-9, Transparency = 2-3 (light sky). Phase, **k** = 0.450. Diameter = 26".2.

SELECTED DRAWINGS, 1988-89 WESTERN (MORNING) APPARITION OF VENUS—
Continued. (See notes on p. 122.)

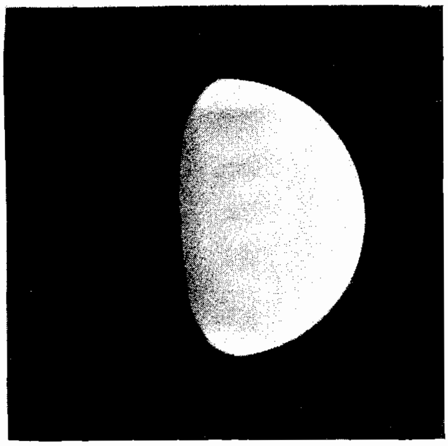

Figure 15. Drawing of Venus by David L. Graham. 1988 SEP 30, 07h10m UT. 15.2-cm (6.0-in) refractor, 286×. W15 (yellow) Filter. Phase, **k** = 0.679. Diameter = 16".7.

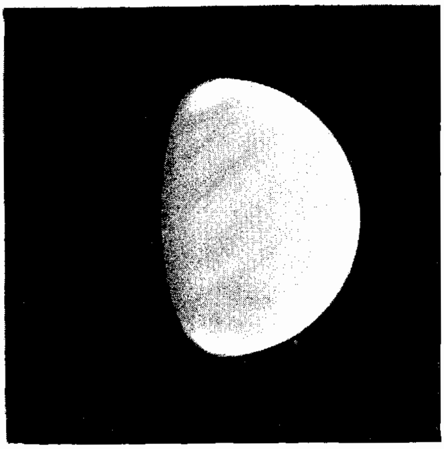

Figure 16. Drawing of Venus by David L. Graham. 1988 NOV 03, 10h15m UT. 15.2-cm (6.0-in) refractor, 286×. W15 (yellow) Filter. Phase, **k** = 0.794. Diameter = 13".6.

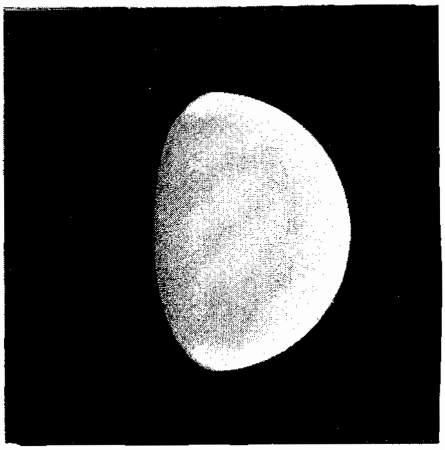

Figure 17. Drawing of Venus by David L. Graham. 1988 NOV 06, 10h55m UT. 15.2-cm (6.0-in) refractor, 286×. W15 (yellow) Filter. Phase, **k** = 0.803. Diameter = 13".4.

A Simultaneous Solar Observing Project

By: Gordon Garcia

ABSTRACT

On Saturday, 1990 JUN 16 at exactly 15h 00m UT, several A.L.P.O. Solar Section observers attempted to photograph the Sun simultaneously, and four successfully did so. The purpose of this unique project was to have different observers at different locations record the solar disk simultaneously at different wavelengths of light.

INTRODUCTION

The idea for a simultaneous solar observing project began with a telephone conversation between the writer and Randy Tatum, the A.L.P.O. Solar Monochromatic Recorder. We decided to image the Sun simultaneously in H-α light. Randy was to make a filtergram in the red wing (i.e., a wavelength slightly longer than the 6562.8-Å centerline), while I was to attempt to photograph the Sun in the blue wing (i.e., a wavelength slightly shorter than the centerline). Furthermore, we decided to ask the A.L.P.O. Solar Section observer Robert Morris to photograph the Sun in the H-α centerline. We also asked several other observers to participate by photographing the whole disk and any interesting regions in white light. In addition, we requested drawings of the Sun to confirm the information captured on film. The date and time chosen were 1990 JUN 16, 15h 00m UT, during Solar Rotation 1830. The writer acted as coordinator for this project, sent letters to several observers, and solicited observations through the *Solar Rotation Report.* The purpose of this observing project was to promote interest and cooperation among A.L.P.O. Solar Section observers and to obtain observations that would be important to the professional community. We considered that this project could lead to larger simultaneous projects in the future, involving more observers and a network of communication among amateur solar observers to coordinate observations when highly active regions are present on the disk.

RESULTS

Four observers were able to obtain images of the solar disk. Due to inclement weather, several observers in the Chicago, Illinois, area, who were to participate, were not successful. These included the writer. Robert Morris in Denver, Colorado, was clouded out at 15h 00m UT, but was able to observe at other times on the same day.

Paul Maxson in Phoenix, Arizona, the A.L.P.O. Solar Section White-Light Recorder, and Brad Timerson, an A.L.P.O. Solar Section observer, in Newark, New York, photographed the Sun in white light. Maxson photographed the Sun at exactly 15h 00m UT, using a 25-cm reflecting telescope stopped down to 15 cm at f/10 on a clock-driven German equatorial mounting. Maxson used a Tuthill "Solar Skreen" with a Wratten 47 (violet) Filter and Kodak Technical Pan (TP2415) 35-mm Film for a 1/500-second exposure at prime focus. The film was developed in HC110 (dilution B) for 2.5 minutes at 70°F and was submitted in the form of an 8×10-inch enlargement. Maxson reported 1-3 arc-second seeing with 0-percent cloud cover.

Timerson's photograph is reproduced on the next page as *Figure 18*. This photograph was also taken at exactly 15h 00m UT. Timerson used a 15-cm Newtonian reflector at f/8.3 on a clock-driven fork mounting. A Tuthill Solar Skreen was the only filtration used for a 1/500-second exposure at prime focus on TP2415 35-mm format Film. The film was developed in modified POTA for 6 minutes at 80°F. Timerson reported 3 arc-second seeing with 0-percent clouds.

Donald Clement of Kenner, Louisiana, another A.L.P.O. Solar Section observer, photographed the Sun in H-α light at 15h 00m UT. He used a 15-cm f/12 refractor, stopped to 6 cm at f/30, on a clock-driven German equatorial mounting. A Daystar 0.68-Å Filter was used for the 1/250-second exposure, tuned to the centerline of H-α. Clement also used 35-mm TP2415 Film, developed in D19 for 8 minutes at 68°F, and was submitted in the form of 5×7- and 8×10-inch enlargements. He reported good seeing (2-3 arc-seconds) with 0-percent cloud cover. The resulting photograph is shown below as *Figure 19* (p. 126).

A.L.P.O. Solar Section Recorder Randy Tatum of Richmond, Virginia, was the fourth participating observer. He observed at 14h 59m UT with a 17.5-cm refractor on a clock-driven German equatorial mounting, with the instrument stopped to 9 cm (f/30). He used a 0.5-Å Daystar Filter, tuned to the centerline of H-α, with 35-mm TP2415 Film at a 1/125-second exposure. The film was developed in D19 for 5.75 minutes at 70°F and was submitted in the form of a 5×7-inch enlargement, reproduced here as *Figure 20* (p. 126). At the time of the exposure, seeing was good (2-3 arc-seconds) with 20-percent cloud cover and light haze. He could not photograph in the red wing at 15h 00m UT due to poor seeing at that time.

CONCURRENT SOLAR CONDITIONS

The position angle of the Sun's axis (P) was -9°.2 at 15h 00m UT, while the disk center's heliographic latitude (Bo) was +1°.2, and the central longitude (Lo) was 291°.6.

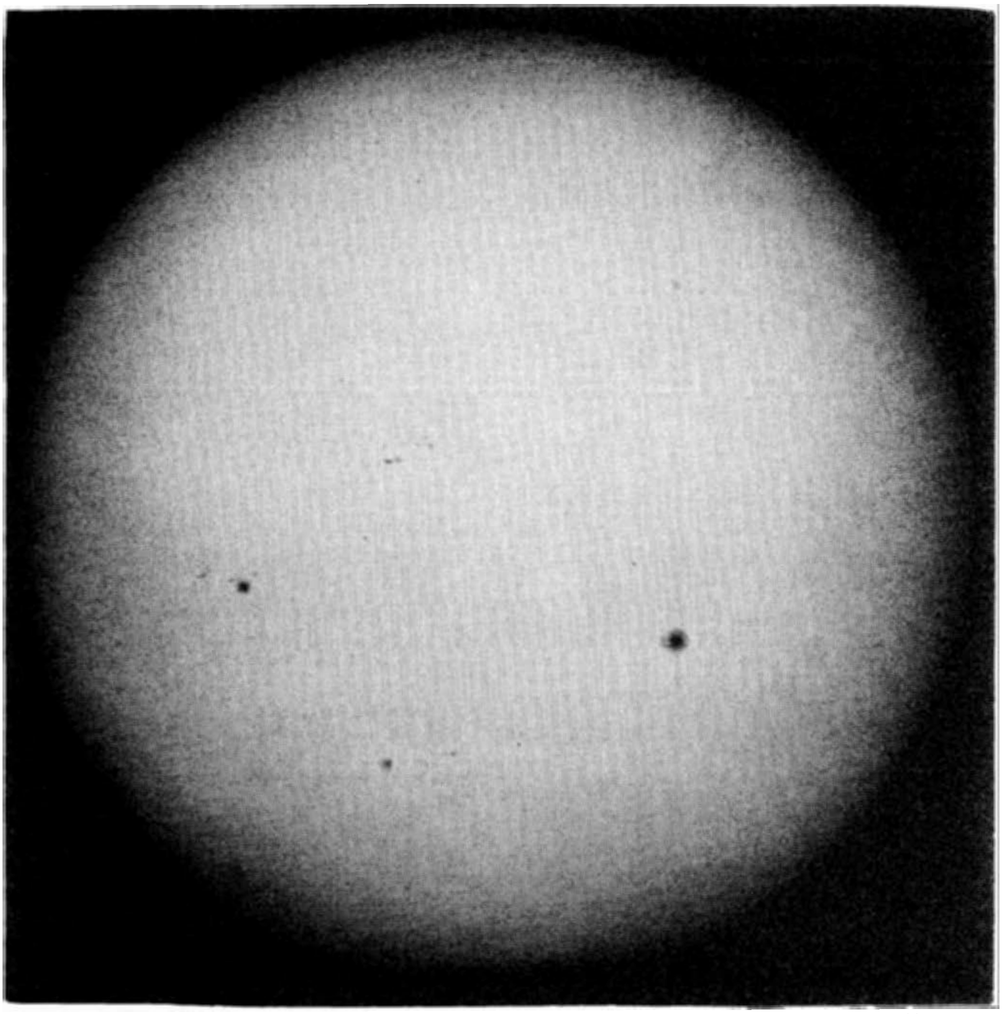

Figure 18. Photograph of Sun in white light taken by Brad Timerson on 1990 JUN 16, 15h 00m UT. North at top and celestial west to the right (unreversed). For technical details see p. 124 of the text.

On the day of the observations, the sunspot count was recorded at RA = 109 and RI = 110 [RA is the American sunspot number, while RI is the International sunspot number. Ed.]. In white light, Maxson and Timerson photographed eight sunspot groups. The largest group, SESC [Space Environmental Services Center] Region 6100, occupied an area of approximately 340 millionths of the visible solar hemisphere. The group was simple magnetically and produced only 2 M-class {intermediate intensity] flares while it crossed the solar disk. A faint subflare (X-ray class C1.7 [1.7×10^{-6} watts per square meter]) was recorded by Tatum and Clement in H-α. The flare was barely detectable from the background plage and, according to the *Preliminary Report—Forecast of Solar Geophysical Data*, reached its maximum brightness at 15h 38m UT. Also, there were several large filaments on the disk; the largest was oriented N-S, was approximately 30 heliocentric degrees in length, and was darker than the other filaments that were present. The writer observed this filament on the following day, indicating that it had not become active over the 24-hour period following the simultaneous-observation time. Several other interesting features were also recorded by Clement and Tatum in H-α.

CONCLUSION

Although, due to inclement weather at several observing sites, only four observations were made, it appears that coordinated solar observations during times of high solar activity are of great interest to amateur astronomers and may also be of interest to the professional community. The A.L.P.O. Solar Recorder, Richard Hill (address on inside back cover), is currently establishing a communication network among interested solar observers so that similar coordinated efforts can be undertaken in the future. Contact him if you are interested in participating in this project. Finally, I wish to thank the observers who participated in this unique project, as well as Mrs. Edith Auchter of the Northwest Suburban Astronomers for her assistance in preparing this report.

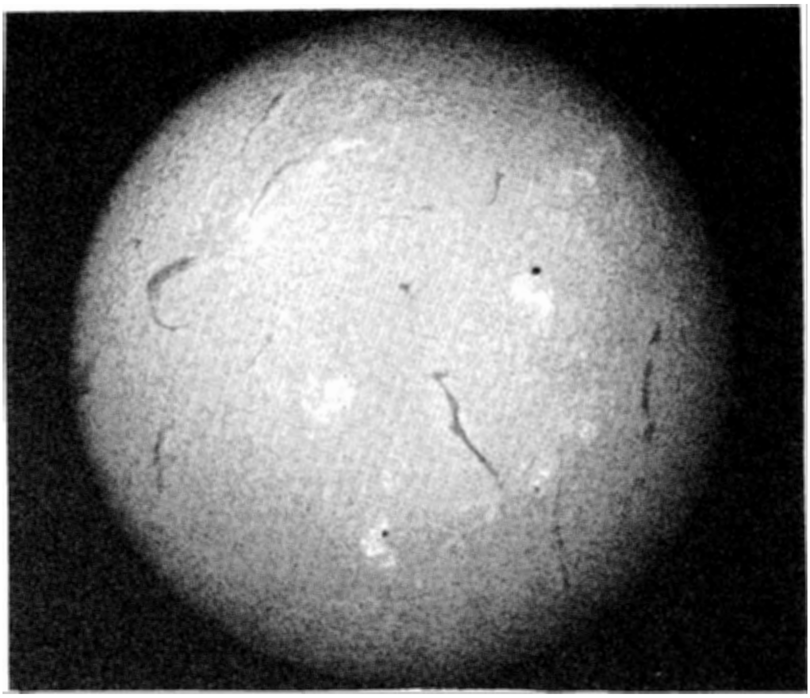

Figure 19. Photograph of Sun in H-α light taken by Donald H. Clement on 1990 JUN 16, 15h 00m UT. North at upper left and celestial west to upper right (unreversed). For technical details see p. 124 of the text.

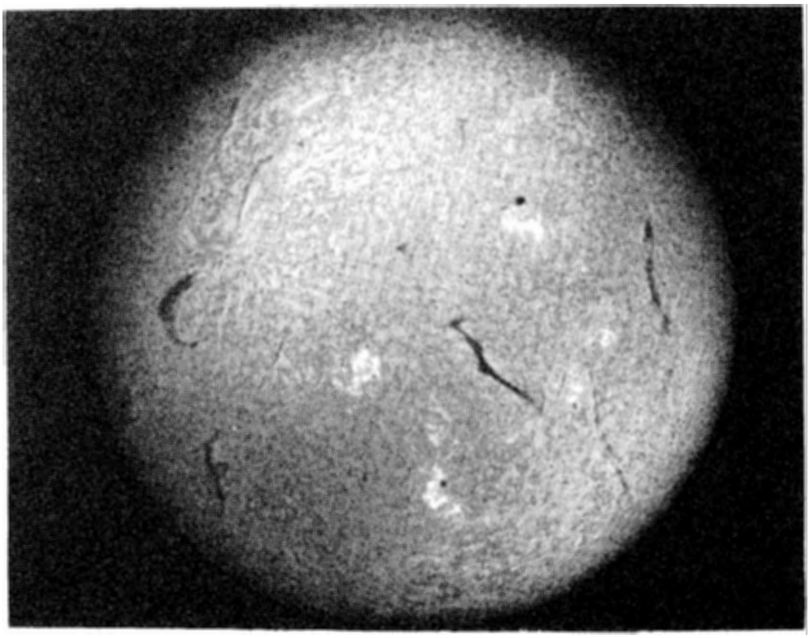

Figure 20. Photograph of Sun in H-α light taken by Randy Tatum on 1990 JUN 16, 14h 59m UT. Orientation as in *Figure 19*. For technical details see p. 124 of the text.

A.L.P.O. SOLAR SECTION OBSERVATIONS FOR ROTATIONS 1829-1832 (1990 MAY 15 TO SEP 01)

By: Richard E. Hill, A.L.P.O. Solar Recorder

ABSTRACT

This report summarizes A.L.P.O. Solar Section observations for Rotations 1829-1832, particularly in terms of the morphology and development of sunspot groups. Seventeen observers in six countries contributed visual drawings and integrated-light and Hydrogen-α photographs. Solar activity remained moderate in this period until Rotation 1832, when there was a dramatic increase in activity.

INTRODUCTION

Solar activity in the period covered by this report continued at the moderate level seen throughout the last reporting period (Rotations 1824-1828); at least until the final rotation! In Rotation 1832 there was a sudden and dramatic increase in activity, reaching high levels. This numerical increase was the greatest ever witnessed by this Section and resulted in the highest *rotational* mean sunspot numbers that we have seen in our nearly ten years of existence.

As is often the case during high activity, there was little difference between the International Sunspot Number, **RI**, and the American Sunspot Number, **RA**. The mean rotational **RI** for this period was 151, with a high mean of 207.0 for Rotation 1832 and a low of 128.4 for Rotation 1829. The highest daily **RI** was 295 on 1990 AUG 20, and the lowest was 57 on 1990 JUN 21 and JUL 18, exactly one rotation apart. The mean four-rotation **RA** was also 151, rising to a highest mean of 201.0 in Rotation 1832, with its lowest being 126.5 for Rotation 1831. The **RA** mean of 201 is high; but, unlike the **RI** mean, it was only the second highest recorded by this Section—a rotational **RA** mean of 202 had been attained in Rotation 1816 in May and June, 1989. In terms of daily **RA** means, the highest was 280 on 1990 AUG 20, and the lowest was 55 on 1990 JUL 18. *Figure 21* (p. 128) graphs the rotational means for both forms of Sunspot Number.

A total of 186 sunspot groups was observed by this Section during the reporting period, giving a mean of 46.5 per rotation. This implies an appearance of an average of almost two groups per day. While both **RI** and **RA** fluctuated during the reporting period, the number of groups observed during each rotation steadily increased from 45 to 72! **[1-6]**

The terms and abbreviations used in this report have been explained in previous reports and will not be tediously reiterated here. However, remember that a *following* feature is to the celestial east and a *preceding* one is to the west. This relationship remains true whether one is referring to objects moving through the sky or to features on the Sun's rotating disk.

Other general solar nomenclature and definitions of terms may be found in the Astronomical League book, *The New Observe and Understand the Sun*; which is available along with the A.L.P.O.S.S. observing forms from this Recorder for $US 6.00, or without the forms for $US 5.75 from: Astronomical League Sales, c/o Wilma Cherup, 4 Klopfer Street, Pittsburgh, PA 15209. Another source is our own book, *A.L.P.O.S.S. Monochromatic Handbook* (available from Co-Recorder Randy Tatum for $US 6.00; 1108 Ocala Road, Richmond, VA 23229). Sunspot classification is explained in "A Three-Dimensional Sunspot Classification System" (*J.A.L.P.O.*, *33*, Nos. 1-3, Jan., 1989, pp. 10-13) and in the Astronomical League book mentioned above.

Seventeen observers from six countries contributed observations to this report. This is fewer observers than in the previous reporting period, even though activity continued at a good pace. As before, all observers lost were in the United States, so we retained sufficient longitude spacing for a potential of 24-hour coverage.

Table 1. Observers Contributing to This Report.

	Telescope			
Observer	Aper.	f/	Type	Location
Alexescu, M.	6 (2.4)	12	Refr.	Romania
Clement, D.	8 (3.1)	15	Mak.	Louisiana, USA
Didick, R.	? (?)	?	?	Mass., USA
Dragesco, J.	36 (14)	10	S.-C.	France
Garcia, G.	20 (8)	10	S.-C.	Illinois, USA
Garfinkle, R.	25 (10)	10	S.-C.	California, USA
Hill, R.E.	6 (2.4)	13	Refr.	Arizona, USA
Luciuk, M.	20 (8)	10	S.-C.	New Jersey, USA
Maxson, P.	15 (6)	6	New.	Arizona, USA
Melillo, F.J.	20 (8)	10	S.-C.	New York, USA
Rousom, J.	13 (5)	10	New.	Ontario, Can.
Ryder, J.	15 (6)	?	Refr.	Qld., Australia
Tao, Fan-Lin and Chang, Grace	13 (5)	?	Refr.	Rep. of China
Tatum, R.	18 (7)	15	Refr.	Virginia, USA
Timerson, B.	18 (7)	8	New.	New York, USA
VanHoose, D.	11 (4.3)	7.8	New.	Indiana, USA

Notes:"Aper." is the telescope aperture in the form cm. (in.); "f/" is its focal ratio; "Mak." is Maksutov; "New." is Newtonian; "Refr." is refractor; and "S.-C." is Schmidt-Cassegrain.

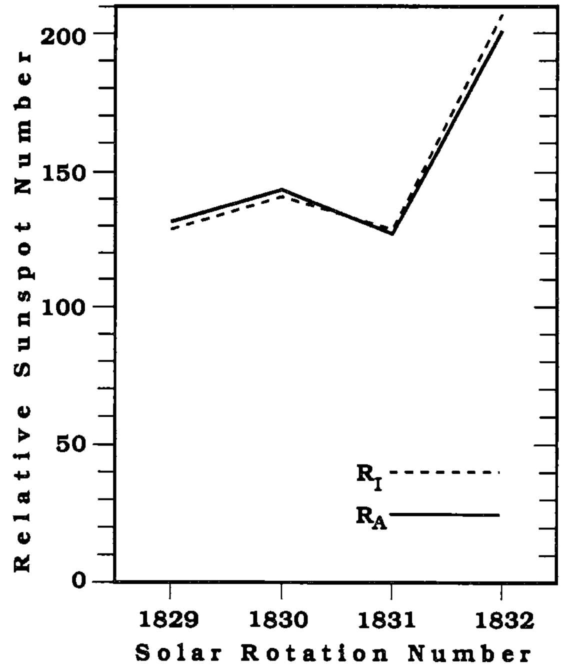

Figure 21. Graph of rotation means of RI (Relative International Sunspot Number) and RA (Relative American Sunspot Number) for Rotations 1829-1832.

fourth significant spot to the N and following the easternmost spot. By that time, the middle-N spot had split in two, providing a fine example of the rapid changes that can take place in a developing sunspot group.

The development of AR 6064 during most of its passage across the disk is shown effectively in a sequence of photographs by Alexescu, published here in *Figure 22* (p. 129).

The four concentrations of spots formed a diamond shape on 1990 MAY 15, with one concentration at each of the SW, W, NE, and E corners, as shown in *Figure 22*. The SW corner consisted of two spots with penumbrae. The W corner held a hook-shaped spot, with disorganized penumbra and with the smaller end of the hook pointing back to the SW spots. The hook then curled N with the long end pointing to the center of the entire group. This spot was followed by some small spots; some with rudimentary penumbrae, some with none. The NE collection comprised three spots with rudimentary penumbrae in a facular region. Lastly, the E concentration was elongated N-S with three or four umbrae in one regular penumbra. On MAY 16, this had evolved into a ring of 7-8 spots open only to the SW and SE. The penumbrae were more organized than earlier, and the entire group then spanned over 10 heliocentric degrees and was recognized as a naked-eye group by Section observers. On the next day, there was little change with some more small spots with rudimentary and fragmentary penumbrae among the older spots. The former SW and W spots appeared to be merging, thus forming many thin light bridges among the umbrae.

AR 6064 underwent substantial changes by 1990 MAY 18, when it had two concentrations of spots. The leader concentration was aligned E-W, V-shaped, and itself led by two small collections of umbrae. The S branch of these contained small umbrae that arced to the N; while the N branch was a concentration of about a half-dozen umbrae, all in one penumbra. Each of the branches was followed by a line of spots, some with and some without penumbrae, with some fragments of penumbra terminated some 5 heliocentric degrees to the E by a larger umbra in a disorganized penumbra. This V-shaped wedge of spots was followed by a large spot in an organized penumbra, surrounded by fragmentary penumbra and a few small spots.

This group remained visible to the naked eye on MAY 19, by which time the leader was a large collection consisting of one large umbra followed by two trains of umbrae, all contained in one penumbra. These two trains were the branches of the "V" of the preceding

Rotation 1829 [1,2]
(1990 MAY 15.25 to JUN 11.45)

Sunspot Number	Mean	Maximum (Date)	Minimum (Date)
RI	128.4	193 (MAY 21)	73 (JUN 03)
RA	131.5	197 (MAY 21)	81 (JUN 05)

In general, this rotation's solar activity tended to be lower than in the final rotation of the previous reporting period. However, although the maxima of 1828 were higher than those of 1829, the minima were lower. This meant that Rotation 1829 approached more to the mean of 1828. Forty-five groups were observed during this rotation, although for the most part they tended to be small. Only a few sunspot groups were well-developed and of these AR 6064 [*AR* means "Activity Region"] was perhaps the most so.

Two days before the beginning of this rotation, AR 6064 was first observed by Alexecsu, Garcia, Hill, and Maxson as a small collection of spots, one of which had a penumbra. In H-α (Hydrogen-alpha; at wavelength 6562.8Å) Garcia caught a subflare on 1990 MAY 13 at 15h 54m UT, a good indicator that this group was probably rising in activity. On MAY 14 at 03h 14m UT, Ryder observed the group as consisting of three main spots with penumbrae, two spots aligned E-W with another between them and to the N, and some small umbral spots surrounding the others. Fifteen hours later, Alexescu, Hill, and Luciuk saw a

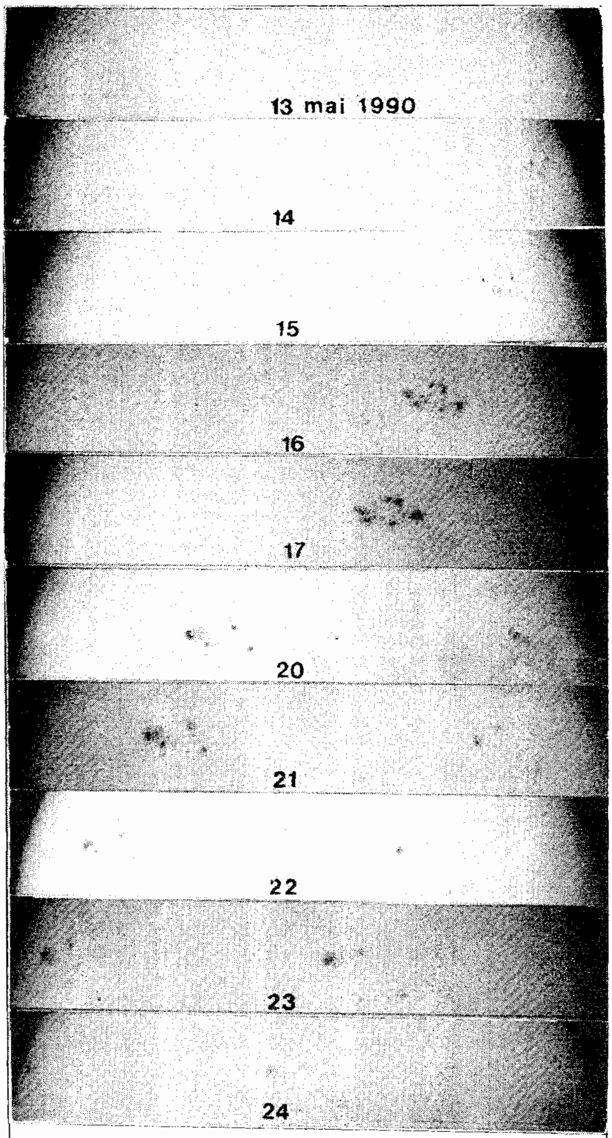

Figure 22. Series of white-light solar photographs by M. Alexescu showing the passage of AR 6064 across the disk starting on 1990 MAY 13 on the top, with AR 6064 on the right, and continuing to 1990 MAY 24 with the group near the limb on the left. South at top. A 60-mm refractor was used with the afocal method for an equivalent focal length of 1950 mm (f/32.5).

spot. The two trains of spots were still in existence on MAY 20, and were then preceded by a large umbra. One train was to the N, the other to the S, all in one penumbra that was organized to the W but fragmented to the E. An umbra to the N had detached with a bit of penumbra. The mid-S spot by then consisted of one large and several smaller umbrae in a SW-NE-aligned penumbra. The follower was a large umbra in a penumbra with small spots and fragmentary penumbrae among all the separate collections.

The first clear evidence of decay began on MAY 21. By then the leader was a complex, irregular umbra with a few smaller umbrae, all in a penumbra becoming more organized. To the N, the detached spot was merging; while to the S, the mid-S spot was breaking up, reducing in size, and becoming more nearly circular. The same general comments apply to the follower. This trend continued on MAY 22, when Melillo noted a huge filament to the S and a smaller one following. On MAY 23, the leader was a large umbra in a regular penumbra, followed by several umbrae in a disorganized penumbra aligned N-S. The mid-S spot had smaller umbrae in a disorganized penumbra, and the follower was much the same. With AR 6064 near the limb on MAY 24, there was more evidence of decay as all spots showed smaller umbrae and reduced penumbrae. Photographs by Alexescu (see *Figure 22*) and Maxson showed large sprawling faculae around all the spots of this region.

day. Among these umbrae were thin, bright light bridges; good sites for flare activity. The leading collection was followed by a large wedge-shaped umbra, oriented with its thick end to the W, in a disorganized penumbra. This collection was followed to the S by another collection of 3-4 umbrae in a disorganized penumbra aligned SW-NE. Both of these collections were followed by a large umbra in a regular penumbra, with a detached bit of penumbra to the W which contained several small umbrae. A H-α photograph by Tatum showed chromospheric filaments connecting the mid-S collection to the follower

Rotation 1830 [2,3]
(1990 JUN 11.45 to JUL 08.65)

Sunspot Number	Mean	Maximum (Date)	Minimum (Date)
R_I	140.7	272 (JUL 01)	57 (JUN 21)
R_A	143.3	261 (JUL 01)	81 (JUN 05)

This rotation witnessed a significant increase in activity over that of previous rotations. Quite a few groups attained naked-eye visibility and reached Modified Zurich Class

E [i.e., bipolar group over 10° across; major spots have very complex penumbrae, among which are smaller spots, many or all with penumbra}. The Section observed 57 groups in this rotation, verifying the increase in activity. **[3, 4]** [Note that the simultaneous solar observing project described in the previous article (pp.124-126) took place during this rotation, and *Figures 18-20* (pp. 125-126) show the Sun on 1990 JUN 16. Ed.]

Though the regions concerned are not highlighted in this report, Tatum took some remarkable H-α photographs on 1990 JUN 10. In one taken at 13h 08m UT, he caught activity in **AR 6095** just two minutes after a flare, and in **AR 6089** during a subflare. In another photograph, giving a three-dimensional effect, at 13h 22m UT, he showed **AR 6100** near the limb with chromospheric fibrils arcing out of the sunspot and partly covering a following plage!

AR 6122 was probably the largest region seen during this rotation. It was first seen on JUN 23 by Maxson and Timerson in white light on the limb as two spots, with penumbrae, attended by pores. There were many faculae surrounding both spots with a particularly bright example running N-S and separating the two spots. A day later, the region was seen as two collections of spots, still aligned E-W. The leading collection consisted of a large spot with a symmetrical penumbra, followed by three small spots in a triangle, two E-W and the other N, of which only the N spot had a penumbra. The following spot was elongated N-S, irregular in form, and with a penumbra. There are no data available for JUN 25, but on JUN 26 Rousom and Timerson saw the leader as a nearly-circular spot, with a half-dozen umbrae in a symmetrical penumbra. A small appendage of penumbral material trailed the leader. Following this were a few tiny umbral spots and one N-S elongated spot having two widely-separated umbrae in one penumbra, which constituted the remains of the previous triangle. The follower spot was still irregular, with a half-dozen small umbrae in one penumbra that was now elongated SW-NE. In H-α, Melillo observed a bright plage following the leader spot and a N-S plage line preceding the follower spot. Little had changed by the next day, except that the two penumbral fragments had separated from the follower and were to the NW of it.

On JUN 28, Ryder noted a change in the leader. The small penumbral extension was now a broad area of penumbra, making the spot elongated E-W. All that followed were umbral spots and pores. The follower spot was still elongated, but now smaller. The detached bits to the NW were also reduced in size. By JUN 29, the leader and the follower were separated by 15 heliocentric degrees. The leader was more nearly circular again, with one large umbra in a symmetrical penumbra. The follower comprised two spots where a photospheric light bridge had split the former spot in two. The were a few pores between the leader and the follower, but all trace of the former complexity was gone. A H-α photograph by Dragesco showed a clear division of polarities as seen in the chromospheric fibrils.

Clear signs of decay were noted on JUN 30. The region's appearance then is shown in *Figure 23* (p. 131). The leader was slightly elongated once more, to the SW-NE, but still symmetrical. The follower consisted of two pieces attached by a penumbral bridge, with the S spot the smaller. Only a few umbral spots and some pores lay between the leader and the follower. In H-α, the region was divided by a plage emanating from the leader. By Jul 01 there was little change. The leader then had two large umbrae in one spot, and the follower was the same as before. Garcia and Clement, in H-α, observed the plage as forming a sigmoid shape extending from the N side of the leader to the SE side of the follower. On JUL 02, both spots were fairly close to being circular, with several umbrae in symmetrical penumbrae and a few umbral spots and pores between the two major spots. As the group neared the limb on the next day, both spots were smaller and the umbral spots and pores were gone. On the limb on JUL 04, both spots were smaller and were breaking up, but otherwise appeared much the same as before.

Rotation 1831 [3,4]
(1990 JUL 08.65 to AUG 04.86)

Sunspot Number	Mean	Maximum (Dates)	Minimum (Date)
RI	128.5	194 (JUL 24 & 25)	57 (JUL 18)
RA	126.5	201 (JUL 24)	55 (JUL 18)

As gauged by the sunspot numbers, this rotation had the lowest activity of the reporting period. However, in keeping with remarks in the Introduction to this report, the trend expressed by the observed number of groups continued to increase from the previous rotation, rising from 57 to 64.

The one sunspot group that stood out from the others was **AR 6162**, which Timerson first observed on the limb on JUL 18. The region could not be seen clearly until JUL 20, when a separate leader and follower were detected. The leader consisted of a large spot containing one large umbra and a few smaller ones, all in one radially-symmetric penumbra. The photosphere itself, not any faculae, was bright around the outer border of the penumbra.The following collection was made up of 8-9 spots which were small umbrae in rudimentary penumbrae. Following this was a bright facular region. The umbrae in the leader consolidated into one large umbra on JUL 21. Likewise, the many follower spots had also consolidated into a mass of 5-6 umbrae in one penumbra, thus becoming more organized.

JUL 22 was an eclipse day, with the partial phase visible for our observers in the NW United States. Garfinkle made a low-sun observation of the eclipse at 01h 45m UT. Later in the day, Maxson and Timerson saw that the leader had become more nearly circular and

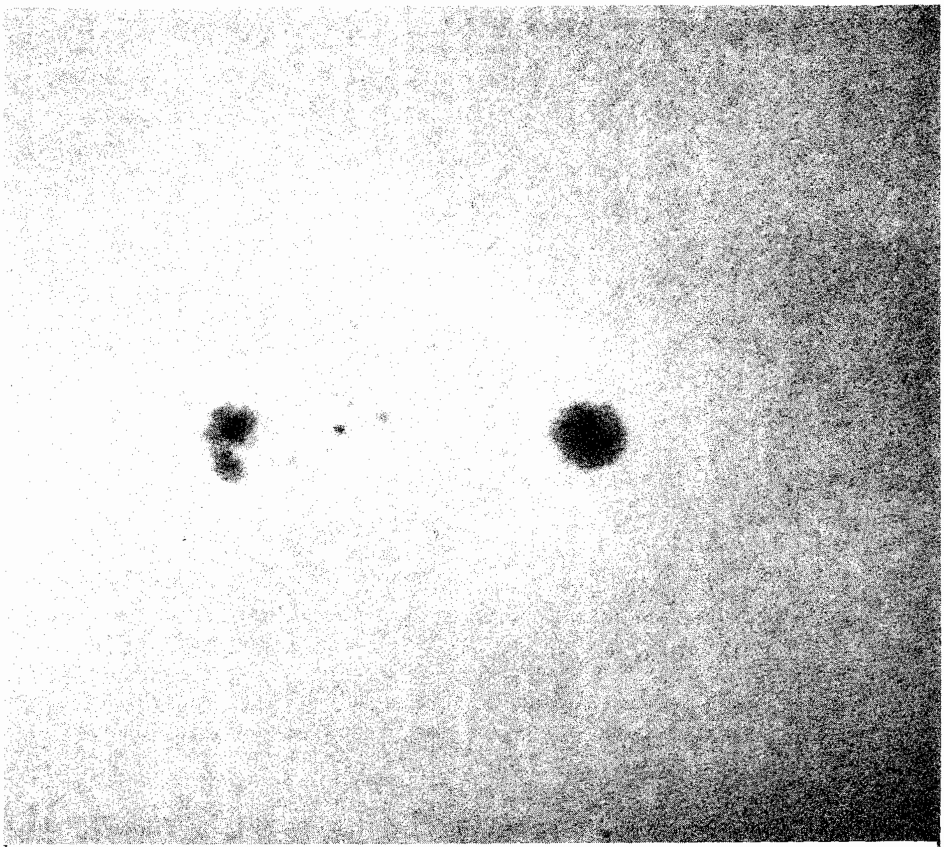

Figure 23. White-light photograph of AR 6122, taken by Gordon Garcia on 1990 JUN 30, 14h 50m UT, using a 20-cm Schmidt-Cassegrain reflector, stopped to 75-mm aperture and using projection with a 30-mm Clave Plössl eyepiece at an effective f/84. 1/500-sec. exposure on Kodak TP 2415 Film with a Tuthill Solar Skreen Filter. Film developed in D19 for 4 minutes at 68°F. North at top, unreversed.

had a distinct white ring surrounding it. The follower now had two parallel rows of 3-4 small umbrae aligned E-W, with penumbrae on the outer edges of each row. To the S of the S row was a detached spot with a rudimentary penumbra. The next day, part of the leader had detached and was now following. The E-W symmetry of the follower was now gone as it was breaking up into a chaos of spots, some with and some without penumbrae, extending over 5 heliocentric degrees. On JUL 24, the leader had developed into two E-W parallel rows of 3-5 umbrae each, all in a large penumbra. This penumbra was ragged on the S side and had some pores following. The detached portion of the previous day was now two umbrae in a rudimentary penumbra. There was little change in the follower, but pores had formed on its W side.

The leader was much the same on 1990 JUL 25, but was somewhat more organized and was still retaining the bright ring. The appearance of AR 6162 on that date is shown well in a high-resolution white-light photograph by Dragesco, reproduced in *Figure 24* (p. 132). The leader was followed by four umbral spots aligned N-S. The detached portion was also similar in appearance to the previous day. However, the follower contained no more than a dozen umbrae in a disorganized penumbra. Some of the umbrae made a N-S sigmoid shape through the center of the collection. On JUL 26, the leader was beginning to show signs of old age, becoming more nearly circular, while the following fragments were gone. The detached spot was dissolving and now consisted of only a few pores surrounding one umbral spot. Significant decay had taken place by JUL 27, with the leader yet more nearly circular and smaller. The bright ring around the leader remained prominent. Meanwhile, the detached spot contained only one umbra with a rudimentary penumbra, along with one pore. The follower was reduced to a SE-NW line of umbrae in a rudimentary penumbra.

The leader had decayed yet more by JUL 28, becoming smaller and more nearly circular, but the bright ring remained the same size as earlier and thus was larger in comparison with the spot. The middle detached piece now was only a naked umbra that had moved closer to the leader. Wreathed in faculae, the follower now consisted of only two umbrae. The decay continued as AR 6162 went around the limb and passed out of sight on 1990 JUL 30.

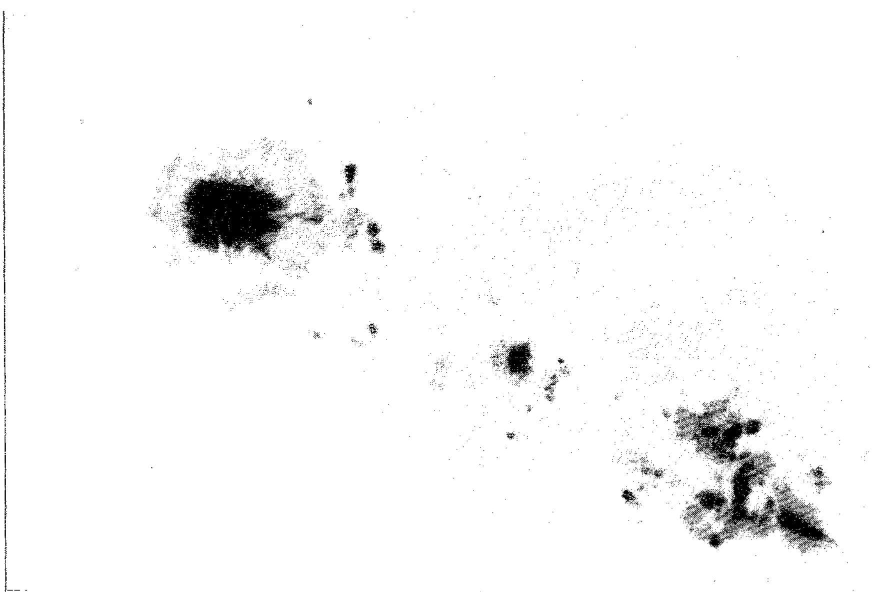

Figure 24. White-light photograph of sunspot group AR 6161, photographed by Jean Dragesco on 1990 JUL 25, 13h 30m UT, using an 18-cm (7-in) refractor. South at top; unreversed.

Rotation 1832 [4,5]
(1990 AUG 04.86 to SEP 01.10)

Sunspot Number	Mean	Maximum (Date)	Minimum (Dates)
RI	207.0	295 (AUG 20)	120 (AUG 07)
RA	201.0	280 (AUG 20)	116 (AUG 06)

A significant increase in solar activity took place during this rotation, in terms of the number of groups and of both forms of Sunspot Number. There were 72 groups seen during the rotation, with many reaching advanced evolutionary stages. Unfortunately, our data file does not reflect this increase because this rotation had the least observations of any in the reporting period! **[5, 6]** Because of the large number of groups, it was impossible to describe the activity of groups or regions separately. Thus this rotational synthesis will include a number of regions.

On 1990 AUG 18, Garcia and Maxson observed a large sunspot, containing several umbrae, on the limb. This was designated **AR 6223**. To its S was **AR 6226**, which was a roughly N-S line of small spots. These two regions looked unremarkable in H-α. When better presented, AR 6223 was seen as a large spot with an organized penumbra, followed by a collection of umbrae with rudimentary penumbrae. The other group, AR 6226, consisted of a large umbra in a disorganized penumbra which was most disturbed on its S. This was followed by 3-4 small spots. On AUG 20, the Sun was littered with spots and groups. AR 6223 now had a leader that was elongated E-W, containing a large umbra that had a very ragged umbral/penumbral border. This was followed by a middle collection of small umbrae with rudimentary penumbrae in a N-S line. The follower held three N-S aligned umbrae in a fragmentary penumbra. AR 6226, still to the S of AR 6223, had a leader with a moderate-sized umbra led by a smaller umbra, all within rudimentary penumbrae. This group had also developed a middle collection of spots in the form of two umbrae aligned E-W in a rudimentary penumbra. The following spot was similar to the middle spot. To the S and following, another group had developed; **AR 6227**, which consisted only of several spots. It will not be described in detail here.

AR 6223 had matured by AUG 21. The leader that was a large umbra in a radially symmetrical penumbra that was breaking up on the following side. Although smaller than before, the middle spots had changed little. The follower had evolved into one umbra in a penumbra, with additional umbrae in a rudimentary penumbra arcing to the N and one small umbra in a similar penumbra to the S. Meanwhile, AR 6226 was growing rapidly and had changed completely. No longer was there a clearly-defined leader and follower. To the N was a row of umbrae arranged like a letter "Y" on its side and opening to the W. This was in a penumbra that was larger on the S. To the S was one large umbra leading, and two close together following, connected by tiny umbrae in rudimentary penumbrae. These two spots were then followed by AR 6227 and **AR 6230**, spanning a large portion of the disk. On AUG 22, the leader of AR 6223 remained much the same, while the middle collection had only a few pores. The follower also had undergone decay, and was then only a large umbra with rudimentary penumbrae surrounded by some pores. In AR 6226, the N and S spots had merged, with the N holding two large umbrae and the S a single large umbra.

Following this were two large umbrae, both immersed in one serpentine mass of disorganized penumbra.

We have a hiatus in our data for AUG 23; but on the next day, with AR 6223 on the central meridian, the umbra in the leader had formed a tail on the following side. The penumbra on that side was disturbed, and was flanked by a profusion of tiny umbrae and pores in a chaos of penumbrae. A row of these pores pointed back to the follower, which consisted of a large umbra with an organized penumbra on all but its leading side. Meantime, AR 6226 had completely changed again! Now it had a leader, the former N spot, consisting of an umbra in an organized penumbra. This was followed by about a dozen small umbrae in a sprawling mass of penumbra, with a small chain of tiny umbrae connecting this feature to the follower. The follower itself was made up of two large umbrae with a penumbra only on their following side. The appearance of the Sun at this time defies description. Along with AR 6227, AR 6230, and **AR 6235**, this chain of activity spanned half the Sun's disk!

By AUG 25, the leader of AR 6223 had developed some small spots on its following side and its tail was now arcing S. The middle spots were gone, and the follower was now only two umbrae with a light bridge dividing it into N and S components. There were also several umbral spots around the follower. AR 6226 was more complex, but less than it had been on the previous day. Its leader was a circular spot with a large umbra in a penumbra that was ragged on its following side. Following this, the middle collection was a group of smaller umbrae in a symmetrical penumbra, followed itself by a half-dozen umbrae in a dissolving penumbra. The follower was a large umbra in an organized penumbra. The decay of AR 6223 continued on AUG 26 with the leader made up of a large umbra with its E appendage surrounded by penumbra that was wider around the appendage. This was followed by two spots, which were remnants of the split follower, which itself was followed by two small spots in a rudimentary penumbra. Still to the S, AR 6226 had a leader that was a large triangular umbra pointing E, with a penumbra that was large on the E and with a tail pointing S toward several small umbrae in rudimentary penumbrae. In the middle was a collection of medium-sized umbrae in a symmetrical penumbra, followed by a N-S line of minute umbrae in a highly-disorganized penumbra. Also triangular in shape, the follower was a single umbra in a penumbra.

AR 6223 and AR 6226 were much the same on AUG 27, with most of their spots reduced in area. These two regions, along with **AR 6228**, AR 6227, and AR 6230, formed two parallel lines of spots that spanned an entire quadrant of the Sun's disk. On AUG 28, AR 6223 was one large spot with a penumbra, still ragged on its E, followed by small spots with a rudimentary penumbra. AR 6226 remained much as before, except that its follower was only a few tiny umbrae in rudimentary penumbrae. Both regions were observed on the next day as they were leaving the disk, and both had changed only in that all their spots had reduced in size.

CONCLUSION

After submitting the previous two reports [*J.A.L.P.O.*, *35*, No. 1 (March, 1991), 31-37; *34*, No. 4 (November, 1990), 170-176], I received observations that filled some of their gaps in coverage. It would have been very helpful to have had these in hand when the reports were being prepared! We strongly encourage all our observers to turn in their observations as soon as possible after making them. Often we receive requests for observations within about a week after a solar event. If critical observations are withheld for some months, they often cannot be used by the very researchers whom we wish to aid.

Also, there has been a question about the nature of the regions that are described in these reports. It has been noticed that there appears to be a tendency for each region's maximum development to occur as it crosses the central meridian, and for decay to be well underway as the region passes behind the limb. The question is, could this be due to an observational effect, perhaps similar to the Wilson Effect? That is, might it be due to our observational perspective? Actually, no. The "effect" is much simpler than that, and is human-caused. First, I try to select sunspot groups that go through a development cycle in plain view as they cross the disk, although this cannot always be done, and in addition are well-observed by Section members. Second, observers tend to concentrate upon groups that achieve their maximum development near the time of their central-meridian passage. Because the vast majority of sunspot groups endure for less than one rotation, it necessarily follows that we would see decay as they leave the disk! So for the most part, the observed effect is a selection effect.

Finally, the decrease in the number of observers is disturbing at a time when sudden increases in activity may still take place. While everyone enjoys observing a Sun that is littered with spots, the fact remains that noting a lack of activity and making careful observations of faculae, which are often precursors of an outburst of activity, are very important. As has been frequently said in our Section: no matter what equipment you have, or how little time available, get out and observe!

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2.) ________, No. 551, July, 1990.
3.) ________, No. 552, August, 1990.
4.) ________, No. 553, September, 1990.
5.) ________, No. 554, October, 1990.
6.) ________, No. 555, November, 1990.

Meteors Section News

By: Robert D. Lunsford, A.L.P.O. Meteors Recorder

Spring, 1991, Summary

We express many thanks to all those who observed meteors during the slow Spring season. It is often quite tedious to observe and to be rewarded with only 2 or 3 meteors per hour. Several minor showers were observed during this period, including the Delta Leonids, Virginids, Delta Draconids, Alpha Boötids, Ophiuchids, Alpha Scorpiids, and the elusive Kappa Serpentids. The only major shower that was free from lunar interference was the Lyrids. A.L.P.O. observers counted 20 Lyrid shower members during a total of 14h 40m of observing. This is not an impressive rate, and implies that the shower is weak when seen away from the maximum night of April 22nd. [The "Coming Solar System Events" article discusses upcoming meteor showers on pp.139-140.]

Meteors Section Newsletter

After communicating with many of the contributing members of the Meteors Section, I have decided to publish an informal newsletter commencing with the 1991 A.L.P.O. Yearly Review in February, 1992. The articles that appear in *J.A.L.P.O.* are intended for the general readership and are thus designed to explain meteor activity to people who may or may not be interested in observing meteors personally. I envision our newsletter as a source of detailed information for minor showers, peculiar activity, and observing techniques and aids. I also hope that our observers will contribute articles that treat our field from more than one point of view. Those interested in receiving the newsletter should send this Recorder (address on inside back cover) four self-addressed stamped envelopes by January, 1992.

Recent Meteor Observations

Table 1, below, summarizes the observations made between 1991 MAR 06 and MAY 17 which have been received at the time of writing (July 27, 1991).

Table 1. Recent A.L.P.O. Meteor Observations.

1991 UT Date	Observer and Location	Universal Time	Number and Type of Meteors Seen*	Comments* (+N = Limiting Magnitude)
MAR 06	John Gallagher, NJ	01:45-03:15	4 SP	+4.5
08	John Gallagher, NJ	01:40-03:10	4 SP	+5.0
09	John Gallagher, NJ	01:35-03:40	1 δ Leo; 5 SP	+5.2
	Mark Davis, VA	04:15-05:15	1 Vir; 5 SP	+5.3
10	John Gallagher, NJ	01:20-03:20	2 SP	+5.0
12	John Gallagher, NJ	02:00-03:30	1 δ Leo; 2 SP	+5.2
16	Mark Davis, VA	04:08-05:08	1 Vir; 6 SP	+5.3
	" " "	05:08-06:08	1 Vir; 5 SP	+5.3
17	Leonard Tomko, PA	01:43-03:20	(none seen)	+4.5
	John Gallagher, NJ	06:18-07:03	1 SP	+5.2
20	Mark Davis, VA	04:00-05:00	8 SP	+5.6
21	John Gallagher, NJ	04:06-05:06	4 SP	+4.3
APR 04	Leonard Tomko, PA	01:37-03:12	(none seen)	+4.5; 20% cloudy
05	John Gallagher, NJ	04:15-05:46	1 Vir; 1 κ Ser; 1 SP	+5.0; 10% cloudy
11	John Gallagher, NJ	03:38-05:34	3 δ Dra; 1 Vir; 4 SP	+5.2
12	John Gallagher, NJ	04:15-06:15	1 δ Dra; 1 κ Ser; 7 SP	+5.6
13	John Gallagher, NJ	03:38-05:38	6 SP	+5.5
16	Mark Davis, VA	07:30-08:30	3 Lyr; 8 SP	+6.0
	" " "	08:30-09:30	10 SP	+6.0
17	Mark Davis, VA	07:03-08:03	3 Lyr; 8 SP	+5.5
	" " "	08:03-09:03	2 α Sco; 4 SP	+5.5
18	Kristine Larsen, CT	02:00-05:00	4 SP	+4.5
	J. Kenneth Eakins, CA	07:31-09:31	4 SP	+5.4

------------ *Table 1 continues on p. 135 with notes* ------------

Table 1—Continued.

1991 UT Date	Observer and Location	Universal Time	Number and Type of Meteors Seen*	Comments* (+N = Limiting Magnitude)
APR 22	Roger Venable, GA	06:32-06:47	3 Lyr; 3 SP	+6.0
	J. Kenneth Eakins, CA	08:00-11:00	7 Lyr; 4 SP	+5.4
23	George Gliba, MD	07:22-08:22	4 Lyr; 6 SP	+5.4
24	Leonard Tomko, PA	02:20-03:45	(none seen)	+3.5; 20% cloudy
MAY 03	Kristine Larsen, CT	02:00-03:00	1 α Boö; 2 SP	+5.0
15	Mark Davis, VA	07:00-08:00	1 Oph; 6 SP	+5.5
	" " "	08:00-09:00	1 Oph; 8 SP	+5.5
16	Mark Davis, VA	07:00-08:00	6 SP	+5.5
	" " "	08:00-09:00	1 Oph; 5 SP	+5.5
17	Mark Davis, VA	07:00-08:00	1 Oph; 6 SP	+5.4
	" " "	08:00-09:00	6 SP	+5.4

*Notes for *Table 1:* α Boö = Alpha Boötid; α Sco = Alpha Scorpiid; δ Dra = Delta Draconid; δ Leo = Delta Leonid; κ Ser = Kappa Serpentid; Lyr = Lyrid; Oph = Ophiuchid; SP = Sporadic; Vir = Virginid.

COMET CORNER

By: Don E. Machholz, A.L.P.O. Comets Recorder

COMET FINDS FOR THE FIRST HALF OF 1991

Ten new comets were discovered, and eight returning comets were recovered, during the first half of 1991. The year started with a large number of discoveries and recoveries, a pattern which also occurred in 1987 and 1989. Activity then slowed down in April and May, only to pick up again in June. The new comets for 1991, as of the date of writing (August 17), are described below:

Periodic Comet Metcalf-Brewington (1991a).—Howard Brewington of New Mexico discovered this comet on 1991 JAN 06 with a 16-inch (41-cm) reflector. This find came after 165 hours of sweeping since Howard's previous find 14 months before. When discovered, Comet 1991a was in the evening sky at magnitude +9.

When this comet's orbit was determined, it was discovered that it is the same as Periodic Comet Metcalf, discovered in 1906 and not seen since. Its orbital period is 7.76 years, but apparently it has remained quite faint. It must have flared shortly before its recovery because photographs taken on JAN 05.5 show it at magnitude +15. In the hours after Brewington found it, T. Kiuchi of Japan, L. Boethin of the Philippines, and William Bradfield of Australia also spotted the comet.

This comet stayed in the evening sky, dimming by a magnitude a month for the next three months.

Comet Arai (1991b).—Masaru Arai of Japan photographically discovered this comet on JAN 05 at magnitude +10.5, a few degrees from Jupiter and the star cluster M44. It was closest to the Sun a month earlier, at 1.4 AU [Astronomical Unit; 1 AU = 149,597,870 km]. Following discovery, it headed toward the celestial north polar region as it dimmed.

Periodic Comet Swift-Gehrels (1991c).- T. Seki of Japan recovered this comet on JAN 07 at magnitude +17. It has an orbital period of 9 years and did not get much brighter than its recovery magnitude.

Comet Shoemaker-Levy (1991d).—The team of Carolyn and Eugene Shoemaker and David Levy discovered this comet as part of the Earth-crossing comet/asteroid discovery program at Palomar Mountain. This comet was magnitude +15 when it was found on JAN 22. It may reach magnitude +12 when it approaches within 2.2 AU of the Sun late this year.

Periodic Comet Shoemaker-Levy 3 (1991e).—The same team that discovered Comet 1991d recovered this comet on FEB 07 at magnitude +16. It was closest to the Sun in December, 1990, at 2.8 AU, with an orbital period of 7.2 years.

Periodic Comet Shoemaker-Levy 4 (1991f).—This was the third find by this team, on FEB 09 at magnitude +17. The comet takes 6.5 years to complete an orbit and was closest to the Sun in July, 1990 at 2.02 AU.

Comet McNaught-Russell (1991g).—Robert McNaught found this comet on a plate that was taken by Kenneth Russell on FEB 12. The comet was closest to the Sun in October, 1990 at a distant 4.8 AU and continues to remain faint.

Periodic Comet Takamizawa (1991h).—Assistant A.L.P.O. Comets Recorder Jim Scotti recovered this comet from Kitt Peak on FEB 17. This strange comet was discovered in 1984 after an outburst; and, on its current passage, was closest to the Sun on 1990 AUG 17 at 1.6 AU. If it behaves "normally," it will be at magnitude +14, but may get much brighter if it outbursts.

Periodic Comet Kowal (1991i).—Jim Scotti recovered this comet on FEB 21. Its orbital period is 15 years, and its perihelion is a distant 4.7 AU. It will remain faint.

Periodic Comet Hartley 1 (1991j).—This began as a "new" comet discovery by the Shoemakers and David Levy on MAR 12. However, calculations showed this to be Periodic Comet Hartley 1, showing up 20 days late and 16 degrees from the predicted position. It too will remain faint.

Periodic Comet Mrkos (1991k).—Anton Mrkos of Czechoslovakia photographed this, his thirteenth comet, on MAR 16. The comet was closest to the Sun at 1.41 AU in the previous month and got no brighter than magnitude +13.

Comet Helin-Lawrence (1991L).—Eleanor Helin, Kenneth Lawrence, and P. Rose used the 18-in (46-cm) Palomar Schmidt to discover this comet on MAR 17. It will be closest to the Sun in early 1992 when it should attain magnitude +9 and be visible to amateurs in the Southern Hemisphere.

Periodic Comet Giacobini-Zinner (1991m).—K. Meech and W. Weller recovered this comet at a very faint magnitude +22. Perihelion will occur behind the Sun next year, so this comet will not become very bright.

Periodic Comet Faye (1991n).—T. Seki of Japan recovered this comet in the morning sky on APR 16. It has a 7.4-year orbital period, with this return being favorable. The comet should be visible in our telescopes this autumn.

Periodic Comet Chernykh (1991o).—Jim Scotti and D. Rabinowitz recovered this comet on JUN 08. It was then magnitude +19 and should not get brighter than magnitude +13.

Periodic Comet Shoemaker 1 (1991p).—P. Kilmartin and Alan Gilmore of New Zealand recovered this comer on JUN 08. This is its first passage since discovery in 1984, and it should not get brighter than magnitude +12.

Periodic Comet Levy (1991q).—David Levy of Tucson, past A.L.P.O. Comets Recorder, discovered this comet not far from the galaxy M74 on the morning of June 14. Its magnitude at discovery was +8.6. He was using his 16-in (41-cm) reflector and had swept for 81 hours since his last previous visual find 13 months before.

Suggestions that it had outburst shortly before discovery were strengthened when it was determined that this is a periodic comet, perhaps not seen since 1499. The orbital period is roughly 50 years. The comet stayed in the morning sky, dimming over the next few months.

Comet Helin-Alu (1991r).—Eleanor Helin and Jeff Alu discovered this comet from Palomar Mountain on JUN 13. It will be closest to the Sun early in 1992 at a distant 4.9 AU, and should remain fainter than magnitude +15.

PRESENT COMET ACTIVITY

During late 1991 and early 1992, these particular comets will be visible in our skies. Their ephemerides are given below on page 137. [There, of course,is always the possibility of new discoveries! Ed.] Please send observations of them to this Recorder (address on inside back cover).

Periodic Comet Schwassmann-Wachmann 1.—This comet will occasionally outburst by several magnitudes; in early August, 1991, it attained magnitude +12. It is in a near-circular 15-year orbit more than 5 AU from the Sun. Please report all positive *and negative* observations to this Recorder. [*Table 1*, p. 137]

Periodic Comet Hartley 2 (1991t).—This comet will be at perihelion on 1991 SEP 12 at 0.95 AU. With an orbital period of 6.3 years, it is making its first predicted return. [*Table 2*, p. 137]

Periodic Comet Wirtanen (1991s).—Discovered from Lick observatory in 1948, this comet orbits the Sun every 5.5 years. It will be closest to the Sun on 1991 SEP 20 at 1.08 AU. [*Table 3*, p. 137]

Periodic Comet Faye (1991n).—This is an old periodic comet, taking 7.4 years to orbit the Sun. It will be at perihelion on 1991 NOV 16 at 1.59 AU, well-placed for observation. [*Table 4*, p. 137]

Comet Helin-Lawrence (1991L).—This comet is moving south and should be visible for the first half of 1992. It may become brighter than suggested here, and observers are asked to record and submit observations in order to establish a long observational arc. We especially need the help of observers in the Southern Hemisphere. [*Table 5*, 137]

Notes: In the "Elongation. from Sun" column, E refers to visibility in the evening sky, and M to morning visibility. "Total Mag." values are forecasts of visual total magnitudes and are subject to considerable uncertainty.

Table 1. Ephemeris of Periodic Comet Schwassmann-Wachmann 1.

1991 UT Date	2000.0 Coörd. R.A.		Decl.		Elongation from Sun		Total Mag.
(0h UT)	h	m	°	'	°		
Oct 01	03	48.0	+30	35	125	M	+17.3
06	03	46.9	+30	39	130	M	+17.2
11	03	45.5	+30	41	135	M	+17.2
16	03	43.9	+30	42	140	M	+17.2
21	03	42.0	+30	41	145	M	+17.2
26	03	39.9	+30	39	151	M	+17.2
31	03	37.5	+30	35	156	M	+17.2
Nov 05	03	35.1	+30	30	160	M	+17.2
10	03	32.5	+30	23	164	M	+17.1
15	03	29.9	+30	15	168	M	+17.1
20	03	27.2	+30	05	169	M	+17.1
25	03	24.6	+29	54	168	E	+17.1
30	03	22.0	+29	43	164	E	+17.1
Dec 05	03	19.6	+29	30	160	E	+17.2
10	03	17.4	+29	17	155	E	+17.2
15	03	15.3	+29	04	150	E	+17.2
20	03	13.5	+28	51	145	E	+17.2
25	03	12.0	+28	38	139	E	+17.2
30	03	10.7	+28	25	134	E	+17.3

Table 2. Ephemeris of Periodic Comet Hartley 2 (1991t).

1991 UT Date	2000.0 Coörd. R.A.		Decl.		Elongation from Sun		Total Mag.
(0h UT)	h	m	°	'	°		
Oct 01	08	37.5	+15	08	060	M	+10.5
06	08	54.0	+13	08	060	M	+10.6
11	09	09.2	+11	11	061	M	+10.8
16	09	23.2	+09	18	062	M	+11.0
21	09	36.2	+07	30	064	M	+11.2
26	09	48.2	+05	47	065	M	+11.4
31	09	59.2	+04	08	067	M	+11.6
Nov 05	10	09.2	+02	35	069	M	+11.8
10	10	18.4	+01	06	071	M	+11.9
15	10	26.7	-00	17	074	M	+12.1
20	10	34.1	-01	35	077	M	+12.3
25	10	40.6	-02	48	080	M	+12.4
30	10	46.2	-03	56	083	M	+12.6

Table 3. Ephemeris of Periodic Comet Wirtanen (1991s).

1991 UT Date	2000.0 Coörd. R.A.		Decl.		Elongation from Sun		Total Mag.
(0h UT)	h	m	°	'	°		
Oct 01	09	14.7	+17	16	052	M	+10.1
06	09	35.1	+16	36	052	M	+10.1
11	09	54.7	+15	50	052	M	+10.2
16	10	13.5	+15	00	052	M	+10.3
21	10	31.5	+14	08	053	M	+10.4

(Continued in right column.)

Table 3—Continued.

1991 UT Date	2000.0 Coörd. R.A.		Decl.		Elongation from Sun		Total Mag.
(0h UT)	h	m	°	'	°		
Oct 26	10	48.6	+13	14	054	M	+10.5
31	11	05.0	+12	19	055	M	+10.6
Nov 05	11	20.6	+11	25	056	M	+10.8
10	11	35.4	+10	33	057	M	+10.9
15	11	49.4	+09	42	059	M	+11.0
20	12	02.8	+08	53	061	M	+11.1
25	12	15.4	+08	08	062	M	+11.3
30	12	27.3	+07	26	065	M	+11.4
Dec 05	12	38.5	+06	48	067	M	+11.5
10	12	49.1	+06	15	069	M	+11.6
15	12	58.9	+05	45	072	M	+11.7
20	13	08.1	+05	21	074	M	+11.9
25	13	16.5	+05	01	077	M	+12.0
30	13	24.2	+04	47	081	M	+12.1

Table 4. Ephemeris of Periodic Comet Faye (1991n).

1991 UT Date	2000.0 Coörd. R.A.		Decl.		Elongation from Sun		Total Mag.
(0h UT)	h	m	°	'	°		
Oct 01	01	43.4	+12	13	159	M	+10.5
06	01	45.2	+11	13	164	M	+10.4
11	01	46.5	+10	07	169	M	+10.3
16	01	47.5	+08	55	174	M	+10.2
21	01	48.3	+07	40	177	M	+10.1
26	01	49.0	+06	25	174	E	+10.0
31	01	49.8	+05	12	169	E	+10.0
Nov 05	01	50.9	+04	06	164	E	+10.0
10	01	52.4	+03	07	159	E	+10.0
15	01	54.4	+02	17	154	E	+10.1
20	01	56.9	+01	38	149	E	+10.1
25	02	00.2	+01	10	145	E	+10.2
30	02	04.0	+00	54	141	E	+10.3
Dec 05	02	08.6	+00	48	137	E	+10.4
10	02	13.8	+00	52	133	E	+10.5
15	02	19.5	+01	06	129	E	+10.7
20	02	25.9	+01	27	126	E	+10.8
25	02	32.8	+01	56	123	E	+11.0
30	02	40.2	+02	30	120	E	+11.1

Table 5. Ephemeris of Comet Helin-Lawrence (1991L).

1991 UT Date	2000.0 Coörd. R.A.		Decl.		Elongation from Sun		Total Mag.
(0h UT)	h	m	°	'	°		
Oct 31	12	25.8	-31	43	032	M	+11.4
Nov 05	12	30.4	-34	14	034	M	+11.2
10	12	35.2	-36	56	037	M	+11.1
15	12	40.4	-39	50	040	M	+10.9
20	12	45.8	-42	59	043	M	+10.7
25	12	51.8	-46	23	046	M	+10.6
30	12	58.5	-50	03	048	M	+10.4
Dec 05	13	06.1	-54	02	052	M	+10.3
10	13	15.1	-58	20	054	M	+10.1
15	13	26.4	-62	56	056	M	+10.0
20	13	41.8	-67	49	058	M	+9.8
25	14	05.1	-72	55	060	M	+9.7
30	14	47.0	-78	03	061	M	+9.6

COMING SOLAR-SYSTEM EVENTS: SEPTEMBER-NOVEMBER, 1991

WHAT TO LOOK FOR

The purpose of this column is to alert our readers about upcoming events in the Solar System; giving the visibility conditions for major and minor planets, the Moon, comets, and meteors. You can find more detailed information in the 1991 edition of the *A.L.P.O. Solar System Ephemeris*. (See p. 144 to find out how to obtain this publication.) Celestial directions are abbreviated. All dates and times are in Universal Time (UT). For the time zones in the United States, UT is found by adding 10 hours to HST (Hawaii Standard Time), 9 hours to AST (Alaska Standard Time) or HDT (Hawaii Daylight Time), 8 hours to PST or ADT, 7 hours to MST or PDT, 6 hours to CST or MDT, 5 hours to EST or CDT, and 4 hours to EDT. Note that this addition may put you into the next UT day!

MORNING AND EVENING PLANETS

The conditions for viewing the planets have changed considerably in recent months. Now, only three planets are conveniently placed in the evening sky—Saturn, Uranus, and Neptune. Except occasionally for Mercury, the remaining observable planets are in the morning sky.

Saturn, in Capricornus, is undoubtedly the most conveniently observable planet, near the meridian as evening twilight ends. Now past opposition, the Ringed Planet is dimming slightly from Mag. (magnitude) +0.3 to Mag. +0.7. It is also shrinking slightly in apparent size with its *Globe's* equatorial diameter diminishing from 18 to 16 arcseconds and the *Rings* major axis shrinking from 41 to 36 arcseconds. The Rings continue well-presented, and their inclination to our line of sight continues to be near 21° in this period.

Uranus and **Neptune** remain somewhat west of Saturn, in Sagittarius. Uranus, at Mag. +5.7-5.8, should be visible to the naked eye under good conditions. Neptune will be a binocular object at Mag. +7.9-8.0. **Pluto** is unobservable, reaching *conjunction* with the Sun on NOV 13.

Mercury oscillates from the morning sky in September to the evening sky in October and November. Its best visibility period, favoring our Southern Hemisphere, is centered on its *Greatest Eastern Elongation* (maximum angular distance from the Sun) of 22°.4 on NOV 19. The innermost planet is more than 15° from the Sun during OCT 28-DEC 01.

Venus pulls rapidly away from the Sun in the morning sky. It was in conjunction with the Sun on AUG 22, but reaches Greatest Western Elongation on NOV 02, 46°.5 from the Sun. Another important Cytherean (adj. of Venus) date is SEP 28, its theoretical greatest brilliancy at Mag. -4.6. Also, during SEP 01-DEC 01, its disk diameter shrinks from 56 to 18 arc-seconds while its phase grows from 4 to 64 percent illuminated. Note that *dichotomy*, predicted half phase, occurs on NOV 02; try estimating Venus' apparent phase for about a week on either side of that date.

Jupiter, in Leo, begins this period too close to the Sun to observe. By October, however, it can be found low in the east during morning twilight, and it moves gradually higher in the sky in November. The Giant Planet's brightness increases from Mag. -1.8 in September to -2.1 by the end of November, while the equatorial diameter of its disk increases from 31 to 37 arc-seconds. The unusual *mutual events* of the Galilean satellites are continuing, with a schedule given on p. 140.

Mars is essentially unobservable because it is never more than 22° from the Sun throughout this three-month period. The Red Planet is in conjunction with the Sun on NOV 08, and indeed will be occulted by the solar disk (an event that we unfortunately cannot see).

PLANET-PLANET AND PLANET-STAR CONJUNCTIONS

There are three conjunctions on SEP 10 involving Jupiter, Mercury, Mars, and Regulus. Then, in October and November, three planet and three stars will be involved in mutual conjunctions.

- OCT 08, 04h. **Venus** (Mag. -4.5) passes 3°S of **Regulus** (Mag. +1.3). Both are 44° W of the Sun.
- OCT 17, 03h. **Venus** (Mag. -4.5) passes 2°S of **Jupiter** (Mag. -1.9) when 45° W of the Sun.
- NOV 11, 07h. **Mercury** (mag. -0.3) passes 2°N of **Antares** (Mag. +0.9), 21°E of the Sun.
- NOV 29, 09h. **Venus** (mag. -4.2) passes 4° N of **Spica** (Mag. +1.0), 45°W of the Sun.

MINOR PLANETS

Just two of the brightest **minor planets** reach opposition in our period. Their 10-day ephemerides are given in the 1991 *A.L.P.O. Solar System Ephemeris*, but their opposition circumstances are summarized below:

	Opposition Data		
Minor Planet	1991 Date	Stellar Magnitude	Declination& Constellation
7 Iris	SEP 04	+7.5	5°N Psc
324 Bamberga	SEP 08	+8.1	3°N Psc

Besides the objects above, all "Big Four" minor planets, **1 Ceres, 2 Pallas, 3 Juno,** and **4 Vesta,** will be brighter than Mag. +10 during at least part of the current period.

THE MOON

During the current period, the schedule for the Moon's **phases** is:

New Moon	First Quarter	Full Moon	Last Quarter
SEP 08.5	SEP 15.9	SEP 23.9	OCT 01.0
OCT 07.9	OCT 15.7	OCT 23.5	OCT 30.3
NOV 06.5	NOV 14.6	NOV 22.0	NOV 28.6

The three lunations above are Numbers 850-852 in Brown's series.

The other significant lunar visibility condition is the Moon's **librations**, or E-W and N-S tilts in relation to the Earth. Extreme librations occur on the following dates:

West	South	North	East
AUG 29	AUG 29	SEP 11	SEP 12
SEP 24	SEP 25	OCT 08	OCT 09
OCT 21	OCT 22	NOV 04	NOV 05
NOV 18	NOV 19	DEC 01	DEC 02

Lunar E and W directions here follow the usage of the International Astronomical Union, with Mare Crisium near the *east* limb. The SW limb can be seen favorably on SEP 23-26, OCT 22-25, and NOV 21-23. The NE limb is presented well on SEP10-11, OCT 10-11, and NOV 08-09. Because the Sun's declination, as seen from the Moon, will be at its farthest south in mid-October, the period of high southerly libration on OCT 20-25 will be very favorable for viewing the Moon's South Polar Region.

PLANETARY AND LUNAR OCCULTATIONS

Nine minor planets will occult stars in 1991 SEP-NOV, as shown in *Table 1* below which lists the date, occulting object, visual magnitude of planet followed by that of the star, and *possible* zone of visibility for each occultation. Note that a naked-eye star is occulted in the NOV 30 event.

As for lunar occultations. the Moon passes in front of bright planets twice during the period covered here. The first such event is an **occultation of Venus by the Moon** on OCT 04, 15h, visible from S and W South America. At that time Venus will be at magnitude -4.5, 42° W of the Sun.

The second event is a **lunar occultation of Mercury** on NOV 08, 04h, unfortunately visible only from the S Indian Ocean and the SW Pacific Ocean. The only land visibility will be from S New Zealand, with the magnitude -0.3 planet 20°E of the Sun.

Although the Moon occults no bright stars during 1991 SEP-NOV, the series of passages of the Moon across the **Pleiades** open star cluster (M45) continues with these events: **SEP 01**, 03h, 57-percent sunlit Moon, visible from Africa; **SEP 28**, 09h, 79-percent phase, from South America; **OCT 25**, 14h, 94-percent phase, from Australia and New Zealand; and **NOV 22**, 00h, 100-percent sunlit Moon, visible from South America and S Africa.

COMETS

Several telescopic comets will be visible; including Periodic Comets Schwassmann-Wachmann 1, Hartley 2, Wirtanen, and Faye; and Comet Helin-Lawrence (1991L). For more information, see the article by Don E. Machholz, "Comet Corner," on pp. 135-137.

METEOR SHOWERS

(Contributed by Robert D. Lunsford, A.L.P.O. Meteors Recorder)

The Fall season offers an unhampered view of the **Taurid** complex and of the strong **Geminids**. All other major showers suffer from lunar interference to some degree.

An interesting shower could occur on the night of October 8-9. With Comet Giacobini-Zinner arriving at perihelion next year, there could be an increase in rates for the October **Draconids** (also known as the Giacobinids). Do not expect much of a display because better circumstances in the past have produced minimal results. To observe this shower, face northward immediately following the end of evening twilight on October 8th, local time, and watch for faint meteors radiating from the head of Draco.

This is a good year to introduce yourself to the **Taurid** complex. Both Taurid showers produce slow and often brightly-colored mete-

Table 1. Occultations of Stars by Minor Planets, 1991 SEP - NOV.

1991 U.T. Date	Occulting Object	Visual Magnitudes		Predicted Visibility Zone
SEP 10.56	**536 Merapi**	+13.2	+7.0	Indonesia, Hawaii; SW U.S.A.?
OCT 13.54	**386 Siegena**	+13.4	+8.4	NW U.S.A.; SW U.S.A., Baja California?
OCT 15.23	**44 Nysa**	+10.7	+8.4	SE U.S.A., N Spain
OCT 15.91	**471 Papagena**	+11.0	+8.3	Indonesia
OCT 17.59	**387 Aquitania**	+11.5	+8.6	N Australia
OCT 18.46	**39 Laetitia**	+11.3	+8.2	SE Asia
NOV 01.13	**363 Padua**	+13.2	+8.2	Africa, South America
NOV 02.99	**796 Sarita**	+11.3	+9.5	SE U.S.A., Africa
NOV 30.52	**6 Hebe**	+9.4	+5.9	Central U.S.S.R.

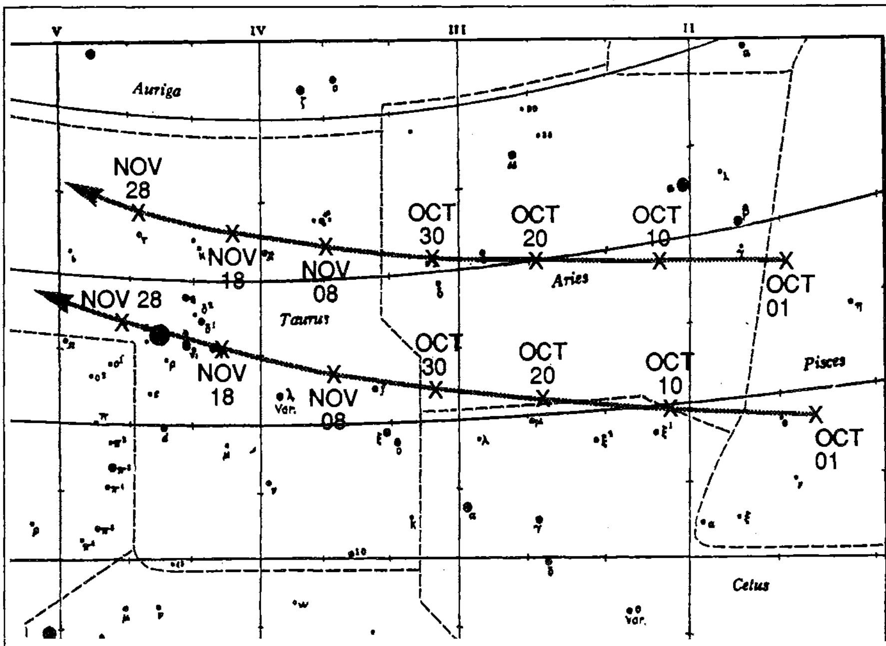

Figure 25. Paths of the radiants of the North Taurids and the South Taurids during October and November, 1991. Background chart courtesy of the American Meteor Society.

ors during October and November. This is also a good opportunity to sharpen your skills in plotting meteor paths. The two Taurid radiants are difficult to distinguish unless you face the Taurus region and are able to trace the path of each meteor. Taurid charts are available from the Meteors Recorder (address on inside back cover), and a sample chart with the paths of the two radiants plotted is shown above in *Figure 25*. The **North Taurids** reach maximum activity on November 13th, while the **South Taurids** have a November 3rd maximum. The southern branch is usually the more active radiant, producing 5-10 meteors per hour at best. The northern branch is usually limited to 5 meteors per hour at the most.

The **Orionids**, which peak on OCT 21.5, are spoiled by a Full Moon. The **Leonids**, which have their maximum on NOV 17.2, also suffer from moonlight; in this case, from a waxing gibbous Moon. However, observers can watch for Leonid activity for an hour or two after moonset between November 14th and 19th. Last year, A.L.P.O. observers witnessed equally strong rates on the 17th and the 18th. Your observations will help to determine this year's date of maximum.

Extending our forecast into December, the **Geminids** occur under favorable conditions, as they did last year. Activity may be seen between December 3rd and the 17th. The maximum will occur on the night of the 13th-14th, with more than 100 meteors per hour being visible from a dark-sky site. The strongest rates usually occur between 1 AM and 2 AM local time, when the radiant is near overhead for Northern-Hemisphere observers. The first-quarter Moon sets near midnight on the night of maximum. Many astronomers predict this shower's demise within the next few decades. Your observations can help determine whether or not the strongest of present showers will be around to entertain our children.

The final major shower of 1991 is the **Ursids**, peaking on DEC 22, unfortunately only two days after Full Moon.

GALILEAN SATELLITE MUTUAL EVENTS

Jupiter's four Galilean satellites continue to eclipse and to occult each other, with the following events scheduled for Fall, 1991:

U.T. Date	Event Type	U.T. Begin	U.T. End	DL	R
1991					
0903	1E3P	1915	1918	00	05
0903	1O3P	2002	2004	00	05
0907	3E2P	1724	1744	100	09
0907	3O2T	1848	1904	36	09
0914	3E2P	2119	2136	97	09
0914	3O2P	2303	2315	25	09
0922	3E2P	0104	0117	53	09
0922	3O2P	0311	0312	00	09
0929	3E2P	0443	0452	09	09
1006	3E2P	0819	0821	00	09
1103	3E1P	0806	0821	05	00

For an explanation of the above table and information on observing these events, see pages 84-85 of the previous issue (Vol. 35, No. 2; June, 1991).

Minutes of the 1991 A.L.P.O. Board Meeting, La Paz, Baja California Sur, Mexico, July 10, 1991

Minutes taken by: Elizabeth W. Westfall, Secretary

The A.L.P.O. Board of Directors Meeting was held in La Paz, Baja California Sur, Mexico, as part of our 41st Convention, which itself was held jointly with the "Symposium for Research Amateur Astronomy" (SRAA). The Meeting was called to order by the Chairman of the Board, John E. Westfall, at 12:20 PM on July 10, 1991.

The Board Members present were John E. Westfall (Chair) and Elizabeth W. Westfall (Secretary). Three other Board members were represented *in absentia*: Walter Haas by Joseph Liu, Donald Parker by Daniel Joyce, and Harry Jamieson by Michael Mattei. Thus five Board members were present or were represented, constituting a quorum.

A.L.P.O. members who were attending, but who are not on the Board of Directors were: Bart Benjamin, Klaus Brasch, Daniel Fisher, John Hewitt, David Levy, Derald Nye, Frederick Pilcher, Norman Sperling, and Janet Stevens. Although members not on the Board do not vote on Board issues, they are always welcome at our meetings for the valuable input that they supply.

Old Business

I. Financial Report.—The total balance in the three A.L.P.O. bank checking accounts was $3383. The amount owed to the Executive Director for expenses is $1317. (Informational.)

II. Walter H. Haas Observing Award.—It was moved that David Levy, who is responsible for ordering the manufacture of the annual Walter H. Haas Observing Award, be reimbursed $40 for his expenses. (Passed unanimously.)

III. Dues Increase.—The following new dues schedule was moved, to become effective on January 1, 1992.

United States, Canada, and Mexico:
$16.00 for 1 year, $26.00 for 2 years.
All Other Countries:
$20.00 for 1 year, $33.00 for 2 years.
Sustaining Membership: $25.00
(for 1 year only).
Sponsorship: $50.00 (for 1 year only).

(Passed unanimously.)

IV. Staff Confirmations.—

(a) It was moved that Richard W. Schmude, Jr., the Acting Remote Planets Recorder, be made permanent Remote Planets Recorder. (Passed unanimously.)

(b) It was moved that Paul H. Bock, Jr., the Acting Coordinator of the International Solar System Observers' Fund, be made permanent Coordinator. (Passed unanimously.)

New Business

V. Journal.—David Levy suggested that we reprint selected articles published in local astronomical society newsletters. (Discussed but not voted upon.)

VI. 1992 A.L.P.O. Meeting.—Those attending were reminded that our 42nd Meeting will be held with **COSMOCON'92** on July 13-18, 1992, at San Jose State University in San Jose, California, U.S.A. A Teachers' Workshop will be held on July 13-14, with the Amateur Astronomy portion of the conference starting on July 15. A.L.P.O. activities will be on Thursday, July 16, including a paper session, workshop, and Board/Members meeting. This national amateur astronomy convention will include the Astronomical League (AL) and the Western Amateur Astronomers (WAA). The organizing group for the conference is the Astronomical Association of Northern California. (Informational; further details will be announced in subsequent issues.)

VII. Walter H. Haas Observing Award.—It was moved by David Levy that the criteria for recipients of the Walter H. Haas Observing Award include that the person "well represents the ideals of the A.L.P.O." (Discussion; passed unanimously.)

VIII. Appreciation.—Derald Nye moved that we express formal thanks to the Symposium for Research Amateur Astronomy Organizing Committee. (Passed unanimously.)

IX. Training Program.—Janet Stevens commented that our Lunar and Planetary Training Program needs better notice or "advertising" in our Journal. Rather than being simply mentioned in listings, the Program needs to be featured occasionally. (Discussed but not voted upon.)

X. European Meeting Announcement.—Daniel Fisher announced a European planetary amateur astronomy meeting to be held in Violau (near Augsburg) in Bavaria, Germany, on September 18-21, 1992. The official language will be English. This "Meeting of European (and International) Planetary and Cometary Observers" is called **MEPCO'92.** The fee for registration, proceedings, lodging, meals, and a field trip, will be approximately DM 200. For further information, contact Wolfgang Meyer, Martinstrasse 1, D-(W) 1000 Berlin 41, Germany. (Informational.)

It was then moved and was unanimously passed that the meeting be adjourned. Board Chairman Westfall thus adjourned the meeting at 1:00 PM.

Dues Increase Notice

As noted in our 1991 Board Meeting Minutes on the previous page, it has been necessary to increase dues for all A.L.P.O. membership categories. This has been a result of increasing expenses, particularly printing and mailing costs. *The increased dues will go into effect on January 1, 1992; prior to that date, you may renew your membership for up to two years at the present rate.* The new dues schedule will be as follows:

United States, Canada, and Mexico .... $16.00 for 1 year or $26.00 for 2 years
All Other Countries* .... $20.00 for 1 year or $33.00 for 2 years

Sustaining Member .... $25.00 (1 year only)
Sponsorship .... $50.00 (1 year only)

Associate membership .... $3.00 (1 year only; excludes *Journal* subscription)

A 20-percent surcharge applies to memberships obtained through subscription agencies or which require an invoice.

* As several overseas members have written that our experiment with a direct mailing service has resulted in much faster delivery for them, we will continue with this method, the additional cost of which is included in the new overseas dues.

Announcements

Association Business

Alika K. Herring Receives Walter H. Haas Observing Award.—The veteran lunar and planetary observer, Alika K. Herring, has been selected by our Awards Committee as the recipient of the Walter H. Haas Observing Award for 1991. Mr. Herring has been an A.L.P.O. member for many years, and perhaps is best known for his accurate, detailed, and attractive drawings of lunar features, many of which have appeared in this Journal and in a series in *Sky and Telescope* magazine in the 1950's and 1960's. He remains active with lunar dome studies.

A.L.P.O. Benefactors.—Once again we a honored to list those A.L.P.O. members who have generously contributed more than the minimum dues required for membership. Thanks to them, we are able to maintain our operations and publications. The persons listed below have made contributions since our previous listing in our March, 1991, issue.

A.L.P.O. **Sponsors** contribute at least $40 per year and are: Richard Baum, Julius L. Benton, Jr., Paul H. Bock, Jr., James R. Brunkella, Nancy J. Byrd, Darryl J. Davis, Phillip R. Glaser, Robert B. McClellan, David McDavid, Patrick S. McIntosh, Michael Mattei, Paul C. Millikan, Brenton R. Ogle, José Olivarez, Arthur K. Parizek, Donald C. Parker, Thomas C. Peterson, Richard W. Schmude, Kenneth Schneller, Harold J. Stelzer, Berton and Janet Stevens, Richard J. Wessling, Matthew Will, and Thomas P. Williams.

Sustaining Members contribute between $20 and $40. They are: W.D. Baldwin, Pete Banholzer, Ulrich Blech, Klaus R. Brasch, Harper M. Bruce, Phillip W. Budine, Reginald F. Buller, Clark R. Chapman, Donald M. Clement, Thomas P. Davis, Kenneth J. Delano, Alan French, Michael Granger, Charles Hance, Richard E. Hill, John T. Hopf, Harry D. Jamieson, Joe and Joann Kamichitis, Kansas Astronomical Observers, H.W. Kelsey, Charles Klausing, Mark Lancaster, George F. Lenz, David D. Meisel, Jay H. Miller, Col. John W. Mohr, Woodie F. Morris, Lee Morrow, New Mexico State University, Gary S. Nichols, Walt Parker, Richard M. Pembroke, James Phillips, Peter Rasmussen, Richmond Astronomical Society, Timothy J. Robertson, Sacramento Valley Astronomical Society, Peter C. Scott, Lee M. Smojver, Don Spain, Richard Stanton, Michael E. Sweetman, Barry B. Thompson, Ken Thomson, Brad Timerson, Gary K. Walker, Leo F. Wellner, Samuel R. Whitby, Jack Whorwood, Matthew Will, Alan P. Witzgall, Jack Whorwood, and Mike Worthington.

Foreign Membership Fund.—Recently, several A.L.P.O. members have kindly donated to our *Foreign Observers Fund*, which provides A.L.P.O. dues for deserving amateur astronomers who live in countries where it is difficult to obtain American dollars. These recent donors are: Paul Bock, H.W. Kelsey, Peter Rasmussen, and John Sanford. Their gifts have enabled us to provide paid memberships to the following individuals: Matei Alexescu (Romania), Jean Bourgeois (Belgium), Chen Dong hua (People's Republic of China), Jirí Dusek (Czechoslovakia), Evan Mbozi (Zambia), Janos Papp (Hungary), and Yuan Qian (People's Republic of China).

Editing Service.—A.L.P.O. member Aryan W. Hastings has volunteered to proofread materials intended for publication by our Observing Sections; this includes handbooks, newsletters, and the like. If our Staff wish to take advantage of his kind offer, his address is: 1306 "F" St., Bedford, IN 47421.

1992 A.L.P.O. Convention.—For information on our 1992 Convention, see our 1991 Board Meeting minutes (p. 141, item VI). As more information becomes available, it will be given in future issues of this Journal.

Staff Changes.—Also as noted in our Board Meeting minutes (p. 141, item IV), the following staff appointments have been made permanent:

Richard W. Schmude, Jr. is now permanent Remote Planets Recorder.

Paul H. Bock, Jr. is now the permanent Coordinator of the International Solar System Observers' Fund.

Both persons' addresses are given on our inside back cover.

SKY EVENTS

Saturn Photometry Alert.—Richard W. Schmude, Jr. reports that whole-disk (Globe plus Rings) photoelectric measures of Saturn's brightness that he made on five nights in June and July, 1991, indicate that Saturn was significantly less bright than in ephemeris predictions. His conclusion was confirmed by John Westfall, who observed on two evenings. We need further confirmation, and urge A.L.P.O. members having access to photoelectric photometers to measure Saturn's whole-disk brightness. Even a small telescope is suitable; and α_1 Cap and β Cap were used as comparison objects. Measure the V (visual) band as a minimum, although (**B-V**) color indices may be useful as well. Communicate your results to our Saturn Recorder, Julius L. Benton, Jr., at the address given on our inside back cover.

Lunar Transient Event?—The Brazilian amateur astronomer Junior Torres de Castro has reported an unusually bright white spot, visible for several evenings beginning with a sighting on 1991 JUN 17, 20h 30m UT. He and Julio Lobo used a 24-in (61-cm) reflector, and their sighting was confirmed by several others and was also video-recorded. De Castro described the LTP as "white, large, with a comet-like tail extending to the [celestial] east." He gave the light spot's lunar coordinates as about 52°.5 E (IAU) and 21°.5 N.

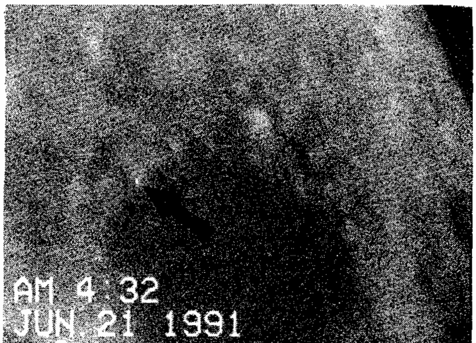

Figure 26. Print of videotape of Mare Crisium area on the Moon. Recorded by John Westfall in S-VHS format with a Sanyo black-and-white CCD video camera and a 25-cm (10-in) f/16.5 reflector at prime focus on 1991 JUN 21, 04h 32m UT. Lunar north is at the top, IAU west to the left. The possible Lunar Transient Event (LTP) is identified with the light spot shown by an arrow. Solar selenographic colongitude = 017°.4.

John Westfall also confirmed the existence of this light spot, and his video image of it is shown in *Figure 26* (below). He questions whether this spot is a normal feature for this area, or whether the previously-known bright area at this location underwent an unusual and prolonged brightening. We urge A.L.P.O. lunarians to monitor this area and to report unusual aspects to our LTP Recorder, Winifred S. Cameron (address on inside back cover).

OTHER ORGANIZATIONS

Observing Opportunity.—The Vermont Astronomical Society (V.A.S.) now has an excellent planetary telescope open for public use. The V.A.S. has a 10-inch (25-cm) f/20 Buchroeder Tri-Schiefspiegler at its observatory in Williston, Vermont. Any A.L.P.O. members visiting the area are welcomed to view through this instrument. To do so, or to find out more, contact Gary Nowak, 38 Thasha Lane #L-1, Essex Junction, Vermont 05452 (home telephone 1-802-879-4032).

23rd Annual Meeting of the Division for Planetary Sciences (DPS) of the American Astronomical Society.—This professional-level meeting, held every Fall, is also suitable for advanced amateurs who wish to keep abreast of developments and to report their own work. This conference will be held in Palo Alto, California, at Hyatt Rickeys Hotel, on November 4-8 (Monday-Friday), 1991. The meeting host is the Space Science Division of NASA Ames Research Center. Regular and special DPS paper and poster sessions will be held mornings and afternoons; with the Banquet, DPS Business Meeting, and public session in the evenings.

Some useful contacts for further information are: *Local Arrangements*; Chris McKay, NASA Ames Research Center, telephone 1-415-604-6864, FAX 1-415-604-6779; *Program*: Carol Stoker, NASA Ames Research Center, telephone 1-415-604-6490, FAX 1-415-604-6779; *Lodging*; Hyatt Rickeys, 4219 El Camino Real, Palo Alto, CA 94306, telephone 1-415-493-8000.

23rd Annual Lunar and Planetary Science Conference.—Every Spring, hundreds of lunar and planetary scientists gather at the Lunar and Planetary Institute at NASA Johnson Space Center in Houston, Texas. Their 23rd conference will be held on March 16-20, 1992. If you wish to be placed on the mailing list concerning this major conference, write to: 23rd LPSC—Attn: Pamela Jones, Lunar and Planetary Institute, 3303 NASA Road 1, Houston, TX 77058-4399. Note that the deadline for abstracts of proposed papers is January 10, 1992.

PUBLICATIONS OF THE ASSOCIATION OF LUNAR AND PLANETARY OBSERVERS

(All Section Publications must be ordered directly from the appropriate Recorders.)
(Checks must be in U.S. funds, payable to an American bank with bank routing number.)

◆◆

Order from: Mark Davis, Pioneer Apts., Apt. E-10, Christiansburg, VA 24073, U.S.A:

The A.L.P.O. Solar System Ephemeris: 1991. $6.00 in the United States, Canada, and Mexico; $8.50 elsewhere (airmail included). 115 pages of tables, graphs, and maps describing the positions and appearances of the Sun, Moon, each major planet, the readily observable planetary satellites, Minor Planets, meteors, and comets. Make payment to "A.L.P.O."

◆◆

Order from: A.L.P.O., P.O. Box 16131, San Francisco, CA 94116, U.S.A:

An Introductory Bibliography for Solar System Observers. *Free* for a stamped, self-addressed envelope. A 4-page list of books and magazines about Solar System bodies and how to observe them. The current edition was updated in June, 1991.

◆◆

Order from: A.L.P.O. Membership Secretary, P.O. Box 143, Heber Springs, AR 72543, U.S.A:

① ***A.L.P.O. Section Directory--1991/92.*** *Free*; just send a stamped, self-addressed envelope. An 8-page description of each Observing Section's personnel, projects, and publications.

② ***A.L.P.O. Membership Directory.*** $5.00 in the United States, Canada, and Mexico; $6.00 elsewhere. Continuously-updated list of members: alphabetically, by location, and by interest or interests. Make payment to "A.L.P.O."

◆◆

Order from: Walter H. Haas, 2225 Thomas Drive, Las Cruces, NM 88001, U.S.A:

Back issues of ***The Strolling Astronomer (J.A.L.P.O.).*** The following are still in stock but may not long remain so. In this list, volume numbers are in *italics*, issue numbers are not, years are given in parentheses, and prices are $1.50 per issue unless otherwise stated. Discounts can be arranged for purchases over $20. Make payment to "Walter H. Haas."

1 (1947); 6. *8* (1954); 7-8. *11* (1957); 11-12. *20* (1967-68);9-10.
21 (1968-69); 3-4 and 7-8. *23* (1971-72); 3-4, 7-8, 9-10, and 11-12.
25 (1974-76); 1-2, 3-4, 7-8, and 11-12.
26 (1976-77); 1-2, 3-4, 5-6, and 11-12 [each $1.75].
27 (1977-79); 3-4, 5-6, 7-8, 9-10, and 11-12 [each $1.75].
28 (1979-81); 3-4 [each $1.75]. *31* (1985-86); 5-6, and 9-10 [each $2.50].
32 (1987-88); 1-2, 5-6, and 11-12 [each $2.50].
33 (1989); 1-3, 4-6, 7-9, and 10-12 [each $2.50]. *34* (1990); 1, 2, and 4 [each $2.50].
35 (1991); 1 and 2 [each $2.50].

Current Issue [*35*, 3]—$3.00.

KEEPING YOUR MEMBERSHIP CURRENT—

Because all regular A.L.P.O. memberships include a subscription to the *Strolling Astronomer (J.A.L.P.O.),* the top line of your mailing label gives the volume and issue number for which your membership will expire (e.g., "35.3" means Volume 35, Number 3). We also include a *Renewal Notice* in that issue.

Please also let the Membership Secretary know if your address changes.

CONTRIBUTING TO *THE STROLLING ASTRONOMER (J.A.L.P.O.)*—

We welcome reports and observations from our readers and our staff. Please submit typewritten, doubled-spaced copy. For articles longer than two pages, begin with a 75-150 word abstract (our Journal is abstracted). Cite pertinent references in full, including page numbers. Fully document observations with the name and address of the observer; the observing site if different from the observer's address; the date and time in Universal Time; the telescope type, aperture (cm. preferred), and magnification; filters used if any; atmospheric conditions (seeing on the 0-10 A.L.P.O. scale; transparency as the limiting stellar magnitude in the vicinity of the object); and other data as pertinent to the object observed. Illustrations are welcome but we cannot publish color. For low-contrast objects, contrasts should be exaggerated on drawings and photographs. Also, be sure to indicate celestial north or south, as well as celestial east or west if the image is laterally reversed.

With all communications with A.L.P.O. staff, please furnish a stamped, self-addressed envelope.

THE ASSOCIATION OF LUNAR AND PLANETARY OBSERVERS

Founded in 1947, the A.L.P.O. now has approximately 700 members. Our dues include a subscription to this quarterly Journal, *The Strolling Astronomer*, and are $14.00 for one year ($24.00 for two years) for the United States, Canada, and Mexico; and $16.00 for one year ($29.00 for two years) for other countries. One-year Sustaining Memberships are $20.00; Sponsorships are $40.00. Associate Memberships, which do not include a Journal subscription, are $3.00 per year. There is a 20-percent surcharge on all memberships obtained through subscription agencies or which require an invoice.

The above rates will increase on January 1, 1992. See page 142 for additional details.

Our advertising rates are $85.00 for a full-page display Ad., $50.00 for a half-page, and $35.00 for a quarter-page. Classified Ads. are $10.00 per column-inch. There is a 10-percent discount for a 3-time insertion on all advertising.

All payments should be in U.S. funds, drawn on a U.S. bank with a bank routing number, and payable to "A.L.P.O." When writing our staff, please furnish stamped, self-addressed envelopes.

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