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A group photograph of the A.L.P.O. members and guests attending our 43rd Convention, held in Las Cruces, New Mexico, August 4-7, 1993. Among the luminaries shown are two Las Cruces residents: A.L.P.O. Founder Walter Haas, holding the association's banner; and, to his immediate right, Clyde Tombaugh, a Charter Member and discoverer of the planet Pluto. For information on obtaining a copy of this photograph, see page 95 of this issue.

THE ASSOCIATION OF LUNAR
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In This Issue

AN OUTLINE OF THE HISTORY OF THE A.L.P.O.

By: Walter H. Haas; Founder, A.L.P.O.

ABSTRACT

The circumstances of the founding of the A.L.P.O. are described. Incidents relating to its Journal, conventions, business problems, and Section Recorders over the years are noted, together with a few current projects and prospects.

This paper was delivered as the Opening Address at the 43rd A.L.P.O. Convention in Las Cruces, New Mexico, on August 5, 1993. A photograph of Prof. Haas delivering this paper is shown in Figure 1 below.

THE FOUNDING OF THE A.L.P.O.

The birth of the Association of Lunar and Planetary Observers, or A.L.P.O., may be properly dated as the mailing of the first issue of its Journal, long known as *The Strolling Astronomer*, in March, 1947. But just as the causes of the American Revolution can be traced back to English trade and colonial practices during the Seventeenth and Eighteenth Centuries, so were there previous significant events. The first cause may well have been the decision of a 17-year old farm boy in his father's home in the Spring of 1935 to accept an offer from Mr. John H. Chase of Youngstown, Ohio, to finance a visit to Professor William H. Pickering's private observatory in Mandeville, Jamaica, rather than the alternate offer to pay for a year of college.The observatory site has been very well described by Edwin P. Mantz, Jr. in "Pilgrimage to a Tropical Observatory" in the old *Popular Astronomy* magazine in 1938. In later years I have often thought that those 3-1/2 months in May-August, 1935, would have been more profitable if the professor had been 10 years younger or if I had been two or three years older, or at least more advanced in formal education and experience. Yet the encounter greatly influenced my later life. Perhaps the most valuable thing Professor Pickering taught me was to write down each observation and its relevant circumstances: date, time, telescope, seeing, and so forth. No, sir, I have never told others that I have seen a bright spot on Jupiter on "Tuesday August" or that there was "something unusual" about Saturn a day or two ago!

Many hours were given to visual studies of the Moon and the bright planets during the ensuing college and university years. In that long-past time I responded to the invariable requests in published papers for more pre-opposition observations of Mars, Jupiter, and Saturn with more than good intentions. While I owned and enjoyed a 6-inch Newtonian reflector, fond memories cling to the Flower Observatory Brashear 18-inch refractor that I had access to in 1941-46. It was this instrument with which Lowell observed the 1894 Apparition of Mars, his first one at Flagstaff. Of course, one legacy of the 18-inch has been frequent disappointment over the last 47 years with the performance of smaller apertures.

Many visual lunar and planetary observations, plus a few photographic ones, generated papers by myself and others in the late 1930's and early 1940's in the magazines *Popular Astronomy*, *Amateur Astronomy*, *The Journal of the Royal Astronomical Society of Canada (J.R.A.S.C.)*, and *The Publications of the Astronomical Society of the Pacific*. My most ambitious effort was certainly "Does Anything Ever Happen on the Moon" in *J.R.A.S.C.* in 1942. Thus there arose a small group of amateur enthusiasts. It included Attorney David P. Barcroft in Madera, California; Hugh M. Johnson and Frank Vaughn, Jr., originally high school students in Des Moines, Iowa; J. Russell Smith, a science teacher in Smyer, Texas; Charles Cyrus in Lynchburg, Virginia; Tom Cave and Tom Cragg, enthusiastic young observers in Greater Los Angeles; Elmer J. Reese, a grocer in Uniontown, Pennsylvania; and a few others. We copied our drawings by hand to show to each other; we corresponded by mail ("*Why* can't you see what I see?"); we occasionally speculated about planetary phenomena. World War II limited our astronomical efforts; but when peace returned, we became more active than ever.

Figure 1. Walter H. Haas, Founder of the A.L.P.O., delivering the Opening Address of the 43rd Convention of the Association, reprinted here.

And now I soon had a problem. By definition an *amateur* astronomer cannot ignore the duties imposed by his employer. It was becoming harder and harder to pursue my celestial pleasures in the available free time. Then came the thought: why not use a newsletter or small journal to expedite communication among this group of skywatchers, and thus save time? This goal turned out to be fully as sound as the *Literary Digest*'s prediction in 1948 that Governor Dewey would be elected President.

The first issue of *The Strolling Astronomer*, a name given by the young woman who typed the text, was mailed out to selected colleagues in March, 1947. It consisted of six mimeographed pages with wide margins. Recipients were invited to send in one dollar if they would like to receive six more issues. Many of them did. The name, the Association of Lunar and Planetary Observers, was my own unimaginative choice. The mnemonic *ALPO* was quickly invented by others. Occasional suggestions for the American Association of Lunar and Planetary Observers as a better name were refused. We intended to be international.

THE A.L.P.O. FROM 1947 TO 1985

The new journal enjoyed a healthy infancy. Notice kindly published by several magazines helped our growth. There were 21 readers for the second issue and perhaps 100 a year or two later. Getting ahead of our story, we can report that membership showed a gradual increase up to a maximum of about 860 in the early 1960's, followed by a decline to about 710 in 1985 and near 600 at the present time. Perhaps these trends reflect our changing national priorities about science.

The first contributed article was "Valuable Contributions to Astronomy by Owners of Small Telescopes," by Frank R. Vaughn in the April, 1947 issue. Other colleagues submitted articles on various Solar System topics; these, along with summaries of contributed observations and notes on future observational opportunities, filled the early mimeographed issues, now with narrow margins. A milestone for *The Strolling Astronomer* came in February, 1950 with a page of illustrations. Mr. Orlando Stevens of the Stevens Agency in Albuquerque, New Mexico, copied drawings photographically from the originals directly upon the stencil. The results were surprisingly clear and worth hundreds of words of text.

It is pleasing that the A.L.P.O. has had an international character from its outset, and this nature has continued down to the present time. There were contacts in the first years with H. Percy Wilkins and Patrick Moore in England, Tsuneo Saheki in Japan, Ernst Pfannenschmidt in West Germany, and others. Observations and other contributions from foreign colleagues have added much to our scientific efforts. Indeed, there have been a few occasions when observations from colleagues overseas were better, more abundant, or both than those from the United States. While speaking of overseas contributors, we should certainly praise the worldwide chain of Mars observers organized by "Chick" Capen, Don Parker, and others; and the cooperative study of lunar domes carried on by Harry Jamieson and his British Astronomical Association counterpart. Complimentary memberships have often been given to financially-pressed colleagues abroad, and the idea has been formalized during the last few years. Under the guidance of Mr. Paul H. Bock, Jr., we have also been able occasionally to give equipment to foreign members unable to obtain needed instrumentation.

At first I undertook to handle all observations submitted by A.L.P.O. members, to study them, and to publish pertinent results. It soon became necessary to obtain assistance, and we followed the British Astronomical Association model in choosing Section Recorders. One need not apologize for imitating what had at time worked well for six decades. In July, 1949 Elmer Reese and Tom Cave were appointed to serve as Jupiter Recorder and Venus Recorder respectively. By the end of 1951 we had Dr. James Bartlett for Venus, Mr. Ernst Both for Jupiter, and Mr. Donald O'Toole for Mercury. In time, there were Recorders for several different lunar projects and for each bright planet. Sections were even eventually added for Minor Planets, for the Sun, for comets, for meteors, and for the Remote Planets—those beyond Saturn. The Solar Section was organized by Mr. Richard Hill in the early 1980's and was in part a response to requests for data from professional astronomers.

The most publicity ever received by the A.L.P.O. in its whole history, with national and even international news coverage, followed an observation of Mars in Japan on January 15, 1950. Mr. Tsuneo Saheki recorded a projecting gray cloud on the south limb at estimated Martian longitude 202°, latitude 58° south. He employed an 8-inch reflector with 400X and 500X in good seeing. The cloud was estimated to be 900 miles in diameter and to lie 60 miles or more above the surface of the planet. The dullness and the gray color impressed this very experienced Mars observer as extremely rare. He suggested that the cloud was Martian volcanic ash. The reason for the extensive press coverage is not really clear. At a time of much concern with thermonuclear weapons, there was some wild speculation in the press that Martians had exploded a super "M-Bomb." The incident did have a major personal effect for me: the news release led to renewed correspondence with the Jamaican girl whom I married in 1953.

In July, 1952 the Astronomical League recognized the work of the A.L.P.O. by presenting the Astronomical League award to Walter H. Haas. The Western Amateur Astronomers did likewise with their G. Bruce Blair Award in 1955. Both organizations gave me undeserved honor with their second award, and each had given its first award to Albert Ingalls of amateur telescope making fame.

It is natural for devotees of astronomy to want to meet with each other. Modern global, eclipse-chasing amateurs can hardly appreciate how little many of us traveled near the middle of this century. For example, one of my uncles was never more than 40 miles from the farm on which he was born. However, by the mid 1950's several annual gatherings of amateur astronomers had sprung into being. Some A.L.P.O. members took part in their programs, occasionally by invitation. The First Convention of the Association of Lunar and Planetary Observers occurred at Flagstaff, Arizona on September 1, 1956.It was part of the Convention of The Western Amateur Astronomers; and the Lowell Observatory, long the only planetary research professional observatory in the United States, was surely an appropriate site. Other Conventions followed, most of them with either the Western Amateur Astronomers or the Astronomical League. We did meet by ourselves at Montreal in 1962, at Tucson in 1966, and now at Las Cruces in 1993. Of course, any convention location is a long ways from most of our widely scattered membership; and attendance is modest, usually a few dozen people. These conventions were made possible by the efforts of host societies, League and WAA officials, and hard-working individuals; and we are grateful. The present meeting is our 43rd Convention.

These paragraphs should indicate something of the nature, aims, and methods of the A.L.P.O. The discussion will continue under a few separate categories.

THE MEMBERS AND THE STAFF

Membership in the A.L.P.O. has always been open to all interested persons. Still, our concern is largely with Solar System astronomy, with observations of these bodies with ordinary instruments, and with the interpretation of such observations. We don't have much to offer to the young novice reading his or her first book on astronomy, and we aren't apt to be much help to teenagers with Science Fair projects. I think of a letter from one enthusiastic youngster: "I have decided to do research in science to help you. But first could you tell me how to find Jupiter in the sky?" There must here be a better starting point than the A.L.P.O.

We have tremendous variety in our membership. They run the whole spectrum of those who love the stars. A few have been professional astronomers, such as Dr. Clyde Tombaugh in Las Cruces; Dr. Joseph Ashbrook of *Sky & Telescope*; and Mrs. Winifred Cameron, who carried on lunar research at NASA's Goddard Space FLight Center. Others have been professionals in other fields, but with a deep commitment to excellence in observational studies, such as Dr. John Westfall and Dr. Donald Parker. A few have shown great skill in classical visual studies, like Elmer Reese and Alika Herring. Just about all professions are represented—teachers, students, doctors, lawyers, technicians, writers, and at least one undertaker.

The A.L.P.O. owes a huge debt to its many Section Recorders for whatever it has achieved. They are too numerous to list here. However, special thanks go to David P. Barcroft, our first Secretary, and to J. Russell Smith, who succeeded him. Both served for many years and, like other staff members, spent their own money freely on society projects. We have sought to review books relevant to Solar System studies under the guidance of J. Russell Smith and José Olivarez. We have attempted to provide a Training Program, supervised by Clark Chapman, José Olivarez, and a few others. This program is being rethought now in terms of methods and modern materials. Perhaps the chief problem is that most members do not appear to think that they need any training! Other services have been suggested, such as instruments, history, and computer software; and we seek to provide new Sections when there is a need not met elsewhere and when a qualified Recorder can be found.

A major problem has been frequent staff changes; the average Recorder probably serves only two or three years. Many staff members have been relieved at their own request for various reasons, and a few have simply stopped doing anything. One may compose a job description for an *ideal* Recorder:

1. He or she has a good knowledge of astronomy and a detailed knowledge of his or her specialty.

2. He or she always answers letters promptly and informatively.

3. He or she submits high-quality reports to the *Journal, A.L.P.O.* soon after each period of observation ends.

4. He or she is an avid observer.

5. He or she always encourages beginners and loves to discuss problems in science with more advanced people.

6. He or she attends numerous astronomical meetings and uses these opportunities to advance to the fullest the A.L.P.O. and the work of his or her Section.

7. He or she keeps thoroughly familiar with the current literature on his or her specialty.

Any graduate student in mathematics will immediately demand proof that such a person *exists.* Experience has shown that good observers may fail to answer their letters and that excellent correspondents simply may not write any reports for the Journal. In practice, one settles for *some* of the desired qualifications. Over much of the history of the A.L.P.O. I appointed volunteer staff members on the basis of apparent qualifications, their willingness to serve, and sometimes recommendations by others. John Westfall has found a better way: Recorders are tentatively appointed at the annual Business Meeting and are confirmed at the next one if they have done well.

CONVENTIONS AND BUSINESS MEETINGS

These meetings, usually with our friends in the Astronomical League or the Western Amateur Astronomers, had many parts. There would be a few invited lectures by professional astronomers or other famous people. There would be papers by amateurs on a wide variety of Solar System subjects. I consider this last feature the chief excuse for us to hold a convention; amateurs here have the opportunity to present their studies and to exchange ideas with their follows. There would be an exhibit where attendees display their drawings, photographs, charts, and the like, even including historical items. There would be field trips to neighboring observatories and other sites of scientific interest. There would be a banquet with a featured speaker and door prizes. There would be one or two star parties, where we often would castigate the weatherman for the cloudy skies. In the early 1980's there began to be workshops, with instructors and discussion less formal than at the paper sessions.

And then there would be–"Business Meetings." The first such A.L.P.O. functions in the 1950's consisted of little but a motion to adjourn. We were smug about their brevity as we watched League Council Members begin their third four-hour session. As time passed, though, we realized that such Business Meetings were a chance for the members present to help us with their thinking and to vote on policy matters. Certain problems came up at one annual meeting after another: financial difficulties, high mailing costs for the Journal, the possible need for a constitution and for incorporation, the desirability of an A.L.P.O. Observing Manual, and whether *The Strolling Astronomer* was a good title. In truth, much talk produced little action.

Some progress was made. Dave Barcroft made the obvious proposal of giving money to the struggling A.L.P.O., himself providing an immediate example, and since then Sustaining Members and Sponsors have voluntarily paid higher dues. Some of them, such as Phil Glaser, have done so for many years; and it is surely true that we would not have survived without their generous support. Another Business Meeting voted to change the preferred name of our Journal to *The Journal of the Association of Lunar and Planetary Observers*, a formality pleasing to some. Others continue to love *The Strolling Astronomer*. Drs. Clark Chapman and Dale Cruikshank in their days as very active amateur observers did compose a worthy and voluminous Observing Manual. They and others searched for years for a publisher. When the manual was finally published, material and references were partially obsolete. The need for a manual was really met in 1988 by the book *Introduction to Observing and Photographing the Solar System*; by Thomas Dobbins, Donald C. Parker, and Charles F. Capen.

PREPARING AND PUBLISHING THE JOURNAL

The first step is clearly a choice of material. Priority always went to reports of past observations and to discussions of future events needing to be observed. Contributed articles on other topics have continually been numerous, giving rise to the pleasant problem of what to fit into limited space. Some offerings were elementary material copied from textbooks, clearly to be rejected. There were naturally "crank" articles from those who knew that the Sun is surrounded by ice or who have corrected Einstein's errors in the General Theory of Relativity. Nevertheless, we did accept and publish what many magazines would consider marginal material, sometimes in the hope that it might stimulate useful thinking in unconventional directions. It would have been better to have a formal system to referee contributed papers and to screen them for merit, or lack thereof.

What with errors in submitted manuscripts and the editing we considered critical, the next step was to type the article to produce camera-ready copy. Whatever American schools have been teaching since 1947, it is *not* grammar, punctuation, or spelling. Now I have avoided typewriters like the plague, until an IBM PC and Wordstar acquired in 1983 now enables me to zip along at 4-5 words per minute. There have been a long succession of typists for *Journal, A.L.P.O.*: my wife Peggy, my daughter Mary, a friend of Mary's, many college students, some indulgent friends at my place of employment, and people in secretarial agencies. One of them, Mrs. Kathy Carruthers, became the First Lady of New Mexico. Peggy helped find many of the ever-needed replacements. Probably the basic trouble was that a job coming up at 2- to 4-month intervals and technically fairly difficult did not generate enough income to be appealing to a typist.

The actual publishing of the Journal was carried out at different times by professional shops in Albuquerque and Las Cruces, New Mexico, and in El Paso and Mercedes, Texas. For the last quarter of a century the publisher has been the ABC Printing Company in Las Cruces. We have enjoyed very pleasant relations with Tony Lopez, Larry Martin, and their workers, even when we insisted that they bring out the invisible fine detail on drawings and photographs. Our first six volumes were mimeographed, the next four were printed, and more recent ones have been produced by an offset process. Although one professional astronomer told me long ago that anything worth publishing is worth printing, the cost of printing forced the change to offset.

While Director, I handled the mechanics of mailing to Journal with help from family, members, and occasionally others.

COMMUNICATIONS AND CORRESPONDENCE

Letters have always been the chief medium of communication among A.L.P.O. members and Recorders. We did use the telephone sometimes when we felt a little richer or when some item required quick distribution, such as a new South Equatorial Belt Disturbance on Jupiter. We rarely used Western Union telegrams for the some reason in our early years. Radio communication then seemed an appealing way to tell others quickly of new and significant observations. Radio "hams," however, disliked to send messages as long as we considered essential, now could they regularly reach any specified place at any requested time. With the help of user-friendly electrons John Westfall, David Levy, and a few others in recent years employ FAX and the CompuServe systems for quick and dependable communication. Also, some Observing Sections have published newsletters from time to time.

The thousands of letters exchanged among A.L.P.O. members in 46 years run the gamut from trivial inquiries to advanced discussions of complex scientific problems. The notes from enthusiastic youngsters are often best answered with a recommendation that they visit the nearest library. One tends to remember what letters are amusing, and my favorite is: "I would appreciate it if you would tell me all about astronomy, space, and the Universe. I would appreciate a fast reply." Clearly, some questions require no answer but instead an education. It was also interesting that in an increasingly materialistic society requests often took the form: "Please send me everything free about space."

THE A.L.P.O. FROM 1985 TO 1993

In the year 1985 I attempted to support the doctors and hospitals in Las Cruces and El Paso all by myself. John Westfall had been chosen Associate Director at a former Business Meeting, and he now took over the duties of Director and Editor. Harry Jamieson soon thereafter became the hard-working Membership Secretary.

Dr. Westfall has brought about many improvements in the A.L.P.O., as described below.

We now publish an annual *Solar System Ephemeris*. It contains most of the data needed by a Solar System observer, and it is cheaper and easier to use that the *Astronomical Almanac* or the *Handbook* of the Royal Astronomical Society of Canada.

A Section Directory exists and tells what observing forms, instruction materials, and the like are available from each Section, along with their prices. It also briefly describes our chief observing programs and their instrumental requirements.

A membership Directory now lists all our members both alphabetically and by geographic location, along with their areas of interest. Harry Jamieson updates this very useful directory continuously.

Thanks in very large measure to Mrs. Elizabeth Westfall, we now finally have a Constitution; we were incorporated in 1990 as a non-profit educational society in the State of California. I would personally have preferred incorporation in New Mexico. Still, California has always supplied us with more members than any other state.

The general physical format of *Journal, A.L.P.O.* has been improved, allowing easier readability; and Dr. Westfall rescued the listing of the volunteer staff members on the back inside cover from near-chaos.

Don Parker, Jeff Beish, John Westfall, and others have increased the exposure of the A.L.P.O. in both the amateur and professional astronomical communities by attending numerous meetings and by contributing articles to scientific journals. One hopes that our colleagues should no longer tell us that they have never heard of the A.L.P.O.

The 1984 Business Meeting voted to give an annual award to an outstanding amateur observer. We had actually given an award and a pin for a few years in the 1960's but dropped the practice when the recipients seemed to find the recognition of little importance. This new version, the Walter H. Haas Award, consists of a plaque, prepared by David Levy, and a year's free membership in the A.L.P.O. The awardee is chosen by a committee; those receiving it so far are "Chick" Capen, Don Parker, Jeff Beish, Jean Dragesco, David Levy, John Westfall, Alika Herring, Phil Budine, and José Olivarez.

We now have a 7-member Board of Directors.

This "outline" of the past may serve to suggest the future of the A.L.P.O. Of course, the most certain thing about forecasts is that they are wrong. Few of us scamper around in the handy personal aircraft envisioned by science fiction writers in the 1930's. Then there was the learned savant who pontificated: "We might as well imagine that Man would fly to the Moon as that he would ever use steam to cross the wide Atlantic Ocean."

In our older years, as what we are able to do becomes less and less, we tend to reflect upon how we have used—and misused—our lives. For me the contacts with many fine persons, both within and outside the A.L.P.O. and far more numerous than those mentioned in this talk, have become precious memories. Technology is always changing, and the day may come when those who make CCD images of the planets will be the backward dinosaurs of their time. Astronomy has always had in addition to its professional practitioners a following of dedicated amateurs, who pursue science just for the love of it. The A.L.P.O. has been part of such a following, and we fancy that the world has been a little richer for what we have sought to contribute.

The mountain was not expected to come to Mohammed. It seemed scarcely more likely that an A.L.P.O. Convention would come to me here in Las Cruces. It is a singular pleasure to share this meeting with all of you, and I thank you for your patience in listening to this summary of our Association's actions, goals, and struggles in its first 46 years.

LIBRATIONAL DATA AND OTHER CORRELATIONS FROM DAVID O. DARLING'S LTP NETWORK FOR THE A.L.P.O. LTP OBSERVING PROGRAM

By: Winifred Sawtell Cameron, A.L.P.O. Lunar Recorder, Lunar Transient Phenomena (LTP)

ABSTRACT

Some 425 LTP reports for the crater Aristarchus and 43 for Gassendi are analyzed as regards the following hypotheses: libration, Earth tides, low sun angle, Earth-Moon System magnetic field, and solar activity. Data are presented in the form of tables and graphs.

INTRODUCTION

The author received data on Lunar Transient Phenomena (*LTP*) from D.O. Darling [Darling 1991a, 1991b] as part of the A.L.P.O. LTP Observing Program. Many of the observations were taken from the author's catalog [Cameron 1978] with additional post-1978 observations. The observers in Mr. Darling's network are: David Darling, Robert Manske, and David Weir in Wisconsin; and Donald Spain in Kentucky as regular observers; and Joseph Caruso and a few others occasionally. Darling reported data for librations of the Moon for the dates of observation and provided graphs for the craters Aristarchus and Gassendi, both of which are in the lunar Western (IAU) Hemisphere, but are in opposite hemispheres of latitude. Mr. Darling also classified the data after Cameron [Cameron 1978], consisting of: brightenings (*Bright*), darkenings (*Dark*), *Blue*, *Red*, *Gaseous* (any phenomena that implied a medium was involved, presumably gas or dust) and *Earthshine*.

LIBRATIONAL EFFECTS

In this paper, LTP librational data will be analyzed for all forms of event for both craters, and additionally will be subdivided by LTP type for Aristarchus. These data are summarized in *Table 1a* and *1b* (below and p. 55) and *Table 2a* and *2b* (pp. 55-56). The distribution of events by libration is also graphed in *Figure 1* (p. 56) [Darling 1991a, 1991b]. One might expect that LTP would be more likely to occur when librations were favorable, placing the features nearer the center of the disk than average. It is interesting to compare these two features as they are rather close in longitude (47°W for Aristarchus and 40°W for Gassendi), but Gassendi is in the Southern Hemisphere while Aristarchus is in the Northern. Thus longitude librations should be favor-

Table 1a. Lunar Transient Phenomena Frequencies by Libration for Aristarchus (47°W, 23°N).
(Favorable librations are negative for longitude and positive for latitude. Values are number of events unless a percentage sign is used. Columns may not add because some events belong to more than one category.)

Libration	All (425)		Bright (233)		Dark (32)		Blue (185)		Red (110)		Gaseous (125)		Earthshine (135)	
Interval ° °	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.
-7.9/-7.0	4	0	3	0	0	0	0	0	1	0	2	0	4	0
-6.9/-6.0	53	55	30	33	3	7	20	23	11	9	21	14	21	20
-5.9/-5.0	31	42	13	25	4	3	16	20	9	13	10	10	7	9
-4.9/-4.0	43	29	17	20	0	0	31	8	11	4	16	9	9	11
-3.9/-3.0	25	24	15	12	1	1	11	8	11	2	7	10	11	8
-2.9/-2.0	22	30	10	16	2	1	13	19	3	12	3	12	5	6
-1.9/-1.0	29	15	13	9	5	1	11	10	12	1	11	3	13	5
-0.9/ 0.0	34	24	18	10	2	0	12	8	8	3	8	7	7	7
Negative	241	219	119	125	17	13	114	96	66	44	76	65	77	66
Total	*57%*	*52%*	*51%*	*54%*	*53%*	*41%*	*62%*	*52%*	*60%*	*40%*	*61%*	*52%*	*57%*	*49%*
0.0/+0.9	31	38	17	19	2	2	10	7	5	8	6	8	6	13
+1.0/+1.9	25	17	18	14	2	3	11	13	5	7	8	9	9	9
+2.0/+2.9	21	17	14	8	1	1	12	9	4	3	4	6	4	5
+3.0/+3.9	21	23	10	10	0	3	3	10	6	4	5	5	7	7
+4.0/+4.9	30	40	20	18	3	4	10	18	10	11	10	14	8	11
+5.0/+5.9	17	32	9	12	2	3	8	16	4	14	7	10	5	8
+6.0/+6.9	31	39	18	27	5	3	17	16	10	19	8	8	13	16
+7.0/+7.9	8	0	8	0	0	0	0	0	0	0	1	0	6	0
Positive	184	206	114	108	15	19	71	89	44	66	49	60	58	69
Total	*43%*	*48%*	*49%*	*46%*	*47%*	*59%*	*38%*	*48%*	*40%*	*60%*	*39%*	*48%*	*43%*	*51%*

Table 1b. Lunar Transient Phenomena Frequencies by Libration for Gassendi (40°W, 16°S).

(Favorable librations are negative for longitude and latitude. Values indicate number of events except where a percentage sign is used)

Libration Interval °	All (43) Long. °	All (43) Lat.
-7.9/-7.0	2	0
-6.9/-6.0	4	8
-5.9/-5.0	2	3
-4.9/-4.0	0	3
-3.9/-3.0	1	4
-2.9/-2.0	2	6
-1.9/-1.0	5	1
-0.9/0.0	3	1
Negative	19	26
Total	*44%*	*60%*
0.0/+0.9	4	4
+1.0/+1.9	2	3
+2.0/+2.9	2	2
+3.0/+3.9	5	2
+4.0/+4.9	1	3
+5.0/+5.9	7	2
+6.0/+6.9	2	1
+7.0/+7.9	1	0
Positive	24	17
Total	*56%*	*40%*

able for both craters when westerly and negative if easterly. On the other hand, northerly libration would be favorable for Aristarchus but unfavorable for Gassendi, while the opposite would be true for southerly libration. The author has indicated the sign of favorable libration on each graph in this article. A glance at *Figure 1* shows that the observations are essentially randomly distributed for both features. Note that Aristarchus has 10 times the number of reports (425) than does Gassendi (43). The two graphs in *Figure 1* are oriented with south at the top, as one usually sees the Moon through an inverting telescope in the Northern Hemisphere. Although the data are well scattered, there appears to be a slight preponderance at extreme librations.

In order to make possible correlations more clear I have taken the detailed list of reports for Aristarchus (not included here), and the data from *Figure 1* for Gassendi, and constructed the histograms given in *Figure 2* (p. 57). The histograms show LTP by category for Aristarchus but only for *All* events for Gassendi. Note also that the scales for Gassendi and for Aristarchus' darkenings differ from that for the remaining Aristarchus events. The longitudinal data are shown with solid lines, while the latitudinal data are plotted with grey lines.

Studying the histograms, we see that the two craters behave similarly in the more extreme positive librations, particularly in latitude, although we would expect just the opposite. If there is a librational influence, Aristarchus behaves as expected although Gassendi does not. Indeed, more LTP were seen when Gassendi was nearer to the limb!

The two features differ in behavior at the extreme negative librations as well. Here Aristarchus behaves as expected; but Gassendi does not in terms of longitude. The behavior of the LTP categories is similar to the *All* data except for *Red* events in terms of latitude libration. Note that we are dealing with small numbers in the case of Gassendi and for Aristarchus' *Dark* events, thus statistics based on them are less reliable. My conclusion for the inconsistent behavior of the two features with respect to libration is that libration has little effect on the frequency of reported LTP.

OTHER HYPOTHESES

I have analyzed the data for comparisons with various hypotheses suggested for the cause of LTP. These analyses are similar to ones I have published previously [Cameron 1967, 1972, 1975, 1977, 1979, 1980]. Each paper made similar analyzes with additional data and discussed the hypotheses in detail, so they will only be briefly reviewed here.

The first suggestion was made by Jack Green [Green 1965], who studied the oil and water levels in wells and found that they fluctuated, with the levels related to the anomalistic period of tides. He found that the effect depended on the change in eccentricity of the Moon's orbit. Extrapolating his findings from the Earth to the Moon, where the Earth's tides on the Moon are much stronger than the Moon's on the Earth, he predicted that lunar degassing would be greatest at apogees when the lunar orbit was more eccentric than average, and would be least at perigees when the eccentricity was less. The range of the effect would be about 0.1, compared with the mean, and varies over a period of about 14 months. Green's paper compared the data for 25 LTP reports with the phase of the anomalistic period and found some correlation with his hypothesis. Barbara Middlehurst and I, independently, investigated this hypothesis. Middlehurst, with J. Burley, published the results of her analysis of 145 LTP observations [Burley and Middlehurst 1966], but found a strong peak at perigee and a weaker one at apogee, just the opposite of Green's result. Her result is shown in *Figure 4a* (p. 62) [taken from Cameron 1977 with Gassendi added].

I also published analyses of the data in terms of other hypotheses, using a set of ob-

Table 2a. Summary of Lunar Transient Phenomena by Libration for Aristarchus (47°W, 23°N).
(Favorable librations are negative for longitude and positive for latitude. Columns may not total because some events belong to more than one category)

Category	All (425)		Bright (233)		Dark (32)		Blue (185)		Red (110)		Gaseous (125)		Earthshine (135)	
Longitude														
Favor.	241	57%	119	51%	17	53%	114	62%	66	60%	76	60%	77	57%
Unfavor.	184	43%	114	49%	15	47%	71	38%	44	40%	49	39%	58	43%
Latitude														
Favor.	206	48%	108	46%	19	59%	89	48%	66	60%	60	48%	69	51%
Unfavor.	219	52%	125	54%	13	41%	96	52%	44	40%	65	53%	66	49%

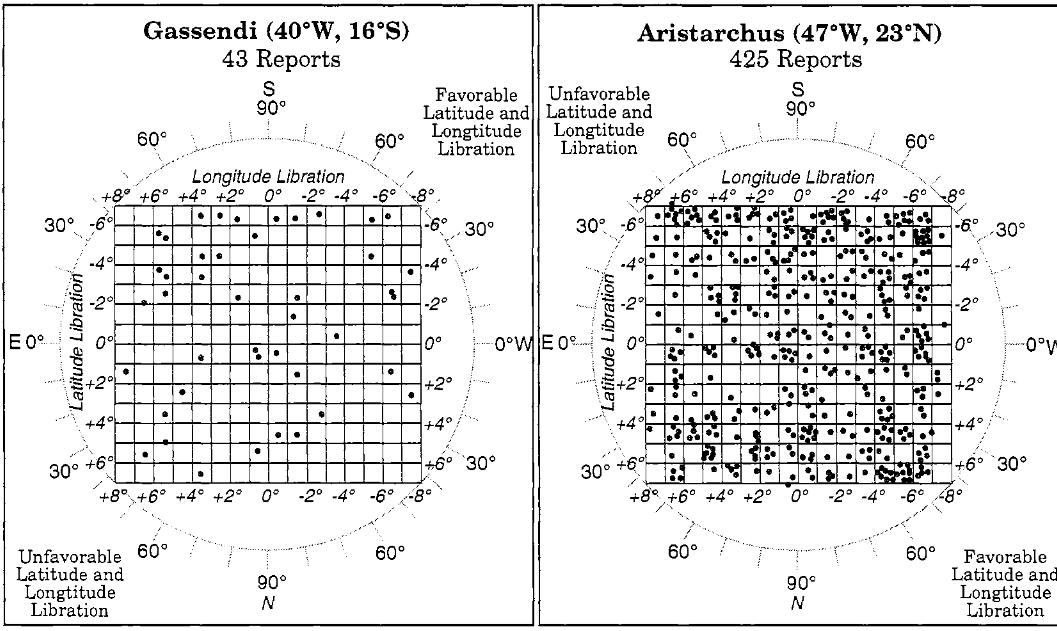


Figure 1. Plots of lunar librations in longitude (horizontal) versus latitude (vertical) for *All* data for Gassendi and Aristarchus. The quadrants for favorable libration are given along with cardinal directions in the IAU convention. South at top. Redrawn from David Darling's graphs.

Table 2b. Summary of Lunar Transient Phenomena by Libration for Gassendi (40°W, 16°S). (Favorable librations are negative for longitude and latitude.)

Libration Category	All (43)	
Longitude		
Favor.	19	44%
Unfavor.	24	56%
Latitude		
Favor.	26	60%
Unfavor.	17	40%

servations larger than the two previous authors' results, to be summarized later. Other hypotheses for LTP were offered by Zdenek Kopal, A.G.W. Cameron, William Chapman, Theodore Speiser, William Pala, Jane Blizard, and Miriam Sidran. James Greenacre suggested two possible explanations for his 1963 LTP observations. Chapman incorporated the Sun's contribution to tides to explain Aristarchus LTP over a 20-year period. This effect must be computed separately for each feature considered; but the sequence of orbital changes repeats after 14 months, simplifying the calculations, which I did using his computed graph for Aristarchus [Cameron 1977]. The LTP data were scattered almost uniformly over the Moon's orbit, with only a slight preponderance at the extremes in apogee, as predicted by Green. In analyzing the data, somewhat arbitrary groupings must be used; Middlehurst chose 0.1 units of the anomalistic period (phase, ϕ), and I have continued this. A mean anomalistic period is 27.6 days, compared with 27.3 days for the lunar sidereal period and 29.5 days for the synodic lunar period or lunation. Thus the data were divided into 2.76-day groups and correlations would be expected in the groups within 2.76 days of perigee and apogee. Were there no tidal effect and LTP were randomly distributed, we would expect 20 percent of all LTP to lie within 0.1ϕ of apogee, 20 percent within 0.1ϕ of perigee, and 40 percent within 0.1ϕ of either. Were there a positive correlation, these percentages would be higher. *Table 5* (p. 63) presents these data for the various hypotheses and their boundary conditions, to be discussed later.

James Greenacre and Edward Barr, while mapping the Aristarchus quadrangle, twice observed LTP at Aristarchus, Schröter's Valley, and a third point between them [Greenacre 1963, Anon. 1964]. The same type of phenomenon at Aristarchus was seen by them in two succeeding lunations at the same phase, shortly after local sunrise. Sunrise on this area comes at an average lunar age of 11 days. Greenacre suggested that the low solar illumination might have rendered the phenomena visible. If so, the phenomena should be visible at local sunset as well. One might expect a correlation to occur within 1 or 2 days after sunrise (SR) or before sunset (SS) on the area. To estimate probabilities, we assume that the Moon is seldom observed within 2 days of

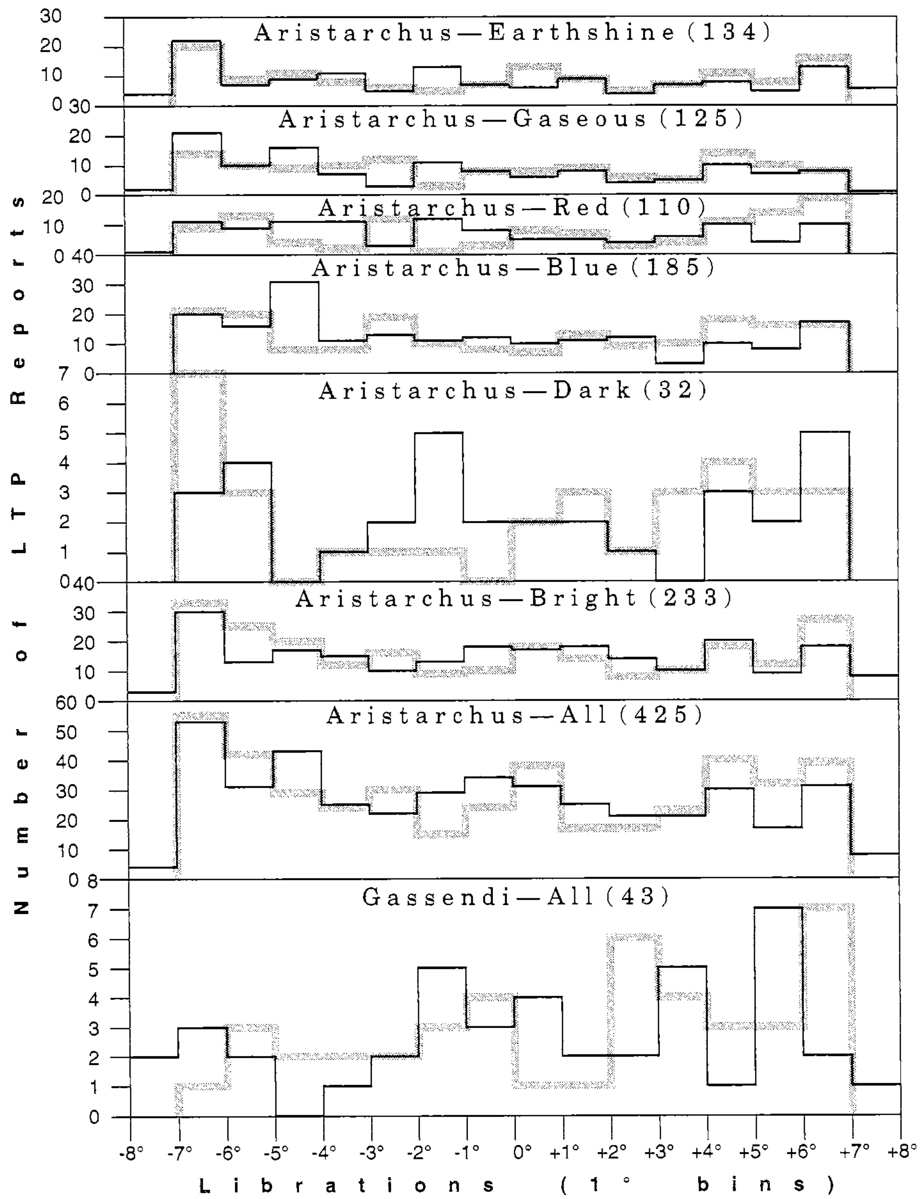


Figure 2. Histograms of number of LTP reports by 1° categories of longitude (black lines) and latitude (grey lines) libration, for *All* types for Gassendi; and for each type, including *All*, for Aristarchus. Note the change in vertical scale between Gassendi and Aristarchus, and for the Aristarchus *Dark* observations. Favorable librations are indicated for each crater.

New phase, so that only 25.5 days of the 29.5-day lunation are observed. Thus, were LTP randomly distributed, one would expect about 4 percent ($1/25.5 \approx .04$) to occur on each day of lunar age. Thus, a positive correlation would be found when more than 16 percent of LTP occurred within 2 days of both sunrise and sunset, making the observed:expected ratio (O/E) exceed 1.0. The O/E ratio can be used to express the degree of correlation, with values over 1.0 indicating positive correlation and those under 1.0 expressing negative.

Two other hypotheses relate LTP with sunrise only. These are the ultraviolet (UV) heating hypothesis [Blizard 1967] and thermoluminescence hypothesis [Sidran 1977]. The first suggests that gases that escape during the lunar night, which lasts 14.8 terrestrial days, hug the ground or are deposited on it, are heated after sunrise primarily by solar UV radiation, then rise high enough to be visible, especially under low-angle illumination. The thermoluminescence hypothesis suggests that gases, minerals in the interstices of rocks, or both, are activated to luminesce by solar heating. The boundary conditions for both hypotheses would be 1 or 2 days after sunrise, with the solar elevation 24° or less.

There are several hypotheses that invoke the Earth's magnetic field's influence on energetic solar particles, particularly those from solar flares that are directed toward the Earth-Moon system. One such hypothesis was proposed by T. Speiser [Speiser 1967], who suggested that, based on his hypothesis for the origin of terrestrial aurorae, solar particles enter the Earth's magnetic field and spiral down field lines. The particles accelerate, thus deriving increased energy, and impinge on local areas in the terrestrial atmosphere. They then activate atmospheric molecules to luminesce, producing our aurorae. He theorized that the magnetic lines, particularly those within the magnetopause (MP), would also extend outward to the Moon and beyond. As the particles bombarded the Moon, if it were within the MP, they would also be localized and might excite minerals or gases to luminesce. Because the particles would gather more energy during the greater amount of time that they were able to spiral, energies 100-1000 times those of solar flare or solar wind particles might be achieved, producing enough light to be seen from Earth. The Moon crosses the boundaries of the MP, on the average, two days before and after Full Moon (FM).

W. Pala [1964] proposed that cathodoluminescence occurred at the Moon, induced from solar particles within the magnetic field, if the Moon were in the correct place at the time. This would happen, on the average, within ±4.5 days of Full Moon. On the other hand, A.G.W. Cameron [1964], in studies of the magnetosphere, suggested that the turbulence at its bow-shock fronts (BSF) might enhance solar particles by accelerating them, particularly particles from flares, to energies sufficient to induce luminescence of lunar materials when the Moon is in the vicinity of the BSF after a solar flare. The BSF is encountered at 4.5 days before and after FM, on the average. In my analysis, I chose boundary conditions of 1 day inside the BSF, thus 3.5-4.5 days before and after FM.

Finally, Z. Kopal [1966] reported an observation he made with T. Rackham, in which they photographed a brightening of almost twice above the background in the vicinity of Copernicus (20°W, 9°N), Kepler (37°W, 7°N), and Aristarchus (47°W, 23°N), which occurred shortly after a large solar flare. P. Moore independently observed an event in that region using photometric equipment. Thus, this represented a confirmed event, recorded in two different media. The event occurred while the Moon was within the MP and also was near perigee. To analyze such events, I chose the *Kp* index of geomagnetic activity [Lincoln var. dates] as an auxiliary datum, along with sudden commencements (*sc*) of a magnetic storm on the Earth, and presumably on the Moon, or a magnetic storm (*ms*) in progress. These factors indicate the presence of solar particles in the Earth-Moon system. Kp ranges from 0 to 9, with a value of 6 or more usually accompanying a magnetic storm. Graphs produced by V. Lincoln before she retired were published in the *Journal of Geophysical Research (JGR)* monthly and yearly. They are now published monthly in the *Geophysical Indices Bulletin* from the National Geophysical Data Center in Boulder, Colorado. These graphs, referred to as "the musical scale" from their appearance, also indicated the onset of magnetic storms (sc). I tabulate both the maximum value of Kp (Kp_{max}) for the day, reported originally at 3-hour intervals, and the daily sum of Kp (ΣKp) for the day, as well as sc or ms, in my catalog [Cameron 1978]. For boundary conditions I chose ±0.5 day of the LTP date and the day of sc or ms.

The above boundary conditions and hypotheses are the ones I have analyzed with the submitted data. I present here the histograms and graphs in the same form I have published previously, but prepared from the new data. For Gassendi, I produced *Table 3* (pp. 59-60) from the data for comparison with the various hypotheses in the same manner as in previous publications. The table and graphs are discussed below. The column headings are the same as those in my catalog and are as follows: Date, Universal Time (UT), Category (Cat.; where D = *Dark*, B = *Bright*, G = *Gaseous*, R = *Red*, and V = violet or *Blue*), Moon's Age in days, Sun's selenographic colongitude in degrees (Col.), Terminator Distance (Term. Dist.) in degrees from sunrise (R) or sunset (S), Tidal Anomalistic Period Phase (ϕ), and the True Anomaly (π; used whenever available). ϕ is calculated by phase ratio, in days, which assumes that the lunar orbit is circular (the difference between ϕ and π can be as much as 0.1), Dates of Perigee before and after the observation date, Apogee Date (between the perigee dates from which ϕ is calculated), Full Moon (FM) Date, Days from Full Moon (From FM), Seeing (See.; based on E = excellent, VG = very good, G = good, F = fair, and P = poor); Solar Data of Kp_{max}, ΣKp, and *sc* or *ms* (Sol.); Chronological Sequence Number (No.), and observers and their locations (Obs.). For similar data for Aristarchus, see my catalog [Cameron 1978]. Note that the histograms for Gassendi have been constructed from the data in *Table 3*.

Figure 3 (p. 61), compiled in *Table 4* (p. 60) for both craters incorporating additional data, depicts the behaviors of the categorical data with respect to the Moon's age in the form of histograms. The curves in the figure were drawn through the data midpoints by eye to indicate trends, constituting a form of derivative. Note the different vertical scales in the figure. At the top and bottom of the graphs are given the mean phases, boundaries of the magnetopause (MP), bow-shock front (BSF), local noon at the feature (LN), and sunrise (SR) and sunset (SS) at the feature, while the shading indicates when the feature is in darkness (on average). The quantities can vary relative to each other by as much as 1.5 days. Comparing the two parts of *Figure 3*, we can see the difference in behavior of two features that are rather close in longitude but which are in different latitudinal hemispheres. There are very few reports of Gassendi being visible in

(Text continues on p. 60)

Table 3. Summary Data for Gassendi.

Submitted by Darling from Cameron [1978]; see Ref. for Aristarchus data. Explanation in text, p. 58.

Date	UT	Cat.	Age	Col.	Term. Dist.	φ/π	Perigee Dates	Apogee Date	FM Date	From FM	See.	Sol.	Seq. No.	Obs./Loc.
m/d/yr	h m		d	°	°		Mo d h	Mo d h	Mo d h	d				
08/27/39	0200	D	11.9	056	016 R	---	----------	----------	---------	----	---	-------	1	---
09/25/39	0130	B	11.6	050	010 R	---	----------	----------	---------	----	---	-------	2	---
07/22/40	0400	B	16.7	119	101 S	.39	Jy 09 19		Jy 19 10	-2.8	---	5-, 22o	3	Haas, NM
						.45	Ag 06 03	Jy 25 05						
08/20/40	0400	B	16.4	113	107 S	.44	Ag 06 03				---	4-, 19+	4	Haas, NM
						.50	Se 03 06	Ag 21 22	Ag 17 23	-2.2				
09/18/40	0400	D	16.0	107	113 S	.49	Se 03 06				---	2-, 6+	5	Haas, NM
						.52	Oc 01 16	Se 18 08	Se 16 15	+1.6				
09/19/40	0600	D	17.0	120	100 S	.53	Se 03 06	Se 18 08	Se 16 15	+2.7	---	1+, 5+	6	Haas, NM
						.56	Oc 01 16							
05/17/51	2200?	B	11.8	052	012 R	---	Ap 23 23				---	------	7	Wilkins, Eng.
						.85	My 22 04	My 03 17	My 21 06	-3.3				
08/25/61	0100	B	13.7	076	036 R	.98	----------	----------	Ag 26 03	-1.0	G	3+, 18-	8	Cameron,
						.98								MD
04/12/66	0105-	R,G	20.9	167	053 S	.93	Ap 03 19						9	Corralitos Obs.,
	0123					.97	My 01 14	Ap 15 18	Ap 05 11	+6.5	---	2o, 6-		NM; Whippey
04/30/66	2130-	R,G	10.0	037	-003 R	.95	Ap 03 19	Ap 15 18		-4.0	E,	3o,19o	10	Corralitos NM,
	2330					.98	My 01 14		My 04 21		VG			Sartory, Eng.
05/01/66	1930-	G,R	11.0	048	008 R	.02	My 01 14				G,	3+, 16-	11	Sartory, Eng.
	2330					.01	My 27 14	My 13 13	My 04 21	-3.0	E			
05/02/66	2015-	R	11.9	061	021 R	.03	My 01 14	My 13 13	My 04 21	-2.1	---	3+, 21o	12	Sartory, Eng.
	2019					.05	My 27 14							
05/30/66	2052-	R,G	10.4	043	003 R	.09	My 27 14				---	sc-1;	13	Sartory, Eng.
	2059					.12	Je 22 08	Je 10 08	Je 03 08	-3.5		2-, 9		
09/02/66	0450-	R	16.7	116	104 S	.52	Ag 17 07					------	14	Moseley, Ire.
	0520					.56	Se 14 17	Ag 31 23	Ag 31 00	+2.2	F			Cave, UK
09/03/66	0111-	R	17.5	126	094 S	.55	Ag 17 07	Ag 31 23	Ag 31 00	+3.0	---	ms;	15	Moore,
	0146					.59	Se 14 17					9-,44-		Moseley; Ire.
09/25/66	2020-	R	11.0	044	004 R	.43	Se 14 17				---	4 , 18	16	Moore,
	2050					.39	Oc 13 03	Se 28 01	Se 29 17	-3.8				Moseley, Ire.
10/25/66	2230	R	11.8	051	011 R	.52	Oc 13 03				---	sc;	17	Moore,
						.46	No 10 09	Oc 25 10	Oc 29 10	-3.4		4 , 29-		Moseley, Ire.
12/04/66	0105	R,G	21.4	167	053 S	.82	No 10 09				---	5-, 26	18	Whippey,
						.86	De 07 18	No 22 03	No 28 03	+6.9				Eng.
12/27/66	0630	R	15.2	089	049 R	.80	De 07 18				---	5 , 35	19	Kelsey, CA
						.79	Ja 01 10	De 20 00	De 27 18	-0.4				
01/21/67	1750-	R,G	11.0	039	-001 R	.71	Ja 01 10				G	3 , 17-	20	Moore, Eng.
	2400					.75	Ja 28 15	Ja 16 21	Ja 26 07	-4.5				
01/22/67	0010-	R	11.2	042	002 R	.72	Ja 01 10	Ja 16 21	Ja 26 07	-4.3	---	2+, 8+	21	Kilburn, Eng.
	0030					.76	Ja 28 15							
01/28/67	0004-	R	17.2	115	105 S	.98	Ja 01 10	Ja 16 21	Ja 26 07	+1.7	G	4-, 19+	22	Moseley, Ire.
	0106					.98	Ja 28 15							
02/18/67	2030-	R	9.3	021	-019 R	.69	Ja 28 15				---	2 , 10+	23	Moore, Ire.
	2040					.75	Fe 25 21	Fe 13 15	Fe 24 18	-7.1				
03/22/67	1939-	R	11.6	050	010 R	.84	Fe 25 21				---	2+, 8	24	Moseley, Ire.
	1943					.87	Mr 26 08	Mr 13 01	Mr 26 03	-3.4				
03/23/67	1840-	R,G	12.5	062	022 R	.91	Fe 25 21	Mr 13 01	Mr 26 03	-2.4	---	3-, 8+	25	Farnham,
	1850					.91	Mr 26 08							Eng.
05/20/67	2105-	R	11.2	051	011 R	.95	Ap 23 19				---	sc+1;	26	Kelsey, CA
	2120					.96	My 22 02	My 06 11	Ap 24 12	0.0		5 , 32		
06/18/67	2110-	R	10.7	045	005 R	.00	Je 18 20				---	3-, 7	27	Whippey,
	2359					.00	Jy 14 20	Je 30 20	Je 22 05	-3.3				Eng.
09/20/67	2111-	R,B,	16.4	113	107 S	.46	Se 06 08				P-F	ms?sc+1;	28	Moore, Ire.
	2146	G				.51	Oc 04 14	Se 22 00	Se 18 17	+2.2		6-, 38		
10/13/67	1917-	B	10.0	033	-007 R	.36	Oc 04 14				---	4 , 17	29	Henshaw,
	2000					.32	No 02 02	Oc 19 08	Oc 18 10	-4.9				Eng.
06/09/68	2135-	R	13.6	088	048 R	---	My 12 17				---	sc-1;	30	Miles, Eng.
	2145					.99	Je 10 03	My 26 12	Je 10 20	-0.2		3 , 16+		
10/03-	1930-	R	11.3	053	013 R	---	Se 25 20			-3.1	P	ms+1;	31	Rawlings,
04/68	0140					.29	Oc 23 15	Oc 11 17	Oc 06 12			6-, 25+		Eng.
01/22/69	0010-	R	3.8	314	-086 R	---	Ja 17 00	Ja 29 03	Fe 02 13	-11.5	---	1+, 7	32	Kilburn, Eng.
	0030					.18	Fe 14 04							
11/20/69	1706-	R,G,	11.3	046	006 R	---	No 13 02				---	3-, 8	33	Duckworth,
	1715	D				.27	De 11 00	No 29 01	No 24 00	-3.3				Eng.
11/20/69	1930-	D	11.4	047	007 R	---	No 13 02				---	3-, 8	34	Becker,
	1945					.28	De 11 00	No 29 01	No 24 00	-3.2				Holland
06/13/71	0722	D,G	19.8	147	073 S	.85	My 21 17				G	4-, 13+	35	da Silva,
						.85	Je 17 10	Je 02 14	Je 09 00	+4.3				Brazil

— Table 3 Continued on p. 60 —

Table 3—*Continued.*

Date	UT	Cat.	Age	Col.	Term. Dist.	φ/π	Perigee Dates	Apogee Date	FM Date	From FM	See.	Sol.	Seq. No.	Obs./Loc.
m/d/yr	h m		d	°	°		Mo d h	Mo d h	Mo d h	d				
02/27/72	2000	R	12.8	070	030 R	.33	Fe 17 19				---	3-, 9-	36	Kemp, Eng.
						.36	Mr 16 21	Mr 04 15	Fe 29 03	-1.2				
10/04/76	2209	R,G,	11.1	048	008 R	---	Se 25 03				---	2+, 13+	37	Foley, Eng.
		B				.34	Oc 23 13	Oc 10 12	Oc 08 05	-3.3				
05/28/77	2300?	-	≈10.8	≈042	≈002 R	---	My 04 05				---	-------	38	Robinson,
						≈.87	Je 01 15	My 18 18	Je 01 21	≈-3.9				Scotland
11/02/87	0115	B	9.3	041	001 R	---	----------							
						---	----------	----------	---------	----	---	-------	39	---
05/11/89	2200	D	6.4	346	-054 R	---	----------							
						---	----------	----------	---------	----	---	-------	40	---
03/02/90	1935	B	5.4	341	-059 R	---	Fe 28 08				---	-------	41	Williamson,
						.09	Mr 28 08	Mr 16 08	Mr 11 11	-8.7				Eng.
03/07/90	0300	B	9.7	033	-007 R	---	Fe 28 08				---	-------	42	Jean, CAN;
						.24	Mr 28 08	Mr 16 08	Mr 11 11	-4.4				Darling, WI
03/31/90	2130	R	5.0	335	-065 R	---	Mr 28 08				---	-------	43	Jackson,
						.12	Ap 25 17	Ap 12 20	Ap 10 03	-9.3				Eng.?

Table 4. Frequency of Reported LTP by Category Versus Age of Moon for Aristarchus and Gassendi.

(Columns may not total because some LTP belong to more than one category.)

	Aristarchus (43°W, 23°N)							Gassendi (40°W, 16°S)				
Age of Moon (d)	All	Bright	Dark	Gas	Red	Blue	Earth-shine	All	Bright	Dark	Gas	Red
Total	425	225	33	124	108	181	134	43	11	7	11	27
00.0-00.9	2	2	0	1	0	0	2	0	0	0	0	0
01.0-01.9	1	0	0	1	0	1	1	0	0	0	0	0
02.0-02.9	23	21	0	6	3	2	23	0	0	0	0	0
03.0-03.9	33	31	0	11	3	7	33	0	0	0	0	0
04.0-04.9	26	25	0	8	1	3	26	0	0	0	0	0
05.0-05.9	29	25	2	11	3	5	29	2	1	0	0	1
06.0-06.9	11	9	0	5	0	1	11	0	0	0	0	0
07.0-07.9	1	1	0	1	0	0	1	0	0	0	0	0
08.0-08.9	5	5	1	2	0	0	5	0	0	0	0	0
09.0-09.9	2	1	0	1	1	0	2	4	2	0	0	2
10.0-10.9	4	3	1	1	2	1	0	5	1	0	2	3
11.0-11.9	28	10	3	9	6	14	0	16	3	4	4	11
12.0-12.9	36	8	3	9	13	20	0	2	0	0	1	2
13.0-13.9	29	9	2	6	12	15	0	2	1	0	0	1
14.0-14.9	37	23	4	7	10	14	0	0	0	0	0	0
15.0-15.9	30	13	3	10	9	16	0	1	0	0	0	1
16.0-16.9	30	5	1	11	8	24	0	5	3	1	1	2
17.0-17.9	19	9	4	3	7	11	0	3	0	1	0	2
18.0-18.9	17	5	1	2	6	12	0	0	0	0	0	0
19.0-19.9	15	4	2	2	8	11	0	1	0	1	1	0
20.0-20.9	12	3	0	3	3	10	0	1	0	0	1	1
21.0-21.9	8	1	1	3	3	6	0	1	0	0	1	1
22.0-22.9	7	3	2	3	4	4	0	0	0	0	0	0
23.0-23.9	7	1	1	2	3	2	0	0	0	0	0	0
24.0-24.9	6	3	2	3	2	1	0	0	0	0	0	0
25.0-25.9	5	3	0	2	1	1	0	0	0	0	0	0
26.0-26.9	1	1	0	0	0	0	0	0	0	0	0	0
27.0-27.9	0	0	0	0	0	0	0	0	0	0	0	0
28.0-28.9	1	1	0	1	0	0	1	0	0	0	0	0
29.0-29.5	0	0	0	0	0	0	0	0	0	0	0	0

(Text continued from p. 58)

Ashen Light (Earthshine), but frequent ones for Aristarchus. Darling's group observes regularly during Earthshine and finds Aristarchus is active most of the time. I think that most of these earthshine phenomena are due to clouds at the Earth's limbs as seen from the Moon,

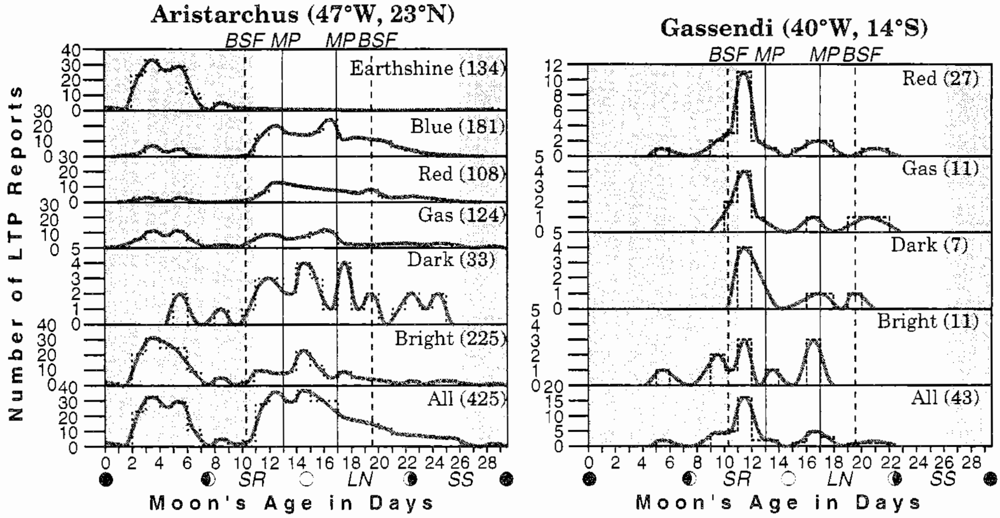


Figure 3. Histograms of number of LTP reports versus lunar age (in days) for Aristarchus (left) and Gassendi (right). The curves were drawn by eye through the midpoints of the histograms to indicate trends. The number of reports for each category are in parentheses. The average age of the Moon, sunrise (SR), and sunset (SS) are given at the bottom. Similarly, at the top are the average entrances and exits of the bow-shock front (BSF) and magnetopause (MP) of the magnetic tail. Slanted lines show when the feature is in darkness on the average. Note that all numbers for Gassendi, except for the *Red* category, are small and thus less reliable than for Aristarchus.

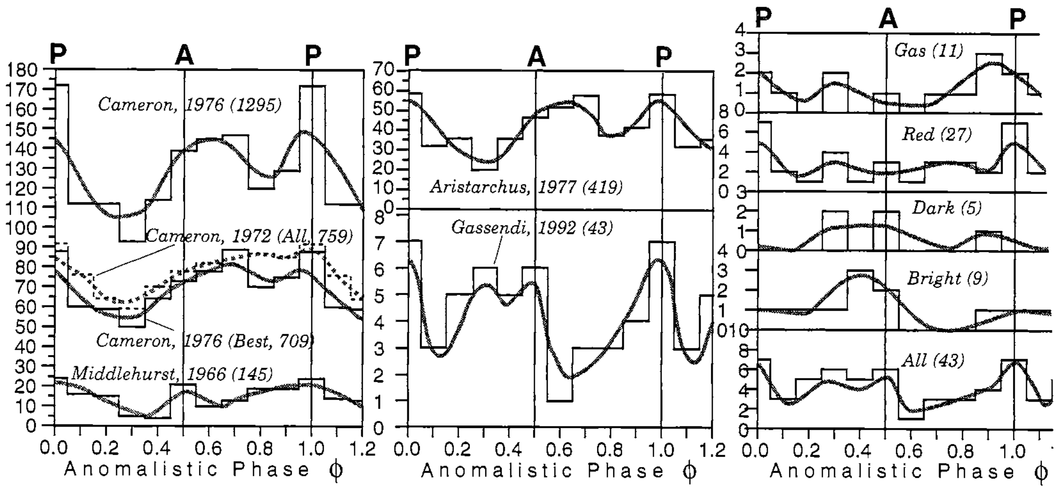
which affect Earth-shine as they do the umbral darkness of a lunar eclipse. Therefore, earthshine brightness phenomena are probably not intrinsically lunar.

If we compare Aristarchus and Gassendi for each LTP category, as well as for the total number (*All*), starting with the latter, we see that both features show strong peaks near SR. This is also near the entrance to the BSF. This could occur at or near perigee or apogee, or at the time of a magnetic storm, but these boundaries or times cannot be plotted against lunar age on a chart. Gassendi's graph has a sharp, but lesser peak at the MP exit boundary, while Aristarchus has a broad and highest peak at the MP entrance and in the MP. Now we can examine the data in terms of various categories. The numbers in parentheses in *Table 3* indicate the number of reports for each category. The numbers for the categories will often not add up to *All* because many reports cite more than one category.

Looking at brightenings, Gassendi has two major peaks, one near SR and one near the MP exit boundary, but actually there is a low in the MP. Note the very small numbers, as always, for Gassendi; less than 100 is usually considered small. Small numbers give less reliable results, as is found in succeeding analyses that use increasing numbers of observations, as illustrated in *Figure 4* (p. 62). Aristarchus' highest peak occurs in Earthshine, for which there is no hypothesis except that of mine contending that these are due to clouds at the Earth's limb. Aristarchus also has a highest maximum in the MP, where Gassendi has a minimum. Note that Gassendi's curve rises at the MP and the BSF exits. A look at the *Red* category for Gassendi shows a concentration near SR. However, at Aristarchus a rise occurs just after SR, really at the MP boundary, then gradually tapers off, dropping rather sharply at the BSF exit. Gassendi's *Red* LTP peak at the MP exit.

There were no *Blue* events seen at Gassendi. For Aristarchus, *Blue* events were frequent from SR through the MP, then fell off precipitously at the MP exit. Finally, for Gassendi, the *Gaseous* events behaved similarly to its *Red* events, with most concentrated near SR, with small rises at the MP and BSF exits. For Aristarchus there are two sets of maxima; one in Earthshine and the other at SR through MP. In conclusion, for both craters there is a strong correlation with sunrise but not with sunset. Both features show rises in LTP when the Moon is in the MP, within ±2 days of FM. We can really put little reliance on these results for Gassendi because of the small number of observations, except possibly for *All* data. The strong maximum near sunrise may be real. In fact, as we shall see later, as well as in all my publications on the subject, the highest correlation with LTP usually is with sunrise, when compared with what would be expected were there no external influences and the observations were evenly distributed throughout a lunation or anomalistic period. *Table 5* (p. 63) bears this out, as will be discussed later.

We now examine the data with respect to the anomalistic period phase (ϕ) for tides. This quantity is computed from the perigee immediately preceding, to the one immediately following, the date of observation. These results are presented in *Figure 4* (p. 62; subdivided into *4a*, *4b*, and *4c*). We can compare in *Figure 4a* [from Cameron 1977] the change in behavior for *All* events for LTP reported for all lunar features for three epochs, and see the effect of increasing the numbers of observation, rising from Middlehurst's 145 in 1966 to mine



A. All Reported Features **B. Aristarchus and Gassendi** **C. Gassendi—Categorie**

Figure 4. Figure 4a and 4b are redrawn from Cameron [1977]. **4a** shows histograms of numbers of LTP reports versus anomalistic period phase (ϕ) for all lunar features for three epochs with increasing number of observations over time, showing the change in behavior in tidal effects. The curves were drawn by eye through the midpoints of histograms in order to show trends. The first two points are repeated to the right to show trends at the critical point of perigee (P) in the hypothesis for tidal effects. Apogee (A) is also indicated at the top. **4b** gives histograms for *All* data for Aristarchus and Gassendi. **4c** shows data for LTP categories for Gassendi, showing changes in behavior between them; note that Gassendi data are based on small numbers.

of 1295 in 1976. Finally, *Figure 4c* gives Gassendi LTP by LTP category.

We are concerned here with the Gassendi and the Aristarchus data, bearing in mind that there are approximately ten times as many observations for Aristarchus than for Gassendi. The Gassendi graph has not changed much from the 1977 results, except at phase 0.2, which rises steeply from 0.1, which shifts the maximum to 0.3, where a minimum should be expected; the histograms have been plotted from the data in *Table 3*. The curves in *Figure 4* have been drawn by eye through the midpoints to show trends, giving a type of derivative of the histogram. Gassendi shows two main maxima; the stronger one at perigee (P) and another, two-peaked one, from 0.3 to 0.5 ϕ. The latter maximum is at apogee (A). We would expect a minimum at 0.25 ϕ. One does appear at 0.2 ϕ, but a peak occurs at 0.3 ϕ! We also see a two-maxima curve for Aristarchus in *Figure 4b*, where the number of LTP are nearly equal between 0.5 ϕ to 1.0 ϕ. The two features behave differently, as Gassendi dips after apogee (A) and rises sharply at perigee (P). Note that, on the tidal hypothesis, we would expect a minimum at 0.75 ϕ. In *Figure 4a*, note the change in behavior of tidal effects at Aristarchus as the numbers of observations are increased. In *Figure 4b* Aristarchus has a minimum where Gassendi has a maximum; at 0.3 ϕ. Aristarchus has a strong minimum in the first half-period and a broad maximum in the second half-period.

FIgure 4c shows the tidal behavior for Gassendi for each category of LTP; repeating *All* but excluding *Blue* events, which were not reported for this crater. Neither *Gaseous* (Gas) nor *Bright* events correlate well with the tidal hypothesis. There is a fairly definite correlation with P for *Red* events, but there are peaks at other phases where minima would be expected, making the correlation doubtful. Again, we are dealing with very small numbers, reducing the reliability of our conclusions. Even for Aristarchus, I would say that there is not a strong argument for a tidal effect because the peak lasts essentially half a period, rather than the 0.1 period expected with the boundary conditions used.

To examine the relative frequencies of observations with respect to those expected for each hypothesis and the chosen boundary conditions, see *Table 5* (p. 63). This table contains the data for Gassendi submitted by Darling. These are supplemented by my catalog data for LTP categories, but for *All* data only for Aristarchus, taken from *Table II* in Cameron [1977]. In *Table 5* I have placed in bold face the highest observed:expected (O/E) ratio, and underlined the highest percentage observed, in each category. The O/E ratio tells us how many times more LTP were observed than expected, with a value of 1.0 indicating that as many were observed as expected. For Gassendi, in each category, the highest ratio was for low-angle illumination. For all the Gassendi categories, the highest percentage of LTP occurred when the Moon was within the Earth's magnetic tail; all seven observations of darkenings. For Aristarchus, the highest ratio for the *All* data, the only computed for the paper, was for magnetic storms from solar particles, and the highest percentage was for the magnetic tail, as with Gassendi. The Aristarchus data are sufficient in number to be reliable. *Table 5* shows the relative importance of each hypothesis and does not support the often-re-

Table 5. LTP Frequency for Gassendi and Aristarchus by Boundary Condition.

Data are arranged by hypothesis: tidal, low sun-angle illumination, Earth's magnetic field, and solar activity. Under tidal; P = perigee, A = Apogee, and the boundaries are in fractions of an average anomalistic period of 27.6 days. Under low sun angle; SR = sunrise, SS = sunset, and values are the number of days (an average lunation is 29.5 days). Under Earth's magnetic field; values are the number of days from Full Moon (FM) for the boundaries of the magnetopause (MP, ±2 days), and the bow-shock front (BSF, 3.5-4.5 days and 4.5 days). Under solar activity; the maximum values during a day of the Kp (magnetic field energy) index of 6 or greater, of which 9 is the highest possible, and the occurrence of a magnetic storm in progress (ms) or its commencement (sc). O = Observed, E = Expected. For each type of event, the highest O/E-ratios are in **bold face** and the highest observed percentages are underlined.

	Gassendi (40° W, 16° S)																				Aristarchus (47° W, 23° N)			
Hypothesis	All				Red				Bright				Dark				Gas				All			
Boundaries	No.	O	E	O/E	No.	O	E	O/E	No.	O	E	O/E	No.	O	E	O/E	No.	O	E	O/E	No.	O	E	O/E
Tidal:		%	%			%	%			%	%			%	%			%	%			%	%	
±≤.05 P	8	19	10	1.9	7	26	10	2.6	1	9	10	0.9	0	0	10	0.0	1	9	10	0.9	59	14	10	1.4
±≤.05 A	7	16	10	1.6	4	15	10	1.5	4	36	10	3.6	1	14	10	1.4	1	9	10	0.9	47	11	10	1.1
±≤.10 P	10	23	20	1.1	8	30	20	1.5	2	18	20	0.9	1	14	20	0.7	1	9	20	0.4	97	23	20	1.2
±≤.10 A	10	23	20	1.1	4	15	20	0.8	4	36	20	1.8	2	29	20	1.4	1	9	20	0.4	82	20	20	1.0
±≤.05 P & A	15	35	20	1.8	11	41	20	2.0	5	45	20	2.2	1	14	20	0.7	2	18	20	0.9	106	25	20	1.2
±≤.10 P & A	20	47	40	1.2	12	44	40	1.1	6	55	40	1.4	3	43	40	1.1	2	18	40	0.4	179	43	40	1.1
Total	43				27				11				7				11				419			
Low Sun Angle:																								
+≤ 1d SR	19	46	4	**11.5**	12	44	4	**11.0**	5	45	4	**11.2**	2	29	4	**7.2**	6	55	4	**13.6**	44	10	4	2.5
-≤ 1d SS	0	0	4	0.0	0	0	4	0.0	0	0	4	0.0	0	0	4	0.0	0	0	4	0.0	10	2	4	0.5
+≤ 2d SR	24	59	8	7.4	16	59	8	7.4	5	45	8	5.6	3	43	8	5.4	7	64	8	8.0	76	18	8	2.2
-≤ 2d SS	0	0	8	0.0	0	0	8	0.0	0	0	8	0.0	0	0	8	0.0	0	0	8	0.0	16	4	8	0.5
±≤ 1d SR&SS	19	46	8	5.8	12	44	8	5.5	5	45	8	5.6	2	29	8	3.6	6	55	8	6.9	54	13	8	1.6
±≤ 2d SR&SS	24	59	16	3.7	16	59	16	3.7	5	45	16	2.8	3	43	16	2.7	7	64	16	4.0	92	22	16	1.4
Total	41				27				11				7				11				421			
Magnetic Field:																								
±≤ 2d FM	**7**	21	16	1.3	5	19	16	1.2	1	11	16	0.7	1	20	16	1.2	0	0	16	0.0	136	32	16	2.0
±≤ 3.5-4.5d FM	8	24	8	3.0	5	19	8	2.4	1	11	8	1.4	1	20	8	2.3	4	36	8	4.5	28	7	8	0.9
±≤ 4.5d FM	32	97	35	2.8	22	81	35	2.3	7	78	35	2.2	5	100	35	2.9	9	82	35	2.3	237	57	35	1.6
Total	33				27				9				5				11				419			
Solar Activity:																								
$K_{pmax} \geq 6$	3	9	2	4.5	3	12	2	6.0	1	20	2	10.0	0	0	2	0.0	1	10	2	5.0	33	9	2	**4.5**
sc, ms day	3	9	4	2.2	2	8	4	2.0	1	20	4	5.0	0	0	4	0.0	1	10	4	2.5	50	14	4	3.5
Total	33				25				5				5				10				351			

peated statement that LTP are related to tidal effects; and certainly not to that hypothesis alone. The tidal effects-only hypothesis is particularly suspect when different features are compared for behavior; Gassendi and Aristarchus here, but many features in my 1977 paper [Cameron 1977]. *Table 5* also gives narrower boundaries, 0.05, than the 0.10 that was originally adopted. The correlations are usually stronger for the narrower boundaries!

CONCLUSIONS

In summary, we find that, with regard to librations, which for the two features we are discussing was the only consideration for the data submitted by Darling, the reports are almost uniformly scattered throughout the plots. I know of no formal hypothesis for the cause of LTP to be related to librations. I venture that one would expect events to be reported during favorable librations that moved features toward the center of the disk, especially for features near the limb. For Aristarchus and Gassendi longitude librations might be significant. The two features are separated by only 7° in longitude; but by 39° in latitude, placing them in different latitude hemispheres. Therefore, favorable longitude librations would be negative for both (between 0° at -8°). In terms of latitude, negative librations (0° to -7°) would be favorable for Gassendi, but positive librations (0° to +7°) would be favorable for Aristarchus. More Gassendi LTP were reported at librations that were favorable in terms of latitude and unfavorable for longitude. For Aristarchus, more LTP were seen at favorable librations in longitude, but unfavorable librations in latitude. These results are summarized in *Table 2* and plotted in *Figure 2*. Dates and times were tabulated by Darling from Cameron's catalog, with additional more recent observations by his group of observers.

I have retabulated the data, including auxiliary data for comparison with the causal hypotheses. Graphs constructed from these tables gave the following conclusions. (1) The histograms with respect to age for *All* data show strong maxima near sunrise (SR) for both features, but not near sunset (SS), which is consistent with other analyses that I have published. This suggests a correlation with those hypotheses favoring SR; but not to low illumination alone, which would also occur near SS. (2) Both features also have strong maxima when the Moon is within the magnetic tail, which is nearly coincident with SR at the BSF entrance. Of course, perigee, apogee, or a magnetic storm might also be coincident, which would complicate interpretation as to which factor was the cause. (3) When we examine the tidal statistics for Aristarchus there is not a sharp maximum at P and a lesser one at A, as was found by Middlehurst using fewer observations, but instead there is a broad maximum from 0.5 to 1.0 ϕ and none at A. There is a broad and deep decline in LTP reports after P to A, with a minimum at 0.3 ϕ where it would be expected. However, a minimum would also be expected at 0.75 ϕ, where the numbers are high instead! Gassendi, however, has peaks at P but also at 0.3 rather than at 0.5 (A); but we are dealing with less reliable data due to small numbers of reports, as illustrated by the different behavior with successively higher numbers of observations for all features shown in *Figure 4a.* In the various LTP categories, behavioral differences appear as illustrated for *Gaseous* and *Dark* LTP for both features. Gassendi has strong maxima while Aristarchus has strong minima. *Red* LTP dip near A then rise after 0.6 ϕ.

Finally, if we compare the observations with expected frequencies on the hypothesis that no external influences are operating, we would expect them to be randomly distributed through the periods considered for each hypothesis of suggested causes. Instead we find that for Gassendi the highest O/E-ratio for *All* data is 11.5 times that expected near SR. The highest percentage of LTP were found in the MP; when the Moon was within the magnetopause of the Earth's magnetic tail. For Aristarchus, the highest O/E-ratio was for LTP occurring on the same day that a magnetic storm was in progress in the Earth-Moon System. At such times the Earth and the Moon are being bombarded by energetic solar particles. The highest percentage of LTP was within the magnetic tail for both features. The next highest percentage was near SR for Gassendi, but was for P and A together for *All* data for Aristarchus. Thus, considering the observations in this more realistic and perceptive way, we find that the tidal effects are not the only, or even the dominant, ones. In some cases, the tidal effects are less than expected. Also, the results for Gassendi must be viewed with caution as they depend on smaller, less reliable numbers.

The Darling Network is to be commended for its strong and dedicated participation in the A.L.P.O. LTP observing program. It has provided albedo data which will be analyzed and presented in a future paper, along with other observers' data including my own.

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A.L.P.O. SOLAR SECTION OBSERVATIONS FOR ROTATIONS 1837-1843 (1990 DEC 19 TO 1991 JUN 28)

By: Randy Tatum, A.L.P.O. Assistant Solar Recorder

ABSTRACT

This report summarizes A.L.P.O. Solar Section observations for Rotations 1837-1843 in terms of the morphology and development of sunspot groups. Sixteen observers from five countries contributed visual drawings and integrated-light and Hydrogen-α photographs.

INTRODUCTION

The mean International Sunspot Number, **RI**, for this seven-rotation reporting period was 142.5. The lowest rotational mean was 106.0 for Rotation 1837, followed by the highest rotational mean of 169.8 in Rotation 1843. For the American Sunspot Number, **RA**, the reporting-period mean was 142.9, and ranged from a lowest rotational mean of 117.3 in Rotation 1837 to a high of 161.2 for Rotation 1838. The highest daily **RI** was 256 on 1991 JAN 31; which was also the date of the highest daily **RA**, 253. *Figure 1* (below) graphs the two forms of sunspot number and the total number of activity regions for each rotation of this reporting period.

Activity for this period was moderately high with 12 active regions (AR's) attaining an EKC or FKC classification with a magnetic delta configuration! [E = group extends 10°-15° of solar longitude; F = group extends over 15°; K = oval penumbra with diameter over 2°.5; C = compact spot distribution; a delta (δ) configuration is one with umbrae with opposite magnetic polarity within the same penumbra] For the most part, the number of AR's was less than in the previous reporting period (Rotations 1833-1836).

The most active solar longitude range in the Northern Hemisphere was between 248°-270°. In the Sun's Southern Hemisphere longitudes 185°-196° were active with secondary sources at 144° and 350°.

All times in this report are UT (Universal Time). Cardinal directions are abbreviated (e.g., N, SW). These directions, and angular dimensions, are heliographic. AR positions are given in the form (latitude, longitude). *Preceding* (p) means celestial west, and *following* (f) means east. *Groups* are white-light collections of sunspots; "regions" are entire magnetically associated areas around sunspots in all wavelengths. AR's are enumerated by the Space Environment Services Center (SESC) of the National Oceanic and Atmospheric Administration (NOAA) in Boulder, Colorado.

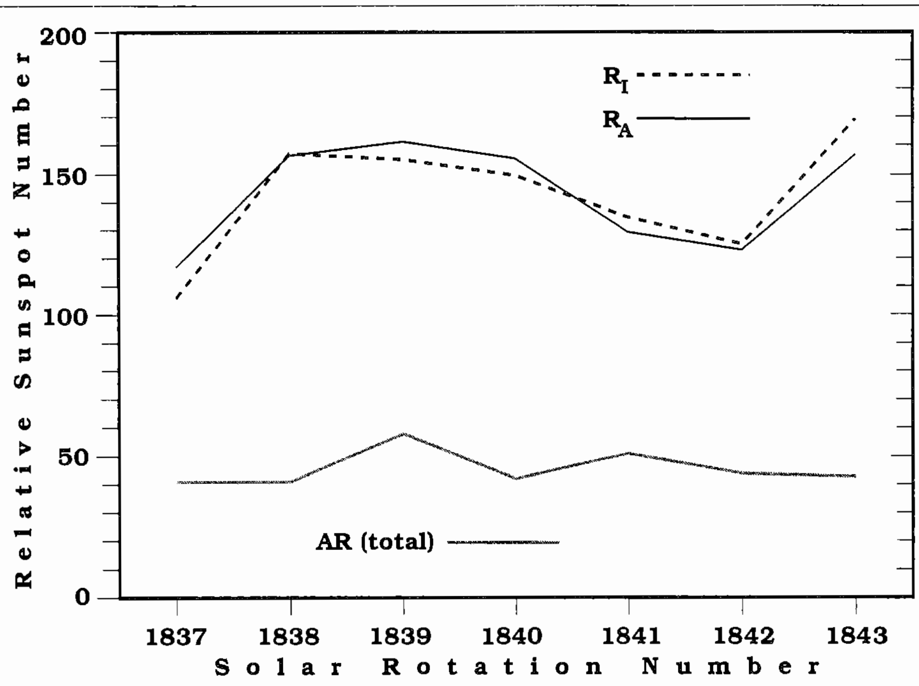

Figure 1. Graph of rotational means of R_I (Relative International Sunspot Number) and R_A (Relative American Sunspot Number), and total numbers of active regions (AR) for Rotations 1837-1843.

Table 1. Observers Contributing to This Report.

Observer	Telescope Aper.	Stop	f/	Type	Location
Clement, D.	15	6	12	Refr.	Louisiana, USA
Dragesco, J.	18	-	-	Refr.	France
	35.6	10	11	S.-C	
Garcia, G.	12	-	8.4	Refr.	Illinois, USA
	20.3	6.3	10	S.-C.	
Garfinkle, R.	25	-	10	S.-C.	California, USA
Gelinas, M.A.	20	-	10	S.-C.	Quebec, Canada
Highlen, C.	20	12.5	10	?	Indiana, USA
Hill, R.E.	9	6, 7.5	11	Refr.	Arizona, USA
Kazmer, L.	5.6	-	35	S.-C.	Illinois, USA
Mangan, M.	20.3	-	10	S.-C.	Illinois, USA
Maxson, P.	25.4	15	10	New.	Arizona, USA
Melillo, F.	20.3	6.3	10	S.-C.	New York, USA
Piorkowski, W.	12.7	-	11.6	Refr.	Illinois, USA
Rousom, J.	12.5	5	10	Refr.	Ontario, Canada
Ryder, J.	15	-	?	Refr.	Qld., Australia
Tao, Fan-Lin	25.4	-	15	Refr.	Rep. of China
Tatum, R..	18	9	15	Refr.	Virginia, USA

Notes: Aper. = telescope aperture, followed by the aperture of the *stop* if any; both in cm. *f/* = focal ratio; *New.* = Newtonian; *Refr.* = refractor; and *S.-C* .= Schmidt-Cassegrain.

The terms and abbreviations used in this report are explained in the book, *The New Observe and Understand the Sun*; which is available for US$5.75 from Marion Bachtell, Astronomical League Sales, 1901 South Tenth Street, Burlington, IA 52601. A.L.P.O. Solar Section observing forms are available from Recorder Paul Maxson (address on inside back cover).

Sixteen observers, two more than in the last previous report, from five countries contributed observations to this report, and are listed in *Table 1* (above), with data about their telescopes and observing locations. Our international observers gave us the potential for 24-hour coverage of solar activity.

ROTATION 1837 (1990 DEC 19.28 to 1991 JAN 15.62; 41 Activity Regions)

Quantity	Mean	Maximum (Dates)	Minimum (Dates)
RI	106.0	145 (JAN 13)	79 (JAN 02)
RA	117.3	146 (DEC 31)	89 (JAN 09)

All data for this rotation were in the form of white-light whole-disk drawings and photographs. As the rotation began, the dominant region was **AR 6412** (N19°, 030°), then 20° W of the central meridian (CM). Drawings by Ryder and photographs by Maxson followed the progression of AR 6412 to the W limb. This was a large bipolar group (FKO ["O"indicates an open spot distribution]), with a dominant f-sunspot; most groups have a larger p-spot. AR 6412 had a length of 20° on DEC 19. Several smaller umbrae and penumbral fragments clustered around the f-sunspot.

There were four or five smaller active regions that formed close to AR 6412. The best-developed of these was **AR 6415**, which formed on the CM 15° W of AR 6412.

AR 6412 passed around the W limb on DEC 23. It reappeared on the E limb on JAN 07 and was redesignated **AR 6444** (N16°, 022°) by SESC. Its performance was similar to before except that it was 22° in length when it crossed the CM on JAN 13. AR 6444 was recorded in drawings by Hill, Ryder, Tao, and Garfinkle, and also in photographs by Maxson. The p-sunspot was indented on its S side, giving it the appearance of a "kidney bean." Two light bridges divided its umbra into three parts.

ROTATION 1838 (1991 JAN 15.62 to FEB 11.96; 41 Activity Regions)

Quantity	Mean	Maximum (Dates)	Minimum (Date)
RI	157.5	256 (JAN 31)	91 (JAN 20)
RA	156.4	253 (JAN 30)	95 (JAN 20)

As AR 6444 passed quietly around the W limb on JAN 20, the Sun's Southern Hemisphere was coming "alive" on the E limb. The first activity to appear was a complex of three active regions consisting of **AR 6462**, **AR 6466**, and **AR 6469**. These three regions are well shown in the photograph by Dragesco in *Figure 2* (p. 67). Nearly the entire disk passage of this complex was recorded in eleven disk drawings by Hill!

AR 6462 (S18°, 203°) in white light appeared as a bipolar, FKI ["I" indicates an intermediate spot distribution], group with a dominant f-sunspot, similar in structure to AR 6412. In photographs by Dragesco and Maxson on JAN 26, the p-spot was double with the two umbrae connected by an arc of penumbrae 3° long. By JAN 29 the arc had disappeared.

A more unusual region was **AR 6466** (S8°, 196°), only 9°N of AR 6462. AR 6466 consisted of two pairs of umbrae of opposite polarity. It was classed by most of the professional observers as FKC and magnetically as Beta Gamma Delta [bipolar-, complex-, and opposite-polarity sunspots in same region]. In an H-α photograph by Dragesco one can see the intimate relationship between AR 6466 and AR 6462. Both were connected by plage and filaments and a reconnection of magnetic field lines likely occurred between the f-sunspot in AR 6462 and the opposite-polarity spot in AR 6466.

The situation became more complex with

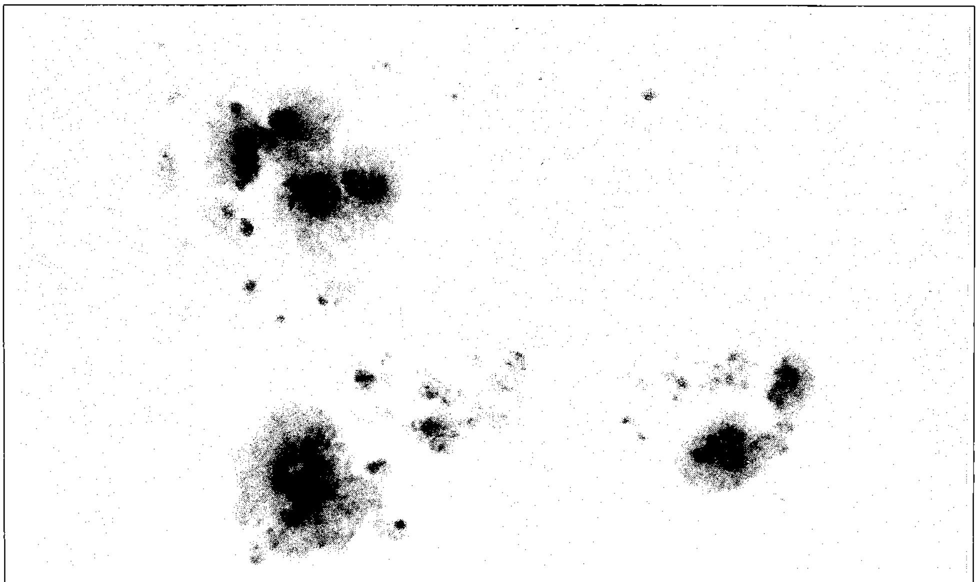

Figure 2. White-light photograph of Activity Regions 6462 (bottom) and 6466 (upper left). Taken by Jean Dragesco with a 7-inch (18-cm) refractor. 1991 JAN 26, 11h 00m UT (Rotation 1838). North at top.

the formation of **AR 6469** (S12°, 184°) on JAN 25. The emergence of these three regions so close together should not be considered a coincidence. AR 6469 developed rapidly and was led by two simple sunspots. As the three-region complex approached the W limb, AR 6469 encroached upon AR 6462 and AR 6466. AR 6469 was the last of the three to round the limb, on FEB 03.

The real star of Rotation 1838, **AR 6471** (S12°, 144°) rotated into view on JAN 25. In early photographs by Maxson on JAN 26 and 27 its large p-spot was elongated NS. All the smaller f-umbrae were in one common penumbra. A series of five high-resolution white-light photographs by Dragesco dramatically showed the evolution of AR 6471. From JAN 28 to JAN 30 the group was compact and elongated EW. The large p-spot was moving away from the rest of the group and the umbra grew in an EW direction. Following the p-spot were as many as 10 medium-size umbrae. One was observed to form between JAN 28 and 29 in the center of the group. It became the second-largest umbra of the group on JAN 30 Then sunspot motion changed the group's appearance greatly between JAN 30 and FEB 02. Three umbrae then clustered into a sunspot larger than the p-spot! The umbrae remained separated, though, and were in one large ragged penumbra. Unfortunately, no high-resolution data were available for JAN 30 or FEB 01. However, by FEB 04 the umbrae had separated. The p-spot had become curved with extensions on both ends. The photosphere was infiltrating the group on its NE side by FEB 01. At the edge of the infiltration was an arc consisting of a chain of umbrae and penumbrae. One medium-size umbra was missing its penumbra on one side, a condition that lasted for several days. On FEB 02, AR 6471 was classed FKC, Beta-Gamma-Delta. Hill recorded 37 spots in this group on the same day. The group's greatest area was 2120 millionths of the solar disk on JAN 31, and its greatest length was 19° on FEB 02.

ROTATION 1839 (1991 FEB 11.96 to MAR 11.29; 58 Activity Regions)

Quantity	Mean	Maximum (Date)	Minimum (Date)
RI	154.8	223 (FEB 21)	55 (MAR 04)
RA	161.2	230 (FEB 21)	80 (MAR 04)

The highlights of Rotation 1839 were **AR 6508** (S13°, 188°) and **AR 6509** (S20°, 194°). These were the same as the previous AR 6469 and AR 6462, respectively. On FEB 18 Maxson was the first to record these groups, on the E limb, in this rotation. His photograph showed the S sunspot of AR 6509 as the most prominent, with a well-developed penumbra. Both groups were surrounded by bright faculae. On FEB 21 Hill counted 19 umbrae in AR 6508 and 21 in AR 6509. On FEB 22 and 23 Hill, Garfinkle, and Rousom made whole-disk drawings. Tatum observed AR 6509 as an easy naked-eye sunspot on FEB 22, as did Rousom on FEB 23.

Dragesco photographed the two regions in high resolution on FEB 21, 23, and 24, the overall appearance not changing much during that period. AR 6509 had three notable spots. The leader was missing part of its penumbra and was in the process of dissolution. The middle spot was a simple circular sunspot. The large f-spot was divided by a light bridge. As for AR 6508, the p-spot was a simple sunspot. The f-spot had three or four umbrae in an irregular penumbra. Numerous pores, small umbrae, and rudimentary penumbrae were forming, and then dissolving, during this time. Both groups were classed EKI when they crossed the CM on FEB 24.

ROTATION 1840 (1991 MAR 11.29 to APR 07.59; 42 Activity Regions)

Quantity	Mean	Maximum (Date)	Minimum (Date)
RI	149.5	188 (MAR 16)	89 (APR 01)
RA	155.6	202 (MAR 16)	91 (APR 01)

Few data were available for this rotation, and most of that was on loan to researchers at the time of writing. There certainly was no lack of activity to observe!

On MAR 16, one day before **AR 6555** actually appeared at the SE limb, a large eruptive surge prominence was first noticed by Tatum at 15h 25m UT. Beginning as a bright spike 8,000 km long, it grew at a constant rate of 167 km/sec until 15h 58m UT. Its maximum height reached nearly 300,000 km. The material at the top became brighter and was visible for nearly one hour. Part of the prominence returned to the Sun along the same path as it had in its previous eruption.

AR 6555 (S24°, 185°) was a mature, complex group when it rotated into view, and was probably the return of AR 6509. A whole-disk drawing by Hill showed a large irregular f-sunspot with eight smaller spots preceding it. Hill counted 13 spots in the group. A drawing on MAR 20 by Rousom showed the large umbra as "E"-shaped. Piorkowski photographed AR 6555 in high resolution on MAR 19 and MAR 24, revealing fine penumbral structures. By MAR 24, a thick light bridge had divided the main umbra and a ragged penumbra had grown in the p-portion connected to the umbra. Almost continuous flaring was observed in AR 6555 on MAR 24 and 25. Tatum videotaped a class-2 flare [class 2 = 250-600 millionths of the disk] in H-α on MAR 24, recording the peak brightness near 14h 12m UT. The flare had three bright portions, each touching an umbra; this phenomenon is often seen with large flares.

ROTATION 1841 (1991 APR 07.59 to MAY 04.84; 51 Activity Regions)

Quantity	Mean	Maximum (Dates)	Minimum (Date)
RI	134.8	227 (APR 12&15)	33 (APR 24)
RA	129.8	218 (APR 15)	38 (APR 24)

Again, few observations are available for this rotation. The unusual nature of **AR 6580** (N29°, 286°) is evident on whole-disk photographs by Maxson. When crossing the CM on APR 13-14, the region appeared dumbell-shaped with two umbrae of equal size connected by a bridge of penumbra; the two umbrae were inferred to be of opposite polarity. Whereas the other Northern-Hemisphere AR's were located near 10°N, AR 6580 was at 29°N. The inclination of this region with respect to the E-W direction was very high; nearly 70°; the p- or leader spot was the one closer to the equator. It is common for the axes of sunspot groups to be inclined to the E-W direction; the higher the latitude, the greater the inclination. A drawing by Rousom on APR 18 showed the penumbra as having grown.

ROTATION 1842 (1991 MAY 04.84 to JUN 01.06; 44 Activity Regions)

Quantity	Mean	Maximum (Date)	Minimum (Date)
RI	125.2	177 (JUN 01)	89 (MAY 05)
RA	123.3	162 (JUN 01)	103 (MAY 05)

As the rotation began, an inconspicuous region, **AR 6615** (S10°, 350°), was growing rapidly on the CM in the S Hemisphere. Few data on this region are available, but its development is noteworthy. On MAY 05 a Maxson whole-disk photograph showed AR 6615 as a bipolar group with several smaller spots, covering 509 millionths of the disk; by MAY 08 it had grown to 1631 millionths of the disk. A disk drawing by Rousom on MAY 08 and photographs by Piorkowski on MAY 09 showed this region as triangular with eight medium-size umbrae embedded in penumbrae. AR 6615 remained complex as it crossed the W limb on MAY 11.

As AR 6615 matured in the SW quadrant of the disk, **AR 6619** (N29°, 270°) rotated into view on the NE limb. It had just cleared the limb when Maxson photographed it on MAY 05. Its structure changed little during its disk passage. The region appeared as two large umbrae, the p-umbra being the larger, nearly touching each other within a large circular penumbra. H-α filtergrams by Clement on MAY 12 and by Dragesco on MAY 14 showed that the two umbrae were of opposite polarity, thus constituting a large delta configuration. A long winding filament divided the two umbrae; filaments form along magnetic inversion lines. There was an overall lack of smaller umbrae associated with this region. Several excellent high-resolution photographs were obtained by Piorkowski and Garcia from MAY 09 to MAY 14; a photograph by the latter is shown in *Figure 3* (p. 69). A great deal of penumbral detail could be seen and penumbral filaments appeared to spiral away from the large umbra, running parallel to each other between the umbrae along the inversion line. AR 6619, the return of AR 6580, crossed the CM on MAY 11 and the W limb on MAY 18.

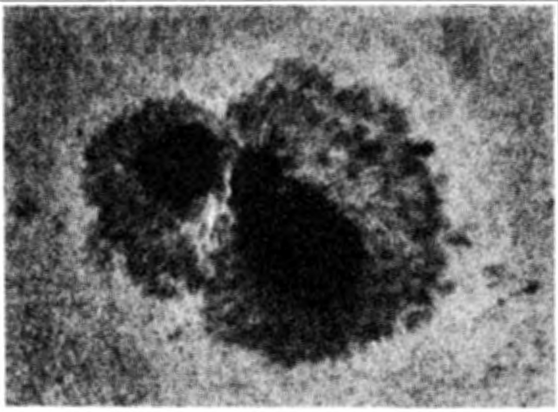

Figure 3. Photograph by Walter Piorkowski; 1991 MAY 11, 13h 53m UT (Rotation 1842), showing Activity Region 6619 near the central meridian. 5-inch (12.7-cm) refractor at effective-f/148. Kodak Technical Pan TP2415 Film, 1/500 sec exposure. North at top. Note bright penumbral filaments between opposite-polarity umbrae.

ROTATION 1843 (1991 JUN 01.06 to JUN 28.26; 43 Activity Regions)

Quantity	Mean	Maximum (Dates)	Minimum (Date)
RI	169.8	251 (JUN 09)	117 (JUN 23)
RA	156.6	200 (JUN 10&11)	114 (JUN 23

This summary for Rotation 1843 will be devoted to one active region, **SESC 6659** (N31°, 248°). It was the premier region of Sunspot Cycle 22 and one of the greatest flare producers ever studied. It was classified as an EKC sunspot group in the Mcintosh system and was a large magnetic delta configuration. All its major sunspot umbrae of both polarities were enclosed in the same penumbra.

Excellent high-resolution white-light photographs by Dragesco and Piorkowski showed the fine umbral and penumbral structure with resolution better than one arc-second. Dodged photographs taken by Piorkowski on JUN 08 and 09 enhanced the umbral details and showed thin, bright light bridges crossing the largest umbra from the NW side. In addition, a few dark cores appeared, separated by lighter veiled regions; large sunspot umbrae are never uniformly dark. The light bridges appeared to be extensions of bright penumbral filaments. In a series of high-resolution white-light photographs by Dragesco, the growth of the complex light bridges can be studied. During JUN 05-12, bridges were observed to divide a single umbra into five parts. The smaller f-umbra was apparently of polarity opposite to that of the large umbra and was separated from it by a magnetic inversion, or neutral line. Penumbral filaments ran parallel to the sheared inversion line between the umbrae, while the edges of both umbrae were smooth. Normally, penumbral filaments are radial to an umbra and the edge of the umbra is irregular. Along the inversion line formed small elongated umbral material and streaks darker than penumbral filaments. On JUN 09, the large umbra had a "tail" that wrapped partly around the umbra of opposite polarity. Most of the magnetic stress occurred along the inversion line and was the site of most of the flare activity. Recurrent flaring was recorded in H-α video by Tatum on JUN 08. Then, dark, active filaments were recorded by Melillo, Garcia, and Tatum on JUN 09 and 10.

The appearance of AR 6659 was similar to that of the other great flare producer of Cycle 22, AR 5395. However, AR 5395 was sheared into a stream of smaller sunspots and gradually became less active, while AR 6659 remained compact and maintained the same overall magnetic geometry throughout its entire disk passage. The disk passage of AR 6659 was illustrated well in a series of nine white-light whole-disk photographs by Highlen, and was observed as a naked-eye sunspot from JUN 05 to JUN 12 by Tatum. Both groups had a high northern latitude; AR 5395 was located at N34° and AR 6659 was at N31°. Comparing size, AR 5395 had a maximum area of 3500 millionths of the disk and AR 6659 peaked at 2300 millionths.

Size, however, is not the most important factor in flare production. AR 6659 produced five great flares that saturated the GOES satellite's X-Ray sensors, while AR 5395 had produced only one. These sensors saturate for flares above X-12 [a flux greater than 12×10^{-4} w m^{-2}]. One of these great flares was photographed by Dragesco on JUN 15. In H-α light, it lasted nearly four hours and was classified as 3B [bright, 600-1200 millionths of the disk]. Because AR 6659 was then approaching the W limb, and the flare saturated the image in the core H-α line, it is difficult to interpret the event. At 09h 15m UT on JUN 15 two bright U-shaped flare ribbons were visible, wrapping around the sunspots while loops

Figure 4. The great flare of 1991 JUN 15 (Rotation 1843) photographed in H-α light by Jean Dragesco, 09h 15m UT, 35.6-cm Schmidt-Cassegrain. North at top. This flare was associated with Activity Region 6659. Note the bright loops growing between ribbons.

were forming between the ribbons, as shown in *Figure 4* (p. 69). By 10h 35m UT the flare was fading and three bright loop tops were visible as prominences. The flare produced enough protons with energies above 500 mev to create a cosmic-ray ground-level event (GLE) on Earth, which lasted from 09h to 11h UT. There was a delay of 24-48 hours between successive large flares, which indicated the time required to build up energy for each flare. Unfortunately for American observers, the largest flares occurred during the night hours in North America.

A possible rapid change in the photosphere was photographed near AR 6659 by Garcia on JUN 24 at 14h 43m UT, showing two bright features just outside the penumbra. They were 5 arc-seconds apart and each was approximately 1-2 arc-seconds across. They appeared brighter than the faculae. By 15h 17m, as shown in *Figure 5* (below), they had faded to facular brightness. In addition, a small nearby umbra that previously had been dark had become indistinct. These changes did not appear to be due to seeing conditions.

Patrick S. Mcintosh of SESC described the unusual motion of AR 6659 in a recent paper [8]. It had been followed for three disk passages and was rotating remarkably slowly for its latitude, with a synodic period of 29.5 days. SESC assigns the same active region a new number for each of its disk passages; AR 6659 had previously been AR 6619 and shifted nearly 80° in longitude in three months!

CONCLUSION

It is gratifying to see such high-quality data from our observers. These observations are in demand by solar researchers, so that there is often more than one request for data for a particular region; it is important to make at least two copies of your observations.

Sunspot Cycle 22 is one of the strongest cycles on record. In fact, four of the five greatest solar cycles have occurred in the last 50 years! Cycle 22 was characterized by a very rapid rise to maximum in 1989 JUN, and had a secondary maximum in mid-1991. Solar activity levels then plummeted after 1992 FEB, heralding the beginning of the decline to solar minimum, expected about 1996. Isolated high activity has occurred in previous cycles within a year of sunspot minimum, so Cycle 22 may still have surprises for observers.

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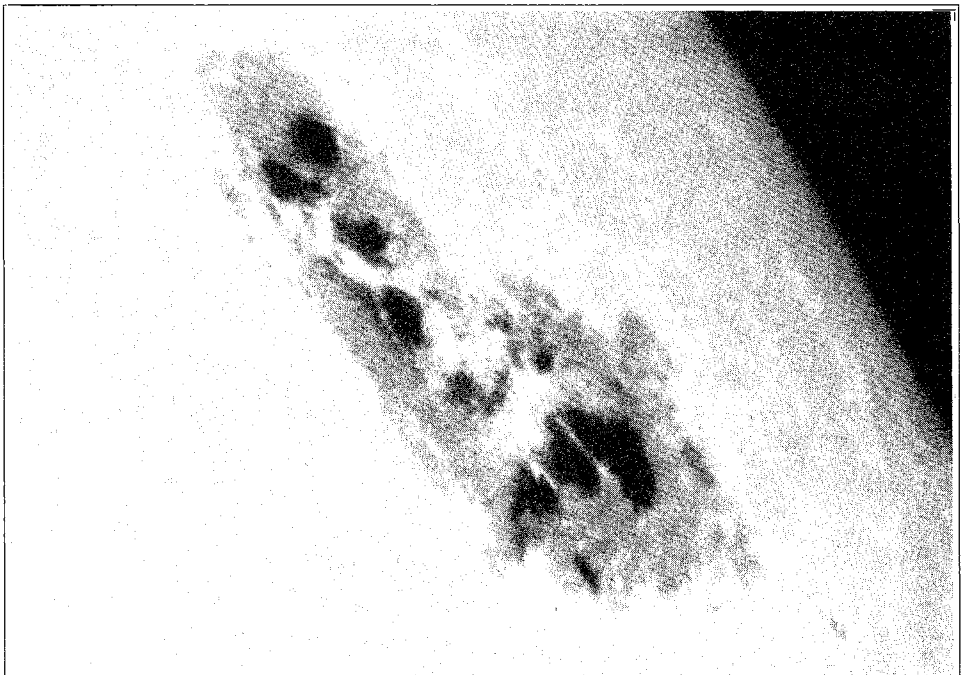

Figure 5. Activity Region 6659 photographed by Gordon Garcia on 1991 JUN 14, 15h 17m UT (Rotation 1843). 12.0-cm refractor at effective-f/95. Kodak TP 2415 Film, 1/1000 sec. Solar Skreen and W58 (green) Filters. North at top.

THE INTERNATIONAL LEONID WATCH

By: Mark A. Davis

ABSTRACT

A brief history of the Leonid Meteor Shower is given with emphasis on the storms of 1833, 1866, and 1966. With conditions favorable for a return of a storm toward the end of this decade, the International Leonid Watch is described.

The Leonid Meteor Shower normally is not very impressive, especially when compared with other major showers such as the Perseids or Geminids. However, this November shower does have a history of providing a rare spectacle in astronomy, that of a major meteor storm. *Meteor storms* are very rare events in which hundreds and even thousands of meteors light up the sky every hour. With conditions excellent for the next Leonid storm to occur near the end of this decade, many amateur astronomers will begin spending their November mornings anxiously awaiting the return of this most wonderful sight.

A search of historical records shows that the Leonids have been observed with certainty since the year 902 [Roggemans, 1989]. However, modern observations of them did not begin until the Leonid storm of November 13, 1833, when the Leonids were first recognized as a meteor shower. In the following year, Hubert A. Newton identified previous returns in the years 931, 934, 1002, 1202, 1366, 1582, 1602, and 1698. He was also able to determine that the Leonids storms had a period of 33.25 years [Kronk, 1988].

In 1866 the Leonids returned, as had been predicted by Newton, and provided a storm with rates reported as high as 5000 per hour. Shortly after the 1866 storm, astronomers recognized a similarity between the orbit of the Leonids and that of Comet Tempel-Tuttle. Discovered by Wilhelm Tempel in December, 1865, and by Horace Tuttle in January, 1866, Comet Tempel-Tuttle has a period of approximately 33 years and provides the particles for the annual Leonid Meteor Shower. With their past success at predicting the return of the Leonid storm, astronomers in 1899 began encouraging the public to be ready for the next storm, which they predicted would occur that year. Sadly, the Leonids failed to produce a storm in 1899, which prompted Charles P. Olivier to call this "the worst blow suffered by astronomy in the eyes of the public." [Olivier, 1925]

The next predicted Leonid storm in 1932 did show an enhanced activity, but it was nothing like the two major storms in 1833 and 1866. The most famous of all Leonid storms occurred with its return in 1966. The United States was the most favorable location for witnessing the return. In Arizona, on the night of November 17, a group of observers reported meteors raining down at a maximum rate of 2,400 per minute!

Due to the 33-year period of the Leonids, another storm may come in 1998 or 1999. With the large number of people expected to be outside anticipating a repeat of the 1966 storm, the International Meteor Organization (IMO) is hoping to enlist a large portion of these people to aid in the collection of data on the Leonids. Because of this opportunity, the IMO has established the International Leonid Watch (ILW).

The primary goals of the ILW are to determine meteoroid spatial density distributions throughout the Leonid period of activity; to ascertain the position and size of the *radiant*, which is the point in the sky from which the meteors appear to originate; and to determine the orbits of individual stream particles [Brown, 1991]. In order to accomplish these goals, we will collect visual, photographic, and radio observations.

The easiest way to monitor Leonid activity is visual. To ensure that one's observations are compatible with all other observations collected worldwide, observing sites should have the darkest skies possible, and reports should contain only individual data, rather than combined group data. In addition, we also need the following information:

Beginning/Ending Time.—Record the double date (e.g., November 16/17) and the beginning and ending time of the observing period in Universal Time (UT). Report observing intervals as blocks of 1 to 3 hours. During the shower maximum, observations should be reported in time intervals of 1.5 hours.

Total Time.—This is the total time spent actually observing the sky during the session; for example, one block of 1.5 hours and a second block of 2.5 hours equals 4.0 hours total for the session.

Limiting Magnitude.—Find the visual magnitude of the faintest star visible to the naked eye. Make this estimate for at least three locations in the sky and at several times during a night's session.

Meteors Observed.—Classify all meteors as either Leonids or "Sporadics" (non-Leonids). A meteor's speed and direction can help to distinguish a Leonid from the Sporadic background. Leonid meteors will appear to move very fast and appear to originate from a point in Leo. This point, known as the radiant, appears to drift among the background stars from day to day. At the shower maximum on

NOV 17, it is located at right ascension 152° (10h 08m), declination +22°.

Magnitude Data.—Record the apparent magnitude of each meteor. This can be determined by comparison with stars of known magnitude, such as Gamma Leo (+2.0 magnitude).

If you should witness a Leonid storm, a time will come when you cannot accurately record data for each observed meteor. Therefore, when observing near the Leonid maximum, we recommend that you supplement visual observation with photography using a 35-mm camera if possible.

In brief, the camera should be mounted on a fixed tripod and pointed toward the zenith, the point on the sky directly overhead, when the altitude is less than 45° above the horizon. When the radiant altitude is greater than 45°, the camera should be pointed as close to the zenith as possible, but approximately 50° away from the radiant. In the latter case. orient the long axis of the film frame parallel to the horizon [Brown, 1991]. A 50-mm focal length lens with black-and-white ISO 400 film is recommended. Depending on background light pollution, exposure of up to several minutes should be possible.

I encourage A.L.P.O. members to participate in the ILW by starting a monitoring program this year during the period of November 5-25, 1993. In normal years, the Leonids may be expected to produce between 10 and 20 meteors per hour near the date of maximum, November 18. However, as we approach the end of the decade and Comet Tempel-Tuttle draws nearer to the Earth, these rates may begin to increase. For this reason, amateurs have already begun monitoring Leonid activity for the ILW. Reporting forms, a list of radiant positions and stars for magnitude estimates, as well as other information regarding the ILW may be obtained by writing to the A.L.P.O. Meteors Section Recorder, whose address is given on the inside back cover.

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METEORS SECTION NEWS

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

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

1993 UT Date	Observer and Location	Universal Time	Number and Type of Meteors Seen	Comments (*+N* = Limiting Magnitude)
JAN 02	John Gallagher, NJ	06:30-08:36	2 SPO	+7.5
03	" " "	05:30-08:19	8 QUA, 4 SPO	+7.3
	Robert Lunsford, CA	09:48-10:48	2 QUA, 1 COM, 3 SPO	+5.4; 25% cloudy
	Frank Melillo, NY	10:00-11:00	7 QUA, 2 SPO	+4.5
	Robert Lunsford, CA	10:48-11:48	11 QUA, 2 COM, 3 SPO	+5.6
	" " "	11:48-12:48	16 QUA, 6 SPO	+5.8
	Michael Morrow, HI	12:00-14:00	2 QUA, 4 SPO	+4.9
	Robert Lunsford, CA	12:48-13:48	14 QUA, 5 SPO	+5.6
04	Michael Morrow, HI	13:00-14:15	2 SPO	+4.4
20	John Gallagher, NJ	05:35-07:40	1 COM, 1 DCA, 4 SPO	+7.2
21	George Zay, CA	03:00-13:45	2 DCA, 43 SPO	+5.5
	John Gallagher, NJ	05:25-07:31	3 DCA, 3 SPO	+7.5
22	George Zay, CA	02:53-13:34	1 DCA, 38 SPO	+5.4
24	" " "	03:00-09:31	5 DCA, 31 SPO	+5.3
26	John Gallagher, NJ	05:40-07:13	4 SPO	+7.5
30	" " "	05:50-08:30	1 DCA, 2 VIR, 9 SPO	+7.5
FEB 02	George Zay, CA	03:00-13:45	19 SPO	+5.1
	John Gallagher, NJ	05:30-07:36	8 SPO	+7.0
03	George Zay, CA	03:10-11:52	21 SPO	+5.0
05	John Gallagher, NJ	06:05-08:08	3 SPO	+7.3

Table 1 continued on pp.73-75 with note on p.75

Table 1. Recent A.L.P.O. Meteor Observations—*Continued.*

1993 UT Date	Observer and Location	Universal Time	Number and Type of Meteors Seen	Comments (+N = Limiting Magnitude)
FEB 09	John Gallagher, NJ	05:45-07:47	2 SPO	+6.1
13	Mark Davis, SC	04:00-05:00	5 SPO	+5.0
14	" " "	04:00-06:00	7 SPO	+5.0; 20& cloudy
15	George Zay, CA	02:16-11:55	17 SPO	+5.5
	John Gallagher, NJ	05:20-07:22	1 VIR	+7.5
19	Mark Davis. SC	04:00-06:00	1 DLE, 10 SPO	+5.1
	John Gallagher, NJ	05:45-07:50	3 SPO	+7.0
20	John Gallagher, NJ	05:55-08:01	2 SPO	+7.3
23	Mark Davis, SC	02:30-03:30	1 DLE, 4 SPO	+5.1
25	John Gallagher, NJ	05:45-07:47	1 SLA, 1 SPO	+7.5
28	George Zay, CA	03:01-05:16	1 DLE, 1 SPO	+3.6
	Tom Giguere, HI	09:45-10:45	1 DLE, 1 SPO	+4.8
	Michael Morrow, HI	09:45-10:45	4 SPO	+4.8
MAR 01	John Gallagher, NJ	05:40-07:45	2 DLE, 4 SPO	+7.5
02	George Zay, CA	09:05-11:18	3 SPO	+4.5
	Robert Lunsford, CA	09:48-12:48	1 DLE, 11 SPO	+5.8
04	George Zay, CA	09:12-12:33	1 DLE, 9 SPO	+4.4
06	" " "	12:00-13:21	5 SPO	+4.5
07	" " "	02:31-04:37	5 SPO	+3.9
09	" " "	02:30-04:35	2 SPO	+4.2
11	" " "	02:30-12:34	24 SPO	+5.1
12	John Gallagher, NJ	06:25-08:27	1 VIR, 1 SLA, 1 SPO	+7.0
13	George Zay, CA	03:35-06:55	8 SPO	+4.6
15	Mark Davis, SC	03:30-05:30	8 SPO	+5.0; 15% cloudy
16	George Zay, CA	02:25-03:29	*None Seen*	+3.9
	Mark Davis, SC	04:00-06:00	6 SPO	+4.9; 25% cloudy
	Robert Lunsford, CA	09:10-13:10	1 VIR, 17 SPO	+5.7
17	George Zay, CA	03:55-06:11	2 SPO	+4.4
	Robert Lunsford, CA	09:00-10:00	*None Seen*	+3.8
18	George Zay, CA	04:09-05:49	4 SPO	+4.6
19	John Gallagher, NJ	05:30-07:34	4 SPO	+5.6
21	George Zay, CA	03:30-13:03	1 VIR, 3 DLE, 33 SPO	+5.6
22	Daniel Rhone, NJ	01:20-02:20	3 SPO	+3.0
	George Zay, CA	02:12-13:00	35 SPO	+5.7
	Robert Lunsford, CA	05:00-13:00	2 VIR, 26 SPO	+6.4
23	George Zay, CA	02:10-13:00	1 DLE, 1 VIR, 50 SPO	+5.7
	John Gallagher, NJ	05:00-07:06	1 VIR, 4 SPO	+6.6
	Robert Lunsford, CA	09:15-13:00	3 VIR, 36 SPO	+6.8
27	John Gallagher, NJ	05:25-07:08	1 VIR, 1 MLE, 1 SPO	+6.7
30	George Zay, CA	08:52-12:43	19 SPO	+5.5
APR 03	" " "	04:45-12:37	2 ASC, 1 VIR, 15 SPO	+4.5
08	John Gallagher, NJ	05:50-07:23	3 SPO	+6.4
09	" " "	04:30-06:18	1 LYR, 1 SPO	+6.8; 10% cloudy
12	" " "	03:30-04:32	1 EDR, 1 SPO	+7.4
14	George Zay, CA	03:54-12:25	1 ABO, 18 SPO	+5.6
	John Gallagher, NJ	05:00-07:04	1 APU, 1 SLE, 1 WCA, 2 SPO	+7.3
	Robert Lunsford, CA	07:30-12:30	4 VIR, 3 SLE, 1 LYR, 24 SPO	+6.2
16	George Zay, CA	06:00-12:20	1 VIR, 1 SAG, 1 LYR, 13 SPO	+5.7

---------- *Table 1 continued on pp.74-75 with note on p.75* ----------

Table 1. Recent A.L.P.O. Meteor Observations—*Continued.*

1993 UT Date	Observer and Location	Universal Time	Number and Type of Meteors Seen	Comments (+N = Limiting Magnitude)
APR 17	George Zay, CA	03:15-12:18	1 VIR, 2 ASC, 3 LYR, 27 SPO	+5.7
18	Mark Davis, SC	04:45-05:45	1 ABO, 1 LYR, 13 SPO	+5.4
	George Gliba, WV	07:59-08:59	4 LYR, 5 SPO	+6.3
	George Zay, CA	09:48-11:42	3 LYR, 1 VIR, 1 ABO, 10 SPO	+5.6
19	John Gallagher, NJ	04:25-06:26	1 SPO	+6.7
20	Robert Lunsford, CA	09:15-12:15	4 LYR, 1 ASC, 4 SPO	+5.9
	Michael Morrow, HI	09:20-10:50	5 SPO	+4.7; 35% cloudy
21	George Zay, CA	03:00-12:15	11 LYR, 1 VIR, 1 ABO, 27 SPO	+5.7
	Michael Morrow, HI	08:00-09:30	2 SPO	+5.0; 50% cloudy
	Tom Giguere, HI	08:09-09:30	*None Seen*	+4.5; 15% cloudy
	Robert Lunsford, CA	09:15-12:15	1 LYR, 1 ABO, 7 SPO	+5.9
22	Charles Douglas, KS	03:55-07:30	10 LYR, 4 SPO	+5.5
	Vic Winter, KS	03:55-10:30	66 LYR, 10 SPO	+5.5
	Robert Lunsford, CA	04:44-12:15	85 LYR, 1 ABO, 51 SPO	+6.7
	George Zay, CA	04:44-12:13	47 LYR, 1 ABO, 3 VIR, 23 SPO	+5.6
	Kathy Machin, KS	05:18-08:55	24 LYR, 8 SPO	+5.4
	Mark Davis, SC	05:35-07:45	10 LYR, 2 ASC, 2 ABO, 23 SPO	+5.3
	Ron Rosenwald, TX	07:50-09:00	7 LYR, 5 SPO	+5.0
	Michael Morrow, HI	08:00-10:40	4 LYR, 2 SPO	+4.3; 50% cloudy
	Tom Giguere, HI	08:10-10:40	4 LYR, 2 SPO	+4.3; 65% cloudy
	Damien Mathew, ND	09:03-10:00	10 LYR, 2 SPO	+5.0
	Earl Mead, CO	09:45-10:45	11 LYR, 1 SPO	+4.4
24	John Gallagher, NJ	04:50-07:59	3 LYR, 1 ABO, 1 AVB, 4 SPO	+6.7
	Frank Melillo, NY	06:25-06:40	1 LYR	+4.5
25	Robert Lunsford, CA	03:15-12:15	2 LYR, 1 SLE, 1 ABO, 1 ETA, 1 ASC, 21 SPO	+6.5
	George Zay, CA	03:42-12:09	1 VIR, 2 NOP, 2 LYR, 2 ABO, 25 SPO	+5.7
	Michael Morrow, HI	07:35-09:00	1 VIR	+5.0; 65% cloudy
	Tom Giguere, HI	07:50-09:00	1 LYR, 1 SPO	+5.5; 65% cloudy
26	John Gallagher, NJ	04:15-05:47	1 GVR, 1 SLE, 1 SPO	+6.2
	Earl Mead, CO	07:10-08:10	4 ABO, 3 SPO	+4.5
	Robert Lunsford, CA	09:00-12:00	5 SPO	+5.7
27	Robert Hays, IN	05:50-07:50	1 FBO, 1 MVI, 1 LYR, 1 ABO, 12 SPO	+6.0
	Earl Mead, CO	06:45-08:00	2 SPO	+4.5
28	John Gallagher, NJ	04:50-06:56	1 MVI, 1 APU, 1 BLE, 2 SPO	+7.1
29	" " "	04:30-06:36	3 SPO	+6.9
	Robert Lunsford, CA	08:30-12:00	1 SLE, 2 ASC, 1 ABO, 1 WCA, 8 ETA, 30 SPO	+6.8
MAY 02	John Gallagher, NJ	05:00-07:36	6 SPO	+6.4
	George Zay, CA	08:00-11:55	8 ETA, 1 NOP, 10 SPO	+4.9
	Robert Lunsford, CA	09:00-12:00	10 ETA, 18 SPO	+6.5
07	Richard Taibi, MD	----------------	2 ETA	------
08	John Gallagher, NJ	05:30-07:32	1 SPO	+6.2
	Richard Taibi, MD	----------------	*None Seen*	------
11	George Zay, CA	03:22-11:41	1 ABO, 1 ASC, 21 SPO	+5.1
	John Gallagher, NJ	04:15-06:20	5 SPO	+6.6
15	John Gallagher, NJ	04:45-06:51	1 AVB, 1 ABO, 2 UMI, 4 SPO	+6.9
21	" " "	05:10-06:21	1 ABO	+5.5
22	" " "	06:00-08:10	5 SPO	+6.9
	George Zay, CA	09:00-11:40	2 NOP, 17 SPO	+5.5
23	" " "	03:00-11:40	1 ASC, 1 GSA, 1 SOP, 23 SPO	+5.7
24	Robert Lunsford, CA	08:00-09:00	*None Seen*	+7.0; 50% cloudy
25	" " "	09:00-10:00	*None Seen*	+5.6; 50% cloudy

Table 1 continued on p.75 with note

Table 1. Recent A.L.P.O. Meteor Observations—*Continued.*

1993 UT Date	Observer and Location	Universal Time	Number and Type of Meteors Seen	Comments (+N = Limiting Magnitude)
MAY 26	Robert Lunsford, CA	09:30-10:30	9 SPO	+6.5
27	John Gallagher, NJ	04:25-07:32	1 SOP, 1 OSC, 1 ETA, 3 SPO	+6.9
30	" " "	05:25-08:01	7 SPO	+7.5
31	" " "	05:40-07:48	7 SPO	+7.4
JUN 01	George Zay, CA	03:30-11:45	2 NOP, 2 ASC	+5.2
	Robert Lunsford, CA	09:00-12:00	1 DAR, 18 SPO	+6.7
02	John Gallagher, NJ	05:00-07:36	3 THE, 1 GSA, 3 SPO	+6.7
07	" " "	04:00-06:35	1 UMI, 3 SPO	+6.8
12	" " "	05:05-07:45	1 JAQ, 3 SPO	+7.3
13	" " "	04:45-07:23	1 JAQ, 1 ISC, 7 SPO	+7.4
	Frank Melillo, NY	06:15-07:15	1 TOP	+4.5
14	John Gallagher, NJ	04:50-06:53	3 SPO	+7.4
	Frank Melillo, NY	04:50-05:50	1 TOP, 1 SPO	+4.5
15	George Zay, CA	03:30-11:30	1 OSC, 25 SPO	+5.5
	Frank Melillo, NY	04:45-05:45	*None Seen*	+4.5
	John Gallagher, NJ	04:50-06:23	1 JLY, 1 SPO	+7.3
	Damien Mathew, ND	06:15-07:15	1 JLY, 11 SPO	+5.5
	Robert Lunsford, CA	08:55-11:55	12 SPO	+6.3
16	George Zay, CA	03:30-11:31	5 JLY, 1 TOP, 1 CSC, 27 SPO	+5.5
	Robert Lunsford, CA	09:00-11:30	5 JLY, 20 SPO	+6.4
17	Frank Melillo, NY	04:30-05:30	1 TOP, 1 JLY	+4.5
	John Gallagher, NY	07:00-08:05	1 BCG, 4 SPO	+6.5; 15% cloudy
18	" " "	03:50-06:28	2 BCG, 2 JLY, 4 SPO	+6.5
19	Karl Simmons, FL	04:48-05:51	4 SPO	+6.2
	Wanda Simmons, FL	04:48-06:02	1 JLY, 5 SPO	+6.0
20	John Gallagher, NJ	05:00-07:04	1 BCG, 1 SPO	+5.7
22	Frank Melillo, NY	04:30-05:30	*None Seen*	+4.5
23	John Gallagher, NJ	04:40-07:49	2 BCG, 9 SPO	+7.4
	Robert Lunsford, CA	06:30-09:30	2 JLY, 12 SPO	+5.7
24	Frank Melillo, NY	04:20-06:05	2 JLY, 4 SPO	+4.8
	John Gallagher, NJ	06:25-08:11	4 SPO	+7.5
25	George Zay, CA	03:30-11:33	1 SAG, 2 TOP, 2 LSA, 36 SPO	+5.7
	Frank Melillo, NY	04:20-05:55	1 JLY, 2 SPO	+4.8
	John Gallagher, NJ	05:00-07:48	1 JLY, 1 DCP, 4 SPO	+7.5
26	George Zay, CA	03:30-09:30	4 TOP, 14 SPO	+5.2
	Frank Melillo, NY	05:00-06:00	1 SPO	+4.8
	John Gallagher, NJ	05:15-07:58	2 JLY, 2 BCG, 4 SPO	+7.4
28	" " "	03:50-05:58	3 BCG, 1 RSA, 1 SPO	+7.2
	Robert Lunsford, CA	08:30-11:30	42 SPO	+6.9
29	George Zay, CA	03:30-11:34	25 SPO	+5.2
	Robert Lunsford, CA	08:30-11:30	41 SPO	+6.7

Key to Abbreviations:

ABO	Alpha Boötid	EDR	Eridanid	OSC	Omega Scorpiid
APU	Alpha Puppid	ETA	Eta Aquarid	QUA	Quadrantid
ASC	Alpha Scorpiid	FBO	Phi Bootid	RSA	Rho Sagittariid
AVB	Alpha Virginid, Radiant B	GSA	Gamma Sagittariid	SAG	Sagittarid
BCG	Beta Cygnid	GVR	Gamma Virginid	SLA	Sigma Leonid (Feb.)
BLE	Beta Leonid	ISC	Iota Scorpiid	SLE	Sigma Leonid (Apr.)
COM	Coma Berenicid	JAQ	June Aquilid	SOP	South Ophiuchid
CSC	Chi Scorpiid	JLY	June Lyrid	SPO	Sporadic
DAR	Delta Arietid	LSA	Lambda Sagittariid	THE	Tau Herculid
DCA	Delta Cancrid	LYR	Lyrid	TOP	Theta Ophiuchid
DCP	Delta Cepheid	MLE	March Leonid	UMI	May Ursid
DLE	Delta Leonid	MVI	Mu Virginid	VIR	Virginid
		NOP	North Ophiuchid	WCA	Omega Capricornid

COMET CORNER

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

COMET FINDS DURING THE FIRST HALF OF 1993

There were no bright comets visible during early 1993 and by mid-year there was nothing brighter than magnitude +11. In addition, no comets were discovered by amateurs in 1993 through the month of July. Below are the discoveries and recoveries that were made by professional astronomers.

Comet Mueller (1993a).—Jean Mueller, taking a plate on JAN 02 from Palomar Mountain for the Second Palomar Sky Survey, discovered this comet in the north polar region when it was at magnitude +15. Its perihelion distance is 1.9 AU [1 Astronomical Unit equals the mean distance of the Earth from the Sun; 149,597,870 km]. The comet is well-placed for Northern-Hemisphere observers and will remain so through early 1994. (See *Table 4,* pp. 77-78.)

Periodic Comet Bus (1993b).—The A.L.P.O. Assistant Comets Recorder Jim Scotti recovered this comet on JAN 01 at magnitude +22, using the 36-in (91-cm) Spacewatch telescope at Kitt Peak. This comet will be closest to the Sun at 2.2 AU in mid-1994 when it is predicted to be magnitude +17.

Periodic Comet Tempel 1 (1993c).—Jim Scotti also recovered this comet, on JAN 21, when at magnitude +21. This comet takes 5.50 years to orbit the Sun and should reach magnitude +11 in mid-1994.

Comet Mueller (1993d).—Jean Mueller's second comet discovery of the year was made on MAR 19. The comet had reached perihelion several months earlier, however, at 5.9 AU. It has remained faint.

Periodic Comet Shoemaker-Levy 9 (1993e).—This is one of the most interesting comets ever found. Carolyn Shoemaker found 1993e on plates exposed by Eugene Shoemaker, David Levy, and P. Bendjoya on MAR 24, when it was only a few degrees from Jupiter at magnitude +14.

The comet's appearance was unusual; it was elongated, with several nuclei in a line. We now know that the comet was close to Jupiter in July, 1992, and was probably torn apart by Jupiter's gravity. Comet P/1993e is predicted to collide with Jupiter in late July, 1994. Portions of it that miss Jupiter will survive as mini-comets in new orbits. [Also see the announcement on p. 92 concerning A.L.P.O. plans to observe this extremely rare impact.]

Periodic Comet Forbes (1993f).—M. Candy of Perth Observatory recovered this comet on MAR 21. It takes 6.1 years to orbit the Sun and is remaining faint.

Periodic Comet Reinmuth 2 (1993g).— Jim Scotti recovered this comet as well. Taking 6.6 years to orbit the Sun, it may reach magnitude +14 in mid-1994.

Comet Shoemaker-Levy (1993h).—Discovered on MAY 23, this comet never got closer to the Sun than 5.9 AU. It also remained faint, at magnitude +17, and is now pulling away from the Sun.

Periodic Comet Holmes (1993i).—T. Seki of Japan recovered this comet on MAY 24 when it was at magnitude +18; it will remain faint.

Periodic Comet Neujmin 3 (1993j).—Jim Scotti recovered this comet on MAY 25, when it was at magnitude +22. It takes nearly 11 years to orbit the Sun and will remain faint.

Periodic Comet Shajn-Shladach (1993k).— Jim Scotti recovered this comet, also on MAY 25. It will remain near magnitude +18, and has a 7.5 -year orbital period.

Comet Helin-Lawrence (1993L).—E. Helin and K. Lawrence found this comet on MAY 17 with the 18-in (46-cm) Schmidt telescope at Palomar Mountain. The comet was then at magnitude +17. With a near-circular orbit and a distant perihelion, taking 9.5 years to orbit the Sun, this comet will not get much brighter.

Periodic Comet Hartley 3 (1993m).—Jim Scotti recovered this comet on MAY 17. The comet was then at magnitude +19 and will not get much brighter. It takes 6.8 years to orbit the Sun.

Periodic Comet Whipple (1993n).—Jim Scotti recovered this comet on JUN 25. It will remain faint, with an orbital period of 8.5 years.

PRESENT COMET ACTIVITY

Comet activity is expected to pick up as we end 1993 and enter 1994. There has recently been a drought of amateur-found comets, but you never know when a new bright comet will be found. You may wish to observe the comets described below; if so, contact the A.L.P.O. Comets Recorder (address given on the inside back cover).

Periodic Comet Schwassmann-Wachmann 1.—This comet remains far from the Sun, at 5 AU, and is very faint. Sometimes, though, it will outburst and reaches magnitude +11 or +12. We never know when this will occur. Thus, you may wish to monitor this comet. (See *Table 1,* p. 77.)

Periodic Comet Schwassmann-Wachmann 2.—Not to be confused with the previous comet, this object will brighten to 11th magnitude within the next few months. Its orbital period is 6.4 years, and it stays outside the orbit of Mars. (See *Table 2*, to right.)

Periodic Comet Shoemaker-Levy 9 (1993e).—This comet's orbit is closely tied to the planet Jupiter, and its fate in July 1994 has been mentioned above. It has many nuclei and multiple tails. This object will remain faint but those of you with large telescopes, or photographic or CCD equipment, or both, may wish to observe it. (See *Table 3*, to lower right)

Comet Mueller (1993a).— This comet has a highly inclined retrograde orbit that brings it into the northern circumpolar region. It is presently living up to the magnitude forecasts. This comet is not periodic and thus will not return to the inner Solar System. (See *Table 4*, to lower right and p. 78.)

Periodic Comet Encke.—This comet has the shortest orbital period of all—3.3 years. This time around it appears in our evening winter sky. It will be a binocular object and is still brightening, but we will lose it in the evening twilight early in 1994. (See *Table 5*, p. 78)

EPHEMERIDES

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. Following our ephemerides are given orbital elements for those who wish to compute their own ephemerides.

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

1993-94 UT Date (0h UT)	2000.0 Coörd. R.A. h m	Decl. ° '	Elongation from Sun °		Total Mag.
Nov 04	07 49.5	+25 44	107	M	+17.6
09	07 49.7	+25 45	112	M	+17.6
14	07 49.5	+25 45	117	M	+17.6
19	07 49.1	+25 47	122	M	+17.6
24	07 48.3	+25 49	127	M	+17.5
29	07 47.3	+25 52	133	M	+17.5
Dec 04	07 45.9	+25 55	138	M	+17.5
09	07 44.3	+25 58	143	M	+17.5
14	07 42.5	+26 01	149	M	+17.4
19	07 40.3	+26 05	154	M	+17.4
24	07 38.0	+26 08	160	M	+17.4
29	07 35.5	+26 12	165	M	+17.4
Jan 03	07 33.0	+26 14	171	M	+17.4
08	07 30.3	+26 17	175	M	+17.4
13	07 27.7	+26 19	175	E	+17.4
18	07 25.0	+26 20	170	E	+17.4
23	07 22.4	+26 21	165	E	+17.4
28	07 20.0	+26 21	160	E	+17.4
Feb 02	07 17.7	+26 20	154	E	+17.5
07	07 15.5	+26 19	149	E	+17.5
12	07 13.6	+26 16	143	E	+17.5
17	07 12.0	+26 14	138	E	+17.5
22	07 10.6	+26 10	133	E	+17.5
27	07 09.5	+26 06	127	E	+17.6

Table 2. Ephemeris of Periodic Comet Schwassmann-Wachmann 2.

1993-94 UT Date (0h UT)	2000.0 Coörd. R.A. h m	Decl. ° '	Elongation from Sun °		Total Mag.
Nov 04	08 08.8	+17 35	101	M	+12.1
09	08 15.0	+17 18	105	M	+12.0
14	08 20.7	+17 03	108	M	+11.9
19	08 25.8	+16 49	112	M	+11.8
24	08 30.4	+16 37	116	M	+11.7
29	08 34.3	+16 28	120	M	+11.6
Dec 04	08 37.5	+16 22	124	M	+11.5
09	08 40.1	+16 20	129	M	+11.4
14	08 41.8	+16 21	134	M	+11.4
19	08 42.8	+16 26	138	M	+11.3
24	08 43.0	+16 35	144	M	+11.2
29	08 42.4	+16 48	149	M	+11.1
Jan 03	08 41.1	+17 05	154	M	+11.1
08	08 39.1	+17 26	160	M	+11.0
13	08 36.5	+17 49	166	M	+11.0
18	08 33.5	+18 15	172	M	+11.0
23	08 30.2	+18 42	178	M	+10.9
28	08 26.8	+19 09	177	E	+10.9
Feb 02	08 23.5	+19 35	171	E	+11.0
07	08 20.5	+20 00	165	E	+11.0
12	08 18.0	+20 22	159	E	+11.0
17	08 16.0	+20 42	153	E	+11.0
22	08 14.7	+20 58	148	E	+11.1
27	08 14.2	+21 11	143	E	+11.2

Table 3. Ephemeris of Periodic Comet Shoemaker-Levy 9 (1993e).

1993-94 UT Date (0h UT)	2000.0 Coörd. R.A. h m	Decl. ° '	Elongation from Sun °		Total Mag.
(Too close to the Sun for observation.)					
Dec 09	14 05.9	-13 39	043	M	+14.2
14	14 09.5	-13 57	047	M	+14.2
19	14 13.0	-14 15	051	M	+14.2
24	14 16.4	-14 32	056	M	+14.2
29	14 19.6	-14 48	060	M	+14.1
Jan 03	14 22.7	-15 03	064	M	+14.1
08	14 25.6	-15 17	069	M	+14.1
13	14 28.2	-15 29	073	M	+14.1
18	14 30.7	-15 41	077	M	+14.0
23	14 32.9	-15 51	082	M	+14.0
28	14 34.9	-16 00	087	M	+14.0
Feb 02	14 36.7	-16 07	091	M	+13.9
07	14 38.2	-16 14	096	M	+13.9
12	14 39.3	-16 18	101	M	+13.9
17	14 40.2	-16 22	105	M	+13.8
22	14 40.8	-16 23	110	M	+13.8
27	14 41.1	-16 24	115	M	+13.8

Table 4. Ephemeris of Comet Mueller (1993a).

1993-94 UT Date (0h UT)	2000.0 Coörd. R.A. h m	Decl. ° '	Elongation from Sun °		Total Mag.
Nov 04	19 05.1	+71 48	098	E	+9.5
09	19 32.2	+66 49	098	E	+9.4

(Continued on top of p. 78)

Ephemeris of Comet Mueller—Continued.

1993-94 UT Date (0h UT)	2000.0 Coörd. R.A. h m	Decl. ° '	Elongation from Sun °		Total Mag.
Nov 14	19 52.0	+61 38	096	E	+9.3
19	20 07.5	+56 26	094	E	+9.3
24	20 20.3	+51 19	092	E	+9.3
29	20 31.3	+46 26	088	E	+9.3
Dec 04	20 41.0	+41 51	085	E	+9.3
09	20 49.8	+37 35	080	E	+9.3
14	20 57.8	+33 42	076	E	+9.4
19	21 05.4	+30 10	072	E	+9.5
24	21 12.4	+27 00	067	E	+9.5
29	21 19.1	+24 09	062	E	+9.6
Jan 03	21 25.6	+21 35	058	E	+9.7
08	21 31.7	+19 18	053	E	+9.7
13	21 37.6	+17 14	049	E	+9.8
18	21 43.4	+15 23	044	E	+9.9
23	21 48.9	+13 44	040	E	+9.9
28	21 54.3	+12 13	035	E	+10.0
Feb 02	21 59.5	+10 51	031	E	+10.1

(Too close to the Sun for observation.)

Table 5. Ephemeris of Periodic Comet Encke.

1993-94 UT Date (0h UT)	2000.0 Coörd. R.A. h m	Decl. ° '	Elongation from Sun °		Total Mag.
Nov 29	22 40.4	+07 29	097	E	+12.1
Dec 04	22 36.3	+06 36	091	E	+11.7
09	22 33.3	+05 51	085	E	+11.3
14	22 31.3	+05 12	080	E	+10.9
19	22 30.2	+04 38	074	E	+10.5
24	22 29.6	+04 08	069	E	+10.1
29	22 29.5	+03 40	064	E	+9.6
Jan 03	22 29.4	+03 12	059	E	+9.2
08	22 29.0	+02 38	053	E	+8.8
13	22 27.5	+01 54	048	E	+8.4
18	22 24.1	+00 46	041	E	+7.9
23	22 16.8	-01 04	034	E	+7.5

(Too close to the Sun for observation.)

Update: Comet Mueller (1993p)

[At the risk of causing confusion, we have to announce the discovery of yet another Comet Mueller!]

Comet Mueller (1993p) was discovered by Jean Mueller on plates exposed on Aug 16 during the Second Palomar Sky Survey. At that time it was at magnitude +14 and located near the planetary nebula M76.

This comet has a highly inclined orbit and will reach perihelion at 0.97 AU in late March, 1994. It is presently moving westward, and then will turn southward, crossing the Equator in mid-December. By then it will be in the evening sky, at about magnitude +10. At the end of February, observers in the Northern Hemisphere will lose this comet in the evening twilight. when it will be at about magnitude +8. The Southern Hemisphere will then pick it up in the evening sky where it may be a binocular object of magnitude +7. It will then dim as it returns northward, allowing Northern-Hemisphere observers a chance to view it again in June and July, 1994. Its ephemeris before solar conjunction is given below in *Table 6.*

Table 6. Ephemeris of Comet Mueller (1993p).

1993-94 UT Date (0h UT)	2000.0 Coörd. R.A. h m	Decl. ° '	Elongation from Sun °		Total Mag.
Nov 04	23 21.3	+28 29	133	E	+11.3
09	23 13.5	+24 52	128	E	+11.2
14	23 06.9	+21 14	121	E	+11.1
19	23 01.6	+17 38	115	E	+11.0
24	22 57.4	+14 09	108	E	+10.9
29	22 54.4	+10 49	102	E	+10.8
Dec 04	22 52.4	+07 41	095	E	+10.7
09	22 51.3	+04 45	089	E	+10.6
14	22 51.0	+02 01	083	E	+10.5
19	22 51.6	-00 30	077	E	+10.5
24	22 52.8	-02 50	071	E	+10.4
29	22 54.7	-05 00	066	E	+10.2
Jan 03	22 57.1	-07 02	060	E	+10.1
08	23 00.1	-08 55	055	E	+10.0
13	23 03.5	-10 42	050	E	+9.9
18	23 07.4	-12 24	046	E	+9.7
23	23 11.7	-14 01	041	E	+9.6
28	23 16.3	-15 36	037	E	+9.4

(Too close to the Sun for observation.

Those wishing to compute their own ephemerides for these six comets may use the orbital elements given in *Table 7* below. In order, the elements are: The UT date of perihelion passage, the perihelion distance, the argument of the perihelion, the longitude of the ascending node, the orbital inclination, and the orbital eccentricity.

Table 7. Orbital Elements of Current Comets.

Value	Sch.-Wach. 1	Sch.-Wach. 2	Sho.-Levy 9	Mueller (1993a)	Encke	Mueller (1993p)
Perihelion Passage (T)	1989 Oct 26.7	1994 Jan 23.9	1994 Apr 17.8	1994 Jan 13.3	1994 Feb 09.5	1994 Mar 26.4
Perihelion Dist. (q, AU)	5.7718	2.0703	5.3825	1.9371	0.3309	0.9672
Arg. of Perihelion (ϖ)	049°.897	358°.142	356°.349	130°.669	186°.270	261°.056
Long. of Asc. Node (Ω)	312°.123	125°.624	220°.502	144°.723	334°.729	193°.791
Orbital Inclination (i)	009°.367	003°.757	005°.061	124°.878	011°.941	105°.032
Orbital Eccentricity (e)	0.04466	0.39875	0.17370	1.00000	0.85021	1.00000

COMING SOLAR-SYSTEM EVENTS: NOVEMBER, 1993 - JANUARY, 1994

WHAT TO LOOK FOR

This will be a busy three-month period, with a Transit of Mercury, a partial solar eclipse, a total lunar eclipse, and three occultations of bright planets by the Moon. There are also three close planetary conjunctions, eleven predicted occultations of stars by minor planets, and rare events involving Saturn's satellites Iapetus and Tethys.

This column is intended to alert our readers to coming events in the Solar System; giving visibility conditions for major and minor planets, the Moon, comets, and meteors. You can find more detailed information in the 1993 edition of the *A.L.P.O. Solar System Ephemeris.* (See p. 96 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), 8 hours to PST, 7 hours to MST, 6 hours to CST, and 5 hours to EST. Note that this addition may well put you into the next UT day!

PLANETS: MAINLY SATURN

All the planets pass near the Sun in late 1993-early 1994. The evening sky is sparsely occupied by Saturn, Uranus, and Neptune. Venus is departing the predawn sky, but Jupiter and Pluto are rising higher before dawn.

Mercury, because of its rapid motion, belongs to both the morning and evening sky. Two apparitions of Mercury occur in these three months, both favorable for observers in the Northern Hemisphere. The first is a morning one, centered on NOV 22, the date of Greatest Western Elongation (19°.7); the planet will be at least 15° from the Sun between NOV 14-DEC 07 with *dichotomy* (half-phase) *predicted* for NOV 19, 22h. Mercury's second apparition is a evening one. Greatest Eastern Elongation is on FEB 04, with the planet then 18°.3 from the Sun, and at elongation 15° or greater from JAN 27-FEB 12. Dichotomy is forecast for FEB 05, 13h. Note that the first apparition will officially begin with a rare **Transit of Mercury** across the Sun, which is described in the article "The Coming Transit of Mercury: 1993 NOV 06" on pp. 84-85 of this issue.

Venus moves from the morning to the evening sky, passing through *superior conjunction* on 1994 JAN 17. Thus, in this period it will probably be visible only in November, just before dawn.

Mars is too near to the Sun to be observed, itself passing through conjunction on DEC 27.

Jupiter is only slightly easier to observe than Mars. The Giant Planet passes through conjunction earlier, on OCT 18, so by December it is far enough from the Sun to be observable before dawn. By the beginning of 1994, Jupiter is 60° W of the Sun and is easily found at magnitude -1.8. Its disk should show some detail since its equatorial diameter is then 34", rising to 37" by 1994 FEB 01.

Saturn continues to be conspicuous in the evening sky. Moving from Capricornus to Aquarius, it remains observable until mid-January, 1994. During this period, its magnitude dims from +0.7 to +0.9, and its equatorial diameter diminishes from 17" to 15". During the same period the Ring major axis contacts from 40" down to 35". Its minor axis contracts proportionally still more, from 9" to 6", because its tilt to our line of sight decreases from 13°N to 10°N.

The Earth and Sun continue to lie near the plane of Saturn's "two-faced" satellite **Iapetus**. On NOV 15, this moon *transits* (passes in front of) Saturn's Globe. This is a rare event; but unfortunately the tiny 11th-magnitude satellite, with a 0".22 diameter disk, will be hard to spot. It is predicted to *ingress* at Saturn's E limb at 09h 41m; and to *egress* at the SW limb at 19h 58m. The next Iapetus event is an *occultation* on DEC 26 that begins with disappearance on the SW limb at 16h 24m and ends with reappearance on the SE limb at 22h 59m.

The 10th-magnitude satellite **Tethys** continues its series of eclipses, and the UT's of disappearance and reappearance for eclipses of Tethys for 1993 NOV-1994 JAN are given in *Table 1* below.

Table 1. Eclipses of Tethys by Saturn, 1993 NOV - 1994 JAN.

(Events behind Saturn's limb are italicized.)

NOV 01	11:19.6-12:13.8	DEC 18	16:02.0-17:26.4
NOV 03	08:37.9-09:33.7	DEC 20	13:20.6-14:45.9
NOV 05	05:56.2-06:53.6	DEC 22	10:39.2-12:05.5
NOV 07	03:14.6-04:13.4	DEC 24	07:57.9-09:25.0
NOV 09	00:32.9-01:33.3	DEC 26	05:16.5-06:44.5
NOV 10	21:51.3-22:53.1	DEC 28	02:35.1-04:04.0
NOV 12	19:09.8-20:12.9	DEC 29/30	23:53.7-01:23.5
NOV 14	16:28.2-17:32.7	DEC 31	21:12.3-22:42.9
NOV 16	13:46.7-14:52.4	*1994*	
NOV 18	11:05.1-12:12.2	JAN 02	18:30.9-20:02.4
NOV 20	08:23.6-09:31.9	JAN 04	15:49.5-17:21.8
NOV 22	05:42.1-06:51.6	JAN 06	13:08.2-14:41.3
NOV 24	03:00.6-04:11.3	JAN 08	10:26.8-12:00.7
NOV 26	00:19.2-01:31.0	JAN 10	07:45.4-09:20.1
NOV 27	21:37.7-22:50.7	JAN 12	05:04.0-06:39.5
NOV 29	18:56.2-20:10.4	JAN 14	02:22.6-03:58.9
DEC 01	16:14.8-17:30.0	JAN 15/16	23:41.2-01:18.3
DEC 03	13:33.3-14:49.7	JAN 17	20:59.8-22:37.6
DEC 05	10:51.9-12:09.3	JAN 19	*18:18.4*-19:57.0
DEC 07	08:10.5-09:28.9	JAN 21	*15:37.0*-17:16.3
DEC 09	05:29.1-06:48.5	JAN 23	*12:55.7*-14:35.7
DEC 11	02:47.7-04:08.1	JAN 25	*10:14.2*-11:55.0
DEC 13	00:06.2-01:27.7	JAN 27	*07:32.8*-09:14.3
DEC 14	21:24.8-22:47.3	JAN 29	*04:51.4*-06:33.6
DEC 16	18:43.4-20:06.8	JAN 31	*02:10.0*-03:52.9

(We thank Brian Loader for furnishing the predictions above. The other bright satellites will gradually follow suit as the Sun and the Earth approach Saturn's Ring plane, crossing it in 1995.)

Uranus and **Neptune** are essentially unobservable. Uranus reaches conjunction on 1994 JAN 12, one day later than Neptune.

Pluto, near the Serpens-Libra border, reaches conjunction with the Sun on NOV 17. It will thus be hard to find until it is sufficiently high in the predawn sky in January.

The proximity of several planets to the Sun means that there will be several planetary conjunctions, some of them close ones. It also means that the proximity of the Sun will make these events hard to observe. Conjunctions of planets approaching to within 1°.0 or less, with the solar elongation and respective visual magnitudes given in parentheses, are: (1) 1993 NOV 08, 17h—Venus 0°.4 N of Jupiter (17° W; -3.9, -1.6); (2) 1993 NOV 14, 13h—Mercury 0°.7 N of Venus (16°W; +0.7, -3.9); and (3) 1993 DEC 25, 08h—Mercury 1°.0 S of Venus (6°W; -0.9, -3.9).

There are two close conjunctions in January, but they occur within 3° of the Sun and cannot be seen. Another interesting but sadly unobservable event occurs on 1994 JAN 09, when five planets lie within 4° of the Sun—Mercury, Venus, Mars, Uranus, and Neptune!

MINOR PLANETS

Five of the brighter **minor planets** reach opposition during 1993 NOV-1994 JAN and will be bright enough to be visible in binoculars. Their 10-day ephemerides are and will be given in the 1993 and 1994 editions of the *A.L.P.O. Solar System Ephemeris*, and their opposition data are given below:

	Opposition Data		
Minor Planet	1993-94 Date	Stellar Magnitude	Declination& Constellation
12 Victoria	NOV 17.9	+10.0	19°N Tau
89 Julia	NOV 29.2	+9.8	46°N Per
30 Urania	DEC 18.6	+9.8	26°N Tau
37 Fides	DEC 30.4	+9.7	28°N Gem
115 Thyra	JAN 29.9	+9.9	18°N Cnc

In addition, two of the "Big Four" minor planets, **1 Ceres** and **4 Vesta,** will be about 7th-8th magnitude during this period and in the evening sky.

THE MOON

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

New Moon	First Quarter	Full Moon	Last Quarter
OCT 15.5	OCT 22.4	OCT 30.5	NOV 07.3
NOV 13.9	NOV 21.1	NOV 29.3	DEC 06.7
DEC 13.4	DEC 20.9	DEC 29.0	JAN 05.0
JAN 12.0	JAN 19.9	JAN 27.6	FEB 03.3

The four lunations listed above constitute Numbers 876-879 in Brown's series. Note that the New Moon on NOV 13 causes a partial solar eclipse, described on the next page. The following Full Moon, on NOV 29, undergoes a total lunar eclipse, which is described in a separate article on pp. 82-83.

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	North	East	South
NOV 06	NOV 09	NOV 18	NOV 21
DEC 03	DEC 06	DEC 16	DEC 19
DEC 29	JAN 02	JAN 13	JAN 15
JAN 25	JAN 29	FEB 08	FEB 11

Our lunar E and W directions follow the convention of the International Astronomical Union, with Mare Crisium near the *east* limb.

During this period the librations are well-synchronized with the phases; the lunar limb will be tilted toward us when there is favorable lighting. First, the S limb can be seen well on NOV 19-25, DEC 16-22, and JAN 14-18. The N limb will be displayed favorably on NOV 06-11, DEC 03-08, DEC 30-JAN 04, and JAN 27-31, with a desirable northerly solar latitude of 1°.43-1°.46 in the last period. The E limb can be well seen on NOV 16-21 and DEC 16-18. Finally, the W limb can be seen well on NOV 03-08, DEC 01-04, DEC 29, and JAN 27.

LOTS OF OCCULTATIONS

Eleven minor planets will occult stars in 1993 NOV-DEC. (As we go to press we do not have predictions for 1994; consult the January, 1994, issue of *Sky & Telescope* or the 1994 edition of the R.A.S.C. *Observer's Handbook* when they become available.) *Table 2* (p. 81) 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 four events—those of NOV 04, DEC 11, DEC 21, and DEC 31—involve stars bright enough easily to be seen in binoculars.

The Moon will occult bright planets three times in Lunation 877! Unfortunately, the Moon will be very close to the Sun when these occur, so they will be visible at best from the narrow zones on the Earth where the Moon will be above the horizon and the Sun below. In each case the Moon will be only 1 percent illuminated. The particulars are: (1) NOV 14, about 18h UT; an occultation of Mars, at magnitude +1.4, 12°E of the Sun. The dark-limb disappearance may be visible just after sunset from the Canary and Açores Islands. (2) DEC 12, about 11h UT; Mercury (Mag. -0.6) is occulted, 12°W of the Sun. Possible views of the dark-limb reappearance may be had just before sunrise from the E Caribbean Basin. (3) DEC 12, about 18h UT; Venus (Mag. -3.9) is occulted 8°W of the Sun. The dark-limb reappearance may be glimpsed from the State of Hawaii.

Table 2. Occultations of Stars by Planets, 1993 Nov-Dec.

(For further information, consult the A.L.P.O. Solar System Ephemeris: 1993 or the 1993 Asteroidal Occultation Supplement to Occultation Newsletter, Vol 5, No. 9.)

1993 UT Date	Occulting Object	Visual Mag. Object	Visual Mag. Star	Predicted Visibility Zone
Nov 04.64	**449 Hamburga**	13.3	7.5	Indonesia
13.02	**712 Boliviana**	13.6	9.4	Africa
21.85	**15 Eunomia**	10.2	8.9	Africa
23.21	**407 Arachne**	12.9	9.1	Scandinavia, NW Canada
27.79	**444 Gyptis**	12.0	8.7	N Africa, SW-NE Asia
Dec 11.08	**12 Victoria**	11.7	7.7	Africa, South America
11.14	**105 Artemis**	12.9	8.9	South America
11.99	**156 Xanthippe**	13.8	8.7	India, Africa, South America
21.47	**9 Metis**	10.5	6.8	Tasman Sea
22.12	**97 Klotho**	10.2	7.7	South America
31.99	**181 Eucharis**	12.5	9.0	Central Asia

Solar and Lunar Eclipses

As sometimes happens, we have a solar and a lunar eclipse in the same lunation. The **total lunar eclipse of 1993 Nov 29** is described separately on pp. 82-83.

On **1993 Nov 13 a partial solar eclipse** will be visible in S and SE Australia and New Zealand in the morning, and in South America S of about 39°S in the afternoon. It will be visible as well in the S Pacific; and also in Antarctica, where the eclipse's maximum magnitude of 0.928 occurs. Because this event happens only a week after the Transit of Mercury visible from Australia, many observers traveling to that area for the transit may stay on for the eclipse. The local circumstances for some selected cities that will see some or all of the eclipse are given in *Table 3* (below).

Table 3. Local Circumstances, Partial Solar Eclipse: 1993 Nov 13.

Location	Maximum Eclipse UT h	m	Sol. Alt. °	Mag. %
Alice Springs, Australia*	20	13.5	-1	12.0
Sydney, Australia	20	22.9	+19	19.0
Adelaide, Australia	20	25.5	+9	32.2
Melbourne, Australia	20	28.8	+16	32.3
Wellington, New Zealand	20	46.4	+42	9.8
Christchurch, New Zealand	20	48.7	+40	16.7
Valdivia, Chile†	23	20.1	+4	2.0

* At sunrise, taking refraction into account.
† Sun sets before eclipse ends.

Comets

The column by Don E. Machholz, "Comet Corner," on pp. 76-78 and the *A.L.P.O. Solar System Ephemeris: 1993* list five known comets that are predicted to be 12th magnitude or brighter during at least part of this period. Of these, **Comets Mueller (1993a)** and **Mueller (1993p)** may be as bright as 9th, and **Comet Encke** is predicted to attain 7th, magnitude; they should be readily visible in small telescopes, or even in binoculars from dark sites.

The above is a conservative statement of comet visibility since it of course does not take into account any discoveries that may be made after this column is written!

Meteor Showers

(Contributed by Robert D. Lunsford, A.L.P.O. Meteors Recorder. Local times are used unless otherwise stated.)

The **Leonids** are predicted to reach maximum activity on Thursday morning, November 18. The Moon is new on the 13th so there will be no lunar interference. Leonid shower members may be seen from the 15th through the 22nd and radiate from the sickle of Leo. The radiant rises near midnight and shower members are better seen later in the morning as the radiant rises higher in the eastern sky. It is now five years to Comet Temple-Tuttle's perihelion, so a real possibility of enhanced rates is at hand.

The **Geminids** will produce a strong display on Monday evening, December 13 and on Tuesday morning, the 14th. Good counts commence shortly after sundown and continue the entire night. From 11 P.M. to 2 A.M., rates from dark-sky locations should exceed 100 per hour. With the New Moon occurring on the 13th, the entire period of Geminid activity, December 7-18, will be relatively free from moonlight. Since the Perseids were either clouded out or weakly seen from most parts of North America this year, the Geminids will be the shower of the year and we recommend that you do not miss it.

The **Ursids** will reach maximum on Wednesday morning, December 22. The Moon will not be full until the 28th, so lunar interference is negligible for morning observers. This shower is active from December 17th-26th. Rates up to 15 per hour may be expected on the morning of maximum activity.

The **Quadrantids** are expected to reach maximum activity near 18h UT on 1994 Jan 03 UT. The Moon will be near its last quarter phase and will cause significant interference to the display. Since the 1993 display did not occur at the time predicted, it is possible that North America may still see a rich display. It would be advisable to face northward with the Moon at your back to see this shower at its best.

A Total Eclipse of the Moon For The Americas: 1993 Nov 29

On 1993 Nov 29, for the first time since 1971, observers throughout North America, as well as in western South America, will be able to see an entire total eclipse of the Moon. Other areas will see at least part of the event: The beginning phases will be visible throughout Europe and also in western Asia and most of Africa. The last portion of the eclipse is above the horizon in most of the Pacific Basin; including New Zealand, eastern Australia, northeast Asia, and Japan. The detailed limits of terrestrial visibility of the eclipse events are plotted in *Figure 1* (to the right).

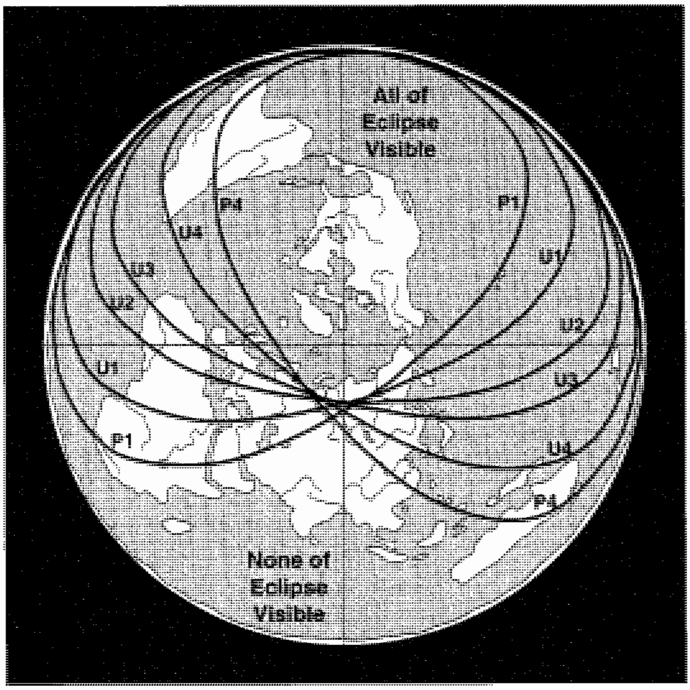

Figure 1. Visibility limits for the Penumbral (P) and Umbral (U) Contacts of the 1993 Nov 29 total lunar eclipse. The lines plotted indicate where the particular contacts will occur with the Moon on the horizon.

This eclipse's *umbral magnitude* will be 1.092; meaning that, at mid-eclipse, the center of the Moon will be 1.092 lunar radii inside the edge of the *umbra* (darker part of the Earth's shadow). The fact that this value is only slightly above 1.000, and that the shadow's center passes north of the Moon's center, means that the southern edge of the Moon will probably remain brighter than the rest of the disk through totality. The writer believes that this eclipse will be fairly bright because there has been no recent large-scale volcanic eruption to inject light-scattering particles into our stratosphere, through which the refracted sunlight that illuminates the umbral interior must pass.

The *phases* of this eclipse are predicted to follow this schedule (where all times are in UT on 1993 Nov 29):

First Penumbral Contact (P1)	$03^h 27.1^m$
First Umbral Contact (U1)	04 40.4
Beginning of Totality (U2)	06 02.2
Middle of the Eclipse	06 26.1
End of Totality (U3)	06 50.1
Last Umbral Contact (U4)	08 11.9
Last Penumbral Contact (P4)	09 25.0

This schedule assumes that the umbra's diameter will be 2 percent larger than simple geometry would predict. Note that totality will be relatively brief; about 48 minutes in length. The position of the edge of the umbra relative to the Moon is shown for each of the four umbral contacts (U1-U4) on *Figure 2* (p. 83).

What to Observe

To find out about the variety of observations that can be made during a total lunar eclipse, write to our Lunar Eclipse Recorder, Francis Graham (address on inside back cover) to obtain a copy of the *A.L.P.O. Lunar Eclipse Handbook* ($4.00). Summaries of some forms of observation are given below.

First, verbal descriptions and drawings are always useful. You can use the naked eye, binoculars, or a telescope of almost any size. Record when and on what part of the Moon's disk that you are first able, and are last able, to detect penumbral shading. Pay particular attention to tones and colors in the penumbra and the umbra, which may change over time. The visibility of features within the umbra is also important to record. Also note the color, tone, and width of the umbral edge and whether it appears circular, elliptical, or irregular.

A permanent record can be made using photography with a telephoto lens or through a telescope. As a starting point, here are some sample exposure times, assuming ISO 400 film at f/8: uneclipsed Full Moon—1/2000 s; Moon deep in penumbra—1/500 s; Moon 1/10-1/2 in umbra—1/30 s; Moon 1/2-3/4 in umbra—1/30 s for the penumbral portion, 1 s or longer for the umbral portion; Moon 3/4 in

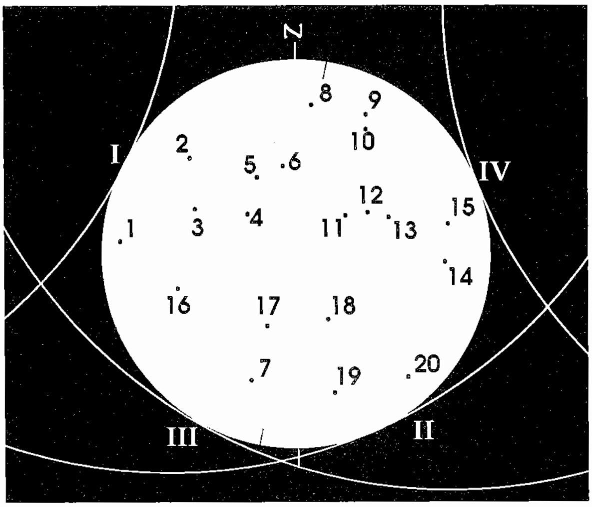

Figure 2. Locations of the edge of the umbra with the Moon's limb at its four contacts, indicated by Roman numerals. Celestial north (N) and south are shown with white ticks; lunar north and south with black ticks. Dots show the positions and numbers of the craters recommended for umbral contact timings.

umbra to totality—1 s or longer. Exposure times in the umbral portion of the shadow depend on the darkness of the eclipse, which cannot be predicted; thus bracket generously.

Videotapes can also be made. A standard camcorder with a telephoto lens, and a telextender if available, gives good results outside of totality. A low-light black-and-white video camera with its lens removed, on a f/3.64 telescope, has given acceptable images during totality. Better yet, a digital CCD camera with a lens focal length short enough to include the entire Moon on the frame gives images that can be used for accurate photometry.

A purely visual project is to make estimates of the *Danjon Luminosity* (L) of the Moon at mid-eclipse. To do so, simply determine which of the descriptions below best fits the Moon's appearance, using a fractional value (e.g., L = 2.5) if you need to:

L = 0. Very dark eclipse; Moon almost invisible, especially at mid-eclipse.

L = 1. Dark eclipse, grey or brownish coloration; details distinguishable only with difficulty.

L = 2. Deep red or rust-colored eclipse, with a very dark central umbra and the outer edge of the umbra relatively bright.

L = 3. Brick-red eclipse; usually with a bright or yellow rim to the umbra.

L = 4. Very bright copper-red or orange eclipse; with a bluish very bright shadow rim.

As a more objective exercise, you can estimate the *stellar magnitude* of the Moon, at mid-eclipse or at various times throughout the eclipse. To do so, you need to make the Moon look like a star, or a star look like the Moon. Two methods that can be used for the former are viewing the Moon through reversed binoculars, or viewing its reflection in a convex reflector. For the latter approach, you need to be quite nearsighted; if so, simply remove your glasses when comparing the Moon with the star. There are several bright comparison stars above the horizon during this eclipse: Sirius, magnitude -1.46; Procyon, +0.38; Rigel, +0.12; Capella, +0.08; and Aldebaran, +0.83. Observers in the tropics and Southern Hemisphere can also use Canopus, at magnitude -0.72. You should correct lunar magnitudes found from such comparisons for *differential atmospheric extinction* if the comparison object's altitude is much different from that of the Moon. This is less of a problem with Aldebaran, which will lie near the Moon.

The angular enlargement of the umbra varies unpredictably from eclipse to eclipse. It can be found accurately by timing the four umbral contacts with the limb, and especially by timing when the umbral edge crosses the 20 selected craters that are listed below and are plotted on the Moon's disk in *Figure 2* (above left). If possible, time both umbral *immersion* and *emersion*. For large craters, take the mean of the times when the umbral edge crosses opposite crater walls. The timing should be precise to 0.1 minute. To help you to be prepared, the *approximate* predicted UT's for immersion and emersion for the selected craters are:

Number	Crater Name	Immersion	Emersion
1	Grimaldi	04^h45^m	07^h05^m
2	Aristarchus	04 50	07 25
3	Kepler	04 55	07 20
4	Copernicus	05 05	07 30
5	Pytheas	05 00	07 35
6	Timocharis	05 05	07 40
7	Tycho	05 30	07 10
8	Plato	05 05	07 45
9	Aristoteles	05 15	07 55
10	Eudoxus	05 15	07 55
11	Manilius	05 20	07 45
12	Menelaus	05 20	07 50
13	Plinius	05 25	07 55
14	Taruntius	05 40	08 00
15	Proclus	05 35	08 00
16	Gassendi	05 00	07 10
17	Birt	05 20	07 20
18	Abulfeda E	05 30	07 30
19	Nicolai A	05 45	07 20
20	Stevinus A	05 55	07 35

Whatever form of observations that you make, be sure to send them to our Lunar Eclipse Recorder. For crater and limb timings, send a duplicate copy to *Sky & Telescope*, P.O. Box 9111, Belmont, MA 02178-9111. Many of us have never seen a really favorable lunar eclipse, so don't miss this chance!

THE COMING TRANSIT OF MERCURY: 1993 NOV 06

Transits of Mercury, or passages of the planet across the face of the Sun, are fairly rare events. One will occur on 1993 NOV 06; the last previous one was in 1986, and the next will be in 1999. Sadly, not everyone can view every transit; this one will be visible from the central and western Pacific including Hawaii, Australia and New Zealand, almost all of Asia, and much of Africa, as shown in *Figure 1* (below). Throughout the visibility zone, the apparent path of Mercury across the southwestern portion of the Sun's disk will be very similar to that plotted in *Figure 2* (to right).

The first event is *Contact I*, when Mercury's limb first touches the Sun only 8°in position angle west (directions in this article are given in the *celestial* sense) of the Sun's southern limb. Mercury's 9.98 arc-second disk will take about 6 minutes to cross the Sun's limb, a process called *ingress*, which is completed at *Contact II*. The innermost planet then takes about 1h 30m to cross the southwestern portion of the Sun, first touching the limb again at *Contact III*. Mercury takes another 6 minutes to *egress*, or to leave the Sun. Because the path of Mercury strikes the Sun's limb obliquely, ingress and egress will last considerably longer than on the average. The final event, known as *Contact IV*, occurs very close to the southwest point of the Sun's limb.

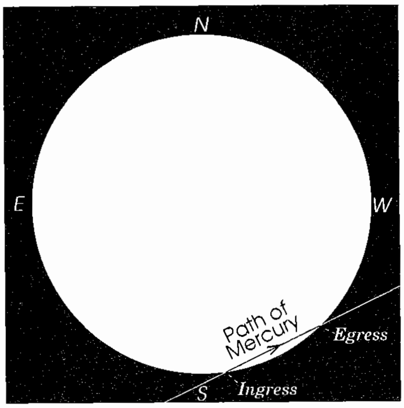

Figure 2. Apparent path of Mercury across the disk of the Sun on 1993 Nov 06 with celestial directions indicated.

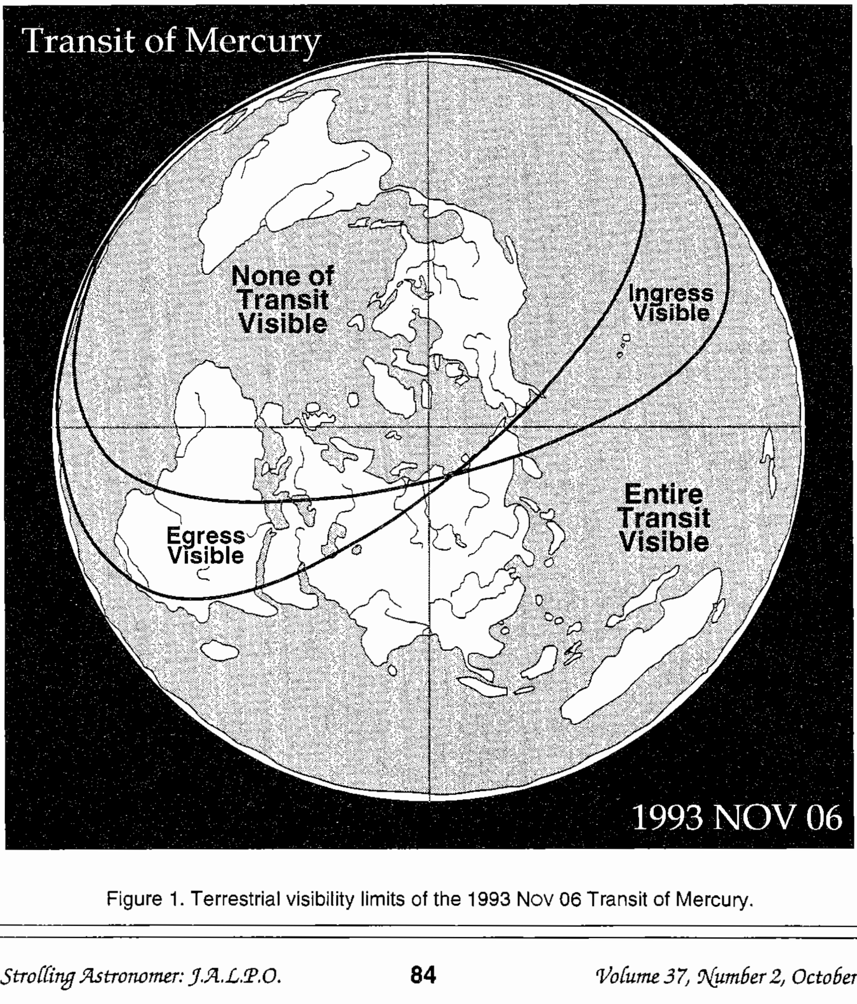

Figure 1. Terrestrial visibility limits of the 1993 Nov 06 Transit of Mercury.

Table 1. Geocentric Data for the 1993 Nov 06 Transit of Mercury.

Type of Contact	UT 1993 Nov 06 (ΔT = +59 s)	Position Angle (East of North)	Mercury in Zenith Longitude	Latitude
	h m s	°	°	°
I. Ingress, Exterior Contact	03 05 51.7	188.1	129.4 E	16.2 S
II. Ingress, Interior Contact	03 11 45.2	190.1	127.9 E	16.2 S
- Least Angular Distance	03 56 32.5	-	116.7 E	16.2 S
III. Egress, Interior Contact	04 41 20.4	221.7	105.4 E	16.2 S
IV. Egress, Exterior Contact	04 47 13.8	223.7	103.9 E	16.2 S

Table 2. Calculations of Topocentric Times of 1993 Nov 06 Transit of Mercury Contacts.

To correct for particular sites, use the following formulae:

$$T(I) = 03h\ 05m\ 51.7s + 132.38s\ \rho \sin \varphi' - 44.58s\ \rho \cos \varphi' \cos (334°.647 - \lambda)$$
$$T(II) = 03h\ 11m\ 45.2s + 146.44s\ \rho \sin \varphi' - 52.25s\ \rho \cos \varphi' \cos (338°.489 - \lambda)$$
$$T(III) = 04h\ 41m\ 20.4s - 111.62s\ \rho \sin \varphi' + 109.46s\ \rho \cos \varphi' \cos (356°.277 - \lambda)$$
$$T(IV) = 04h\ 47m\ 13.8s - 96.57s\ \rho \sin \varphi' + 100.80s\ \rho \cos \varphi' \cos (355°.914 - \lambda)$$

Note: ρ = local radius (relative to equatorial radius); φ' = geocentric latitude; λ = longitude E of Greenwich. ρ and φ' may be found from the geodetic latitude φ by the following formulae:

$$\rho \cos \varphi' = C \cos \varphi, \quad \rho \sin \varphi' = S \sin \varphi, \quad \text{where:}$$
$$C = \sqrt{(\cos^2\varphi + 0.993306 \sin^2\varphi')}, \quad S = 0.993306\ C$$

These formulae take the Earth's equatorial radius to be unity, ignore elevation above sea level (making a maximum difference of well under 1 second), and assume that ΔT = +59 seconds.

Mercury moves rapidly. For all locations the contact times will vary at most by about ±2.5 minutes from their geocentric values, given in *Table 1* (at top; topocentric correction formulae are given in *Table 2* below *Table 1*). Approximately speaking, those in the Pacific Basin will see the Transit in the afternoon; on November 5th local time east of the International Date Line and on November 6th to its west. Observers in Asia and Africa will see the event on the morning of November 6th, local time. Observers will also be interested in knowing the Sun's altitude above their horizon; particularly if this quantity is negative! The predicted times of Contacts I-IV and the solar altitude at the beginning and end of the transit are given in *Table 3* (below) for selected cities in the visibility zone. For information on how to observe the transit, see the following "Getting Started" article (pp. 86-88).

Table 3. Circumstances of the 1993 Nov 06 Transit of Mercury for Selected Cities.

Locations are listed from west to east; invisible events are given in italics.
Times are calculated using the formulae and assumptions given in *Table 2*.

Location	Universal Time 1993 Nov 06 Contact I	Contact II	Contact III	Contact IV	Solar Altitude Ingress	Egress
	03h	03h	04h	04h		
Cape Town, South Africa	*04m 12s*	*09m 50s*	43m 46s	49m 32s	*-8°*	+13°
Cairo, Egypt	*06m 36s*	*12m 31s*	41m 42s	47m 43s	*-15°*	+6°
Nairobi, Kenya	*05m 28s*	*11m 15s*	42m 46s	48m 39s	*-2°*	+23°
Teheran, Iran	07m 00s	12m 58s	41m 07s	47m 08s	+0°	+18°
Bombay, India	06m 40s	12m 36s	41m 08s	47m 06s	+25°	+43°
New Delhi, India	07m 03s	13m 02s	40m 42s	46m 42s	+23°	+38°
Calcutta, India	06m 59s	12m 58s	40m 34s	46m 33s	+35°	+49°
Bangkok, Thailand	06m 48s	12m 47s	40m 28s	46m 24s	+49°	+60°
Singapore	06m 23s	12m 19s	40m 45s	46m 38s	+59°	+73°
Irkutsk, Russia	07m 55s	14m 02s	39m 26s	45m 31s	+19°	+22°
Jakarta, Indonesia	06m 07s	12m 02s	40m 54s	46m 45s	+66°	+80°
Hong Kong	07m 13s	13m 15s	39m 51s	45m 49s	+49°	+51°
Beijing, People's Republic of China	07m 43s	13m 49s	39m 27s	45m 30s	+33°	+33°
Manila, Philippines	07m 01s	13m 02s	39m 52s	45m 49s	+58°	+55°
Shanghai, People's Republic of China	07m 33s	13m 38s	39m 28s	45m 29s	+42°	+40°
Alice Springs, Australia	05m 37s	11m 30s	40m 51s	46m 38s	+81°	+61°
Tokyo, Japan	07m 43s	13m 51s	39m 04s	45m 06s	+37°	+29°
Melbourne, Australia	05m 06s	10m 56s	41m 14s	46m 58s	+64°	+48°
Sydney, Australia	05m 15s	11m 06s	41m 00s	46m 44s	+64°	+44°
Auckland, New Zealand	05m 06s	10m 57s	40m 59s	46m 44s	+45°	+25°
Suva, Fiji	05m 50s	11m 46s	40m 11s	45m 59s	+43°	+20°
Honolulu, Hawaii, United States	07m 08s	13m 14s	*39m 08s*	*45m 07s*	+9°	*-12°*
Papeete, Tahiti	05m 36s	11m 32s	*40m 27s*	*46m 16s*	+13°	*-10°*

GETTING STARTED: OBSERVING TRANSITS OF MERCURY AND VENUS

By: John E. Westfall;
Acting Recorder, Mercury/Venus Transits Section

THE NATURE OF TRANSITS

A *transit* is the passage of a planet across the face of the Sun. From the vantage point of the Earth, this event can happen only for the *inferior planets* Mercury and Venus. Although at least part of each transit usually can be seen from over half the Earth, these phenomena are fairly rare, as is shown in *Table 1* (below).

Table 1. Mercury and Venus Transits, 1950-2050

Planet	Universal Time (Geocentric)
Mercury	1953 Nov 14, 15.6h-18.2h
Mercury	1957 May 05-06, 00.0h-02.5h
Mercury	1960 Nov 07, 14.6h-19.2h
Mercury	1970 May 09, 04.3h-12.2h
Mercury	1973 Nov 10, 07.8h-13.3h
Mercury	1986 Nov 13, 01.7h-06.5h
Mercury	1993 Nov 06, 03.1h-04.8h
Mercury	1999 Nov 15, 21.3h-22.1h
Mercury	2003 May 07, 05.2h-10.5h
Venus	2004 Jun 08, 05.2h-11.5h
Mercury	2006 Nov 08-09, 19.2h-00.2h
Venus	2012 Jun 05-06, 22.2h-04.8h
Mercury	2016 May 09, 11.2h-18.7h
Mercury	2019 Nov 11, 12.6h-18.1h
Mercury	2032 Nov 13, 06.7h-11.1h
Mercury	2039 Nov 07, 07.3h-10.3h
Mercury	2049 May 07, 11.1h-17.8h

Data from Jean Meeus, Transits (1989).

In the 100 years covered by the table there are just 17 transits and only two of these are of Venus. Indeed, the last previous Transit of Venus occurred in 1882! Transits must occur at *inferior conjunction*, but not at every inferior conjunction; because of the inclination of the planets' orbits to the ecliptic, these planets usually pass north or south of the Sun. *Table 1* also tells us that Transits of Mercury fall only in May and November, and more frequently in the latter month. (We must note here that some published lists of Transits of Mercury omit the 1993 Transit, the 1999 Transit, or both. Some essentially *invert* the 1999 Transit, stating erroneously that the event will be visible *only* from Antarctica!) Transits of Venus occur in pairs 8 years apart, each pair separated by over a century. They happen in June (e.g., 2004 and 2012) or December (e.g., 1874 and 1882, and 2117 and 2125).

Transits of either planet usually take several hours. The 1993 Transit of Mercury is unusually short because it passes near the south limb of the Sun. An even briefer one occurs in 1999, when Mercury will not completely enter the Sun's disk for observers in the South Pacific. Also, the Universal Time (UT) of each transit gives an indication of where it will be visible, local noon occurring approximately at the following locations depending on the UT: 00h—Central Pacific, 06h—Asia, 12h—Europe and Africa, 18h—the Americas.

When the inferior planets transit the Sun they are about as close to us as they ever get. Mercury's disk has a diameter of about 10" (arc-seconds) for a November Transit, and 12" for a May Transit. Venus' diameter is about 58" for a June transit and 64" for one in December.

Because of their finite size, these planets take a finite time to pass across the Sun's limb. We recognize four events for the usual transit: *Contact I*, the first exterior contact of the planet's limb with the Sun's; *Contact II*, the first interior contact, the planet now being fully within the Sun's disk; *Contact III*, the last interior contact when the planet begins to leave the Sun's disk; and *Contact IV*, the last exterior contact, when the planet leaves the Sun's disk. (Note that for *partial transits* like that of 1999, some observers will not have Contacts II and III.) *Figure 1* (below) diagrams the four contacts for a typical transit.

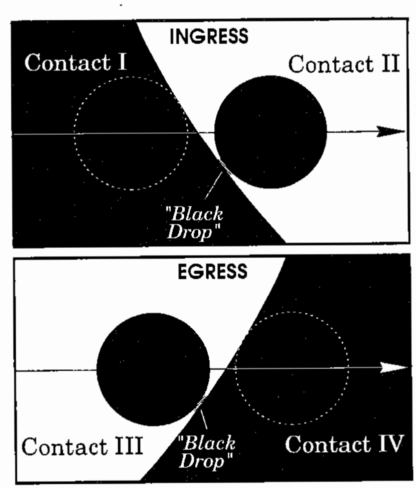

Figure 1. The four contact events visible during a typical planetary transit. (See text on p.88 regarding the "Black Drop.")

EQUIPMENT

In terms of equipment, think of watching a transit as observing an unusually dark sunspot. As with all solar observation, the only safe methods are by eyepiece projection or with a safe full-aperture filter. Examples of the latter are No. 14 Welding Glass or aluminized glass or mylar transmitting no more than 1/100,000 of the energy in the visual, ultraviolet, and infrared bands.

Visually, the 1986 Transit of Mercury was observed with a 20×60 monocular mounted on a camera tripod; probably even lower magnification would have sufficed. A Transit of Venus can be seen with the naked eye, provided that the eye itself is protected by a full-aperture filter.

However, to see and time the individual contacts, and to watch for unusual optical phenomena, an equatorially-mounted clock-driven telescope is desirable. At least 75mm aperture and 90× magnification is needed for visual work. For photography or electronic imaging, image amplification with eyepiece projection or a Barlow Lens will probably be needed to see a planet in transit as something more than a black speck.

If you plan to time the contacts accurately, you will need an accurate time source, such as a shortwave receiver to detect a radio signal broadcast from the part of the World you happen to be observing from. For the 1993 Transit, suitable stations would be RID (Irkutsk; 5004, 10004, and 15004 kHz), ATA (New Delhi; 5, 10, and 15 mHz), VNG (Llandilo, Australia; 5, 10, and 16 mHz), JJY (Sanwa, Japan; 2.5, 5, 8, 10, and 15 mHz), HLA (Taejon, South Korea; 5 mHz), and WWVH (Kauai, Hawaii; 2.5, 5, 10, and 15 mHz).

For photography, use the same equipment and procedures that you would use to photograph sunspots, including an H-α filter if you have one. If the Sun's image covers the entire film frame, or at least its central portion, a camera's built-in exposure meter, or a video camera's automatic gain control, will give a reasonable exposure.

WHAT TO OBSERVE

When you watch a Transit of Mercury or Venus you are following a tradition that goes back to 1631, when Pierre Gassendi was the first to watch a Transit of Mercury. The Transit of Venus in the same year was missed, and Jeremiah Horrocks and William Crabtree, in 1639, were the first to observe a Transit of Venus. Basically, there are two forms of useful observation that can be done.

Contact Timings.—In the past, transit contacts were timed in order to derive the value of the *solar parallax*, and thus the distance of the Earth from the Sun, and occasionally also the diameter of the planet involved. For the first purpose, Transits of Venus were more useful than those of Mercury, but neither one is now useful for parallax or diameter determination. Accurate timings still have some use for refining the orbital parameters of the inner planets. They also provide important evidence for resolving the question of long-term changes in the value of the solar radius. Finally, because transit contact timings were so significant in astronomical history, it is important to time them with modern techniques so that we may come to understand the optical and psychological phenomena involved and the errors they cause. When you observe a transit, it will be obvious that atmospheric seeing, solar limb darkening, and finite instrumental resolution all conspire to make the limbs of the planet and the Sun variable and blurred in appearance, doubtless affecting timing accuracy.

To time contact events, you need a telescope and a visual magnification or imaging resolution sufficient to *clearly* show the planet as a disk. Two techniques are possible: (1) Direct visual observation, noting the times on a tape recorder. (2) Video recording of the transit, with later viewing for timing. In either case, a time signal should be recorded in the background. Try to time to a *precision* of 0.1 second UT, even if it is clear that the *accuracy* will be lower.

The following events should be timed:

Contact I—Possible to time well only if the planet can be seen off the Sun's disk beforehand; silhouetted against either the inner corona, if a coronagraph is used, or against the chromosphere if you are using an H-α filter. Most of us will have to be satisfied simply with estimating when the planet's indentation of the solar limb first becomes visible.

Contact "I.5"—Estimate when the planet is exactly bisected by the Sun's limb as mentally extended through the planet.

Contacts II and III—Time both: (a) The moment when you estimate that the limbs of the planet and the Sun would have been in contact had they been circular; rather than, as is probable, distorted. (b) The moment when there is the first definite sunlight between the planet and the Sun's limb (Contact II) or when the last sunlight disappears (Contact III).

Contact "III.5"–See Contact "1.5" above.

Contact IV—Time the moment when the planet ceases to be visible on the Sun's limb.

Optical Phenomena.—The appearance of a planet in transit sometimes differs from what we would expect from simple geometry. We wish well-documented reports on any deviation of the planet's disk from a sharply-defined totally black circle. Such phenomena can be recorded in several ways, listed here in *increasing* order of usefulness:

Written Description—Describe the size and position relative to the planet, tone, and color of any phenomena.

Drawing (or series of drawings)—Indicate graphically all the information above.

Photograph (or series of photographs).

Videotape (with time signals or display).

Photoelectric Photometry (whole-disk photometry of planet on solar disk).

CCD Image (with calibration frames).

When observing a transit you may see any or none of several forms of optical phenomena that range from the "real" to the debatable to the unexplained.

1. The "Black Drop." This has been reported by many, but not all, observers of transits. It has the appearance of a ligament connecting the limbs of the planet and the Sun near the times of Contact II and Contact III. Sometimes the ligament flickers or varies rapidly in size, occasionally containing light spots. CCD or video photometry of this phenomenon would be sources of information that, to the best of my knowledge, have not ever been used. The simplest explanation of the Black Drop is a limb blurring due to our atmospheric seeing and finite telescopic resolution. In the case of Venus, the planet's atmosphere also contributes to the effect.

2. Planet's Limb Illuminated. Here, the planet appears to be outlined by a bright circle or arc thereof. This can occur when the planet is partly or completely off the Sun's limb. In the case of Venus, refraction in the planet's atmosphere is the most likely explanation. At times this bright ring exhibits a form of "Bailly's Beads." In addition, a broad light aureole is sometimes reported surrounding a planet when it is completely on the solar disk.

3. Planet Visible Against the Sky. Rarely, the disk of the planet, rather than just the limb, is reported as standing out against the sky before Contact II or after Contact III. If the planet is darker than the sky, it may be silhouetted against the chromosphere, a prominence, or the inner corona. It is more difficult to explain a planet's appearing brighter than the sky.

4. Dark Band Around Planet. This is occasionally reported when a planet is at least partly on the Sun's disk. It may take the form of a blurred planetary outline, explicable by the planet's atmosphere in the case of Venus. However, the effect may instead take the form of a broad ring, which is harder to explain.

5. Bright areas or points on the Night Hemisphere of the Planet. This phenomenon was frequently reported until about 80 years ago, but rarely thereafter. Sometimes observers reported portions of a planet's disk as vaguely illuminated. At other times, one or more distinct bright points on the night hemisphere were reported. Again, Venus' atmosphere may be an explanation for that planet, but it is hard to think of a reason for this phenomenon in the case of Mercury.

6. Deviation of the Planet's Outline from Circularity. This is rare and is probably a telescopic or seeing effect.

The above forms of event may be subjective effects, or due to contrast or to reflection in one's optics. If you suspect something unusual you should move the telescope slightly to see if the phenomenon moves, changes, or disappears at the same time. Sadly, we have very little quantitative data on these anomalies. We greatly need to confirm or to disprove them objectively with photography, photoelectric photometry, or electronic imaging. Note that there is plenty of light available during a transit, so photography or electronic imaging through narrow-band filters is also feasible and would likewise be breaking new ground.

DOCUMENTING AND REPORTING

None of the above forms of observation is of any use unless the observations are documented. For all forms of observation give: Name and address of observer; location of observing site to one arc-minute of geodetic latitude and longitude; aperture and type of telescope; filter or filters used; diameter of aperture stop if used; *precise* time in UT; source of time; seeing on the A.L.P.O. Scale (0 for worst to 10 for perfect); and transparency on the A.L.P.O. Scale (0 for worst to 5 for best). Provide the following *additional* data for the succeeding particular forms of observation: Visual contact timing, description, or drawing—magnification. Photograph—effective focal length, exposure time, and film type and development. Videotape—effective focal length; indicate if manual or automatic gain control was used. Photoelectric photometer—effective focal length and physical aperture size *or* angular aperture size in arc-seconds, and integration time. CCD image—effective focal length, pixel dimensions, number of pixel rows and columns, and integration time. With any drawing, photograph, or image, indicate which direction is celestial north and whether the view is laterally reversed.

Your observations will help the amateur and professional astronomical community only if you *submit* them to someone who can analyze and publish the results. The A.L.P.O. Mercury/Venus Transits Section, whose address is on the inside back cover, welcomes all forms of transit observation. We do ask that: (1) Videotapes be in VHS or S-VHS format using the NTSC video standard. (2) Electronic images of any form (CCD images or digitized video frames or photographs) be in the form of PICT files on 3.5-inch MS-DOS or Macintosh diskettes. (3) CCD images be already corrected using flat, dark, and bias frames. We plan to publish a report after each of the coming transits (at least while we are still able to do so!). If sufficient geographically-scattered contact timings are submitted, it will also be possible independently to derive our own estimate of the value of the solar parallax; an interesting exercise in itself and useful in assessing the accuracy of our timings.

Transits of Mercury do not happen often, let alone those of Venus. Fortunately, a "cluster" of them, more frequent than usual, is now commencing. We need to take full advantage of them when they occur. You may have to travel to see most of them. However, "transit chasers" appear to be a growing market, with commercial expeditions planned to visit Australia to view the 1993 event. You can make useful observations with even a small telescope providing that you are in the right place at the right time and know what to do.

Our Readers Speak

(As always, these letters have been slightly edited for style; but not for content; this means that the letter writers are responsible for their opinions, not the A.L.P.O.)

Dear John:

The 1995 Mars Opposition, which will occur on February 12, will be very similar in circumstances to the February 9, 1916 [Feb 10 UT] Opposition, the well-known 79-year cycle being in effect here. The Ephemeris which you and Dr. Parker provided a few years ago regarding the various pertinent data for Mellish's November 13, 1915 observations might prove well worthwhile following up on in November, 1994 when the disk diameter, phase, and so forth will closely match the tabular data for Mellish's 1915 work.

Recently, as published in the January, 1993, *Sky & Telescope*, Stephen J. O'Meara and William Sheehan were unable to duplicate the Mellish observations with the 1-meter Cassegrain at the Pic du Midi Observatory. However, their observations were carried out on a disk only 6.2 arc-seconds in diameter, while Mellish's were done on a 7.7 arc-second disk, over 20 percent larger in diameter and about 50 percent larger in surface area.

Perhaps an ephemeris might be published in the 1994 *A.L.P.O. Solar System Ephemeris* that would cover the dates in November, 1994 when the disk size, phase angle, and central meridian match or nearly match the 1915 Melish observations. Such times might cover the period when Mars is 7.5-8.0 arc-seconds in diameter. This might allow A.L.P.O. members with large telescopes, or who have access to such instruments, time to plan for this observational period. Such observations should be carried out, say, before dawn in early twilight up to one or two hours after sunrise to duplicate the conditions Mellish had as well as possible. Of course, many factors could interfere such as poor seeing, and clouds in our atmosphere as well as in Mars', but the attempt should be made.

Since Mellish indicates that the craters became invisible when the 40-inch Yerkes refractor was diaphragmed to 24 inches aperture, the latter aperture would seem to be a cutoff point. However, observations with smaller instruments, down to say 12-inches diameter, might be worthwhile. It may also prove possible, given the current advances in CCD technology, that such features might be recorded unambiguously. Since Mellish used 750X and 1100X, any instrument used should be optically capable of handling these magnifications, and the seeing of course would have to be excellent. While the chance of duplication of the exact conditions Mellish enjoyed might appear small, nevertheless they are enough that there is some hope of success.

Such an ephemeris, of course, should also be carried in the regular *J.A.L.P.O.* closest to the November, 1994 date, in order to have as wide a distribution to members as possible.

Since this period of observation, when Mars is still quite far away, is seldom observed properly, this might be an extra incentive to induce members to observe the planet at that time. This would at the very least provide additional coverage of phenomena still not adequately covered for that time frame.

Permit me now to address Karl Fabian's letter (*J.A.L.P.O.*, Vol. 37, No. 1 [July, 1993], pages 42-43).before going on to the other letters in that issue. I would suggest that he read my article "Resolution and Contrast" (*J.A.L.P.O.*, Vol. 27, Nos. 9-10 [March, 1979], pages 180-190); this article was used as a reference in Dobbins, Capen, and Parker's *Observing and Photographing the Solar System* [1988]). Contrast in an image is the *sine qua non* for revealing planetary detail. While contrast is somewhat aperture dependent, it has more to do with the quality and the number of the optical surfaces present and the presence or absence of obstructions. Mr. William Zmek clearly shows (in *Sky & Telescope*, Sept., 1993, page 86) how a 10-inch reflector with a 3-inch secondary and 1/8-wave R.M.S. [Root-Mean-Square error] optics reveals no more detail than a high-quality unobstructed 4-inch instrument. But take that same 10-inch telescope, reduce the secondary central obstruction to 1 inch, and make the the optics 1/16-wave R.M.S. and it is now the equivalent on an unobstructed 8-inch! The doubling of the optical accuracy in this case plus reducing the central obstruction from 3 inches to 1 inch has transformed it into an *effective* aperture of 8 inches instead of an effective aperture of 4 inches.

Karl Fabian cannot equate his excellent 8-inch SCT [Schmidt-Cassegrain Telescope] with others in amateur hands. One must go on the *average*. A former Vice President of a major manufacturer of SCT's, after quitting the firm, told me that the chance of getting a good SCT from the firm was "about 1 in 35." These are better chances than the lottery, but hardly odds to inspire confidence! Mr. Peter Ceravalo, a master optician, has been testing SCT's via interferometric methods for the past several years. He finds that they are often no better than 1/2 λ P-V (Peak-to-Valley; λ is the wavelength of light in the visual range). This, coupled with a 35-percent central obstruction, hardly qualifies the *usual* SCT as a telescope to be considered by lunar and planetary observers, assuming that Mr. Ceravalo's tests are random selections. A member of our local society spent over two years and five returns to one SCT manufacturer's factory in an attempt to get a good set of optics and this year finally sold it without being able to get the quality that was promised. Another member of our group had a similar experience with the same manufacturer.

I have no doubt that Mr. Fabian's telescope is a good one, but I'll give him a standing invitation to bring his SCT up to Vernonscope, where we have two Zeiss Jena 130-mm and 100-mm APQ Fluorite Refractors, and see if he can match them. He may bring along any competent judge of optics that he cares to.

Now to Mr. Louderback. I find it interesting that he would reference my letter in the April, 1988 *Sky & Telescope* [page 348] without ever reading it. Be that as it may, I'll soon send a reply to him.

As far as the rest of his letter is concerned, I too have Slipher's *Mars, The Photographic Story* plus about 60 other volumes on Mars. Mr. Louderback is "beating a dead horse" as to the "Canal Controversy." We are all disappointed that Lowell's views were proven wrong. Romanticism is "heady fun" and stimulates the imagination; as Lowell's did, especially if you were a youngster in the early 1900's and Lowell's works happened to influence you to become an astronomer. At the time, Lowell's ideas were quite logical; time has proven them incorrect although they still make interesting reading.

As far as the "Face on Mars" is concerned, it belongs in the sensational tabloids where it is sometimes found with other articles such as "I Had Bigfoot's Baby", the latest celebrity-hound tells how they were abducted by aliens, and so on *ad nauseam*.

The chief exponent of the "Face on Mars" theory is Richard Hoagland, who in his book *The Monuments of Mars, City on the Edge of Forever*, tries to make a case for this particular marking being a relic of intelligent origin. The whole affair is reminiscent of a similar book done in 1956 by Wells Alan Webb, who certainly had far better scientific credentials than Hoagland, called *Mars, the New Frontier: Lowell's Hypothesis*. Webb compared various types of natural and man-made intersecting lines and concluded that the canals of Mars were of intelligent origin. Well's book makes much more fascinating reading that Hoagland's, in part because the former was written in the era when it was still possible to put forth such an argument. In a way, Wells was right; the lines on Mars were created by intelligence, but unfortunately as Carl Sagan has put it, "the intelligence was on the eyepiece end of the telescope." Mr. Hoagland's ideas have about as much chance of being correct as stating that the Pyramids of Egypt were constructed by scarab beetles.

Mr. John Gallagher of New Jersey has done considerable effort in examining current and older maps of Mars. He discovered that, by superimposing older maps by Lowell, Schiaparelli, Nathaniel Green, and Antoniadi over a modern U.S. Geological Survey contour map of Mars, most of the prominent "canals" very closely followed the contour lines on the USGS maps. Mr. Gallagher's work is unpublished, but he sent me copies of all of the maps involved, and after studying them I must concur that what have been called "canals" are nothing more than elevational differences in topography. This fact, coupled with the meteorological conditions on the planet, can explain the variations and visibility of these details as seen from Earth. Lowell saw these details and explained them using the science of his time, plus some insightful imagination. Today, we now know that they are the results of natural geology and aeolian forces and we need not resort to "fringe" explanations which now belong to the realms of science fiction.

I am far more interested in what scientists like Dr. Gilbert Levin, who designed the Labeled Release Experiment for the Viking Landers in 1976, say. Dr. Levin was recently interviewed in the June, 1993, issue of *Final Frontier* and presented a powerful case in showing that NASA misinterpreted the Labeled Release Experiment data and stated that the only conclusion that is reasonable, based on the experiment's constraints, is that active biology is now taking place on Mars. Evidently Dr. Levin is not regarded as a crackpot as he is on the NASA Mars Soil Oxidant Team and has designed an updated version of the Labeled Release Experiment that will fly on Russia's proposed Martian Rover in 1996.

There may well be life on Mars now, but it isn't going to wave back at you!

Rodger W. Gordon

637 Jacobsburg Road
Nazareth, PA 18064

April 2 and August 8, 1993

Dear John:

Since the appearance of my "Getting Started: Telescope Selection" article nearly two years ago, a great deal of controversy has arisen over which telescope and eyepiece types are best for planetary observing.

While I recommend "planetary" Newtonian reflectors or well-corrected refractors to those who ask me what type of telescope to buy for lunar and planetary observing, I also try to encourage those who have already purchased an SCT to use it to its fullest. If well corrected and collimated, it can rival or equal average specimens of the other two types. It might be noted that the Director of the A.L.P.O. owns two SCT's, and has produced CCD images of the Moon using the smaller one that show more detail than can be seen on plates in the *Orthographic Atlas of the Moon*.

This sort of discussion in the letters column is very healthy, but it would be a shame if any of our members who own SCT's were to become discouraged and stop using them. It's important to remember here that the caliber of the observer is just as important as the telescope that he or she uses, and I think that I can speak for all of the Recorders when I say that we welcome your observations.

Harry D. Jamieson

P.O. Box 143
Heber Springs, AR 72543

August 18, 1993

Dear John:

The ideas in this letter were suggested by Dr. Clyde Tombaugh's comments on the Tombaugh-Smith Seeing Scale in a floor discussion during the August 4-7, 1993 A.L.P.O. Convention in Las Cruces. Perhaps they should then have been part of continuing floor discussion, but some thoughts can be presented more adequately in this format.

Drs. Clyde W. Tombaugh and Bradford A. Smith describe their scale in an article called "A Seeing Scale for Visual Observers" in *Sky & Telescope*, Vol. 17, No. 9 (July, 1958), page 449.

Regarding this, I offered some comments in "Some Remarks Upon the Tombaugh-Smith Seeing Scale," in *The Strolling Astronomer*, Vol. 12, Nos. 10-12 (February, 1959), pages 144-145. Briefly, their concept is to determine the seeing, or atmospheric steadiness, from the observed diameter of the "confusion disk" or "image blur" of a star. This observation is made by selecting double stars of known separations. The Tombaugh-Smith Scale was intended to replace widely used subjective seeing scales, such as the one ranging from zero (worst) to ten (perfect).

The mathematical equation below is equivalent to the table in the original *Sky & Telescope* article, where *D* is the diameter of the "confusion disk" and *S* is the Tombaugh-Smith seeing. Then:

$$D = 7''.9\ (0.631)^S,$$

where a graph of this function will allow the quick and easy choice of S for a given observed D. [You may also use the transpose of the above equation: S = 4.5 - 5 log D. Ed.]

The not-so-new proposed scale must be praised for at least three reasons:

1. It seeks to make Solar System observations more quantitative. (In a similar vein I have sought for more than 30 years to persuade amateur observers to estimate transparency as the limiting stellar magnitude, instead of, say, a subjective scale of 1 to 5 with 5 best.)

2. The two authors discovered that the diameter of the "confusion disk" is an exponential function of the estimated seeing, as it had been assessed by Dr. Tombaugh with a zero-to-ten scale for many years prior to 1958. In exactly the same way the brightness of a star is an exponential function of stellar magnitude, as is well known.

3. The Tombaugh-Smith Scale will give us an immediate value of the *actual* telescopic resolution as determined by aperture, optical quality, atmospheric turbulence, and perhaps other parameters. Surely that value is more informative than the *relative* amount of atmosphere-caused image-blurring.

One should note that since there is a Dawes Limit on resolution for any given aperture, it follows that the estimated seeing can never be better than a certain limit. With a 6-inch telescope the best possible seeing is about 5; with a 16-inch it is between 7 and 8.

Perhaps the chief difficulty in using the Tombaugh-Smith Scale is the need to move the telescope from the object being studied to a selected double star and back again, to be repeated at suitable intervals. This exercise will be troublesome for some amateur telescopes, such as a 16-inch f/7 Newtonian in a dome. One also must choose a double star at about the same angular height above the horizon as the object being studied. But is the seeing always the same in all azimuths at the same height? What may be of greater importance: how often do we need to examine a double star in order to make a useful seeing estimate? Each such interruption in our viewing may be very troublesome, as when making central-meridian transit timings of features on Jupiter or while trying to complete a drawing of Mars in the 15 minutes or so allowed by the rotation of the planet. Finally, seeing is sometimes subject to rapid changes.

My own strong preference would be to estimate the seeing from some selected appearance of the body being observed—the Moon, planet, comet, or what have you. It is admittedly then often a problem to find features of know angular size for estimating the dimensions of the "confusion disk." One may get very limited help from the Galilean satellites of Jupiter or from lunar craterlets with diameters which have been measured. It is tempting to wonder whether Saturn observers could work up a scale based upon the appearance of Cassini's Division. (I remember how surprisingly black this gap looked in my first views of Saturn with an 18-inch refractor in the autumn of 1941 as compared to its aspect in 4- to 12-inch telescopes during the preceding 6 years.)

A better approach might be to introduce into the eyepiece field of view artificial objects of known dimensions—for comparison with the "confusion disk" of a point source. One idea might be two micrometer wires of adjustable separation. An artificial star of variable size might also serve.

Finally, let me hope that current observers will pursue these suggestions more vigorously than their scientific forebears did in 1959.

Walter H. Haas

2225 Thomas Drive
Las Cruces, NM 88001

September 5, 1993

THE GREAT CRASH OF 1994

In the third week of July, 1994, an event will occur that surely was common in the early history of the Solar System, but to the best of our knowledge has not happened in human history: a comet will strike a planet.

More specifically, the scattered nuclei of Periodic Comet Shoemaker-Levy 9 will strike Jupiter during the period 1994 JUL 18-24. The impacts will be on the hemisphere of Jupiter hidden from Earth; however, we may well observe atmospheric disturbances, satellite brightenings, and other side effects. Indeed, the dust tail of the comet may affect the Jovian system as early as late May.

Not surprisingly, a worldwide observing effort is being organized by professionals and amateurs. Most major observatories, including the Hubble Space Telescope, will take part. The person responsible for the A.L.P.O. "Crash of '94" program is Jupiter Recorder Phillip W. Budine, whose address is on the inside back cover, and who is preparing an Observer's Guide for participating observers around the world in order to provide continuous monitoring of Jupiter during "impact week." Write him for information on observing this extraordinary phenomenon, and be sure to mark your calendar!

Book Review

Edited by José Olivarez

Beyond the Blue Horizon: Myths & Legends of the Sun, Moon, Stars & Planets.

By E.C. Krupp.

Oxford University Press, 200 Madison Avenue, New York, NY 10016. 1992. 342 pages, Illus., Biblio., index. Price $18.95 paper (ISBN 0-19-507800-4).

Reviewed by Robb Linenschmidt

Friends being shown the sky frequently will ask how the peoples of long ago came up with the patterns we call the constellations. The more popular constellations are obvious—Lyra, Taurus, and Orion are three of the more notable examples. However, the smaller, fainter groupings of stars are not as obvious.

Dr. Krupp has written *Beyond the Blue Horizon* to explain not only how the patterns came to be, but also how important the sky was to past peoples. Krupp wrote this book in a logical sequence of chapters starting with the most important and obvious celestial influences, the Sun and Moon, and moving to the less obvious objects, such as the planets and stars.

The book begins with a brief introduction about ancient stories and myths. The value of storytelling is explained in regard to ancient and current fables, legends, and folk tales.

Chapters 3-7, respectively, cover stories related to the heavens and sky in general, the Sun, the Moon, the seasons, and weather. Chapter 4 gives the stories about the Sun from three major cultures; Egypt, Mesoamerica, and Greece. Other cultures' stories are presented too, but in less detail. Chapter 5 covers the history of lunar stories and legends, including the relationship between woman and the Moon. The discussion of the seasons in Chapter 6 carefully describes the actual geometry of the Earth in its orbit. These descriptions, along with several well-developed diagrams, enhance the text of the ancient legends, giving insight into how observant past peoples were. Chapter 7 covers weather. Topics simple for us to understand, such as lightning and rainbows, were not so easily understood in the past. There is a small section about "thunderstones", or meteorites.

Chapters 8 through 10 cover the relationship between the Sun and the Moon in cultural histories, describing the ways that past peoples have used the Sun, the Moon, and both together to creates a multitude of calendars. Chapter 8, about Zodiacal stories and legends, is especially detailed, discussing each constellation and its associated tales in separate sections.

The chapter about eclipses was very revealing. The general beliefs and superstitions that different cultures have about eclipses are stated, along with the specific reactions that people had to eclipses, some of which are quite humorous. It was interesting to read about how past peoples feared eclipses, with events as recently as in 1880 in Russia:

> "With the noise of cymbals, tambourines, and drums, they attempted to drive away whatever it was that was savaging the moon."

Krupp carefully explains the geometry of eclipses and how they occur.

Chapters 11 and 12 discuss the legends of the planets. Since Venus was so prominent in past histories and cultures, its tales have a separate chapter. The sections in these chapters are grouped by culture, making it easier to see what each culture believed about each planet.

Chapters 13-17 involve stellar legends. Following the general mapping of the celestial sphere, Krupp describes culture-specific constellations, along with entirely different mapping systems that were used by the Chinese, ancient Mesopotamians, and others. Interestingly, some of the ancient groupings are easier to visualize in the night sky than are the present constellations. The stories include two well-known groups of stars, the Big Dipper (Ursa Major) and the Pleiades. Each grouping held special significance in the major cultural centers of the world, as well as minor cultures. In many cultures the Big Dipper was depicted as a bear; and the Pleiades were seven sisters, or seven brides. One interesting chapter discusses the Milky Way exclusively. Krupp details many different legends and myths about the Milky Way from many past cultures.

Chapter 18 uses records from many cultures to consider what the Star or Bethlehem may have been; whether it was a planetary conjunctions, a passing comet, or something else; and the possible dates of the event.

Chapter 19 covers those bearers of famine, war, and disease—the comets, along with predictions of destruction from planetary alignments, and the role that the sky plays with the era of the "New Age."

The final chapter includes present-day sky "legends," phenomena such as UFO sightings and abductions, and our fascination with space travel in science fiction books, movies, and television.

This book is that it is well researched and well written. Special attention appears to have been made to keep different legends bout a topic separate. This helps to avoid the confusion that could occur with so many stories. It is well-illustrated, although unfortunately only in black and white, giving examples and diagrams when needed. Depictions of ancient pottery, hieroglyphs, and carvings show how cultures incorporated their beliefs into everyday objects. While this is not a scientific text, it does extremely well as a history or anthropology book in its treatment of the old stories about the sky. It also makes good recreational reading for any amateur astronomer.

New Books Received

Notes by José Olivarez

Beyond the Solar System

By David J. Eicher

Astromedia, a division of Kalmbach Publishing Co., 21027 Crossroads Circle, P.O. 1612, Waukesha, WI 53187. 1992.
80 pages, Illus. Price $12.95 paper
(ISBN 0-913135-10-0)

Beyond the Solar System is an attractive introduction to the 100 best deep-sky objects. With this guidebook and your backyard telescope, you should be able to identify the brightest and most spectacular star clusters, nebulae, and galaxies.

All of the objects in this compilation have one thing in common: they are all beautiful when viewed with small telescopes. Beyond that, the objects are distinctly individual and include 23 galaxies, 19 open clusters, 18 bright nebulae, 11 globular clusters, 10 planetary nebulae, 8 double stars, 5 variable stars, 5 dark nebulae, and 1 star cloud. In addition to a brief description of the object and a black-and-white photograph illustrating it, *Beyond the Solar System* provides fundamental data and include the object's popular name.

Beyond Southern Skies. Radio Astronomy and the Parkes Telescope

By Peter Robertson

Cambridge University Press, 40 West 20th Street, New York, NY 10011-4211. 1992.
357 pages. Price $75.00 cloth
(ISBN 0-521-41408-3).

Beyond Southern Skies tells the story of the planning and construction of the Parkes Telescope in rural New South Wales, Australia and surveys its achievements over the past 30 years.

Part One of the book looks at the beginnings of radio astronomy starting with the American pioneers of the 1930's, and then the post-war expansion of this fledgling science in countries such as Australia, Britain, and the Netherlands. Part Two tells the story of the funding, design, and construction of the Parkes Telescope during the 1950's. The telescope was Australia's first successful venture into the world of big science.

The achievements of the astronomers at Parkes are reviewed in Part Three. Over one thousand research papers have been produced from Parkes during its existence.

Beyond Southern Skies is a handsome book that will make enjoyable reading for anyone interested in radio astronomy and its history.

Exploration of the Solar System by Infrared Remote Sensing.

By R.A. Hanel, B.J. Conrath, D.E. Jennings, and R.E. Samuelson.

Cambridge University Press, 40 West 20th Street, New York, NY 10011-4211. 1992.
458 pages. Price $125.00 cloth
(ISBN 0-521-32699-0).

This technical book describes all aspects of the theory, instrumental techniques, and observational results of the remote sensing of objects in our Solar System through studies of infrared radiation. In the text, the theories of radiative transfer, molecular spectroscopy, and atmospheric physics are first combined to show how it is possible to calculate the infrared spectra of model planetary atmospheres. Next, the authors describe instrumental techniques as well as the techniques that allow the retrieval of atmospheric and surface parameters from observations. All of the planets and many of their satellites are discussed, with the exception of Pluto, in a presentation that will appeal to advanced students and professional planetary science researchers.

The Fullness of Space. Nebulae, Stardust and the Interstellar Medium.

By Gareth Wynn-Williams.

Cambridge University Press, 40 West 20th Street, New York, NY 10011-4211.
1992. 202 pages, Illus. Price $65.00 cloth
(ISBN 0-521-35591-5); $29.95 paper
(ISBN 0-521-42638-3).

Interstellar matter is the stuff out of which the Solar System, the Earth, and even our bodies are made. There is enough of it left in the Milky Way Galaxy to make ten billion more stars like the Sun! But to some astronomers interstellar matter is a nuisance, since it hides and distorts their view of more distant objects in the Universe. Yet, others view it as a cosmic laboratory whose vastness allows atoms to behave in ways that cannot be duplicated on Earth.

The Fullness of Space is a comprehensive account of what astronomers have learned about interstellar matter: where the material comes from, what it is made of, and how it collects together to form new stars and planets. The text is non-technical and no prior knowledge of astronomy or physics is needed to enjoy the book. The text is illustrated with numerous photographs and explanatory line drawings.

Galaxies and the Universe

Edited by David J. Eicher

Kalmbach Publishing Co., 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187. 1992. 112 pages, Illus. Price $14.95 paper (ISBN 0-913135-14-3).

Galaxies and the Universe is an observing guide culled from the pages of the now defunct *Deep Sky* magazine. It represents some of the best material assembled during *Deep Sky's* existence. The fourteen articles here will take an observer out under the stars and explore with him the world of galaxies as they appear from the backyard. The galaxies included range from the biggest and the brightest—like the Andromeda Galaxy, M33, and M51—to the most challenging, like Maffei 1 and the Coma Berenices galaxy cluster. Whether you have a 4-inch refractor or a 25-inch Dobsonian, this highly-illustrated guide will offer you plenty of galaxy observing opportunities during all four seasons of the year.

Some titles included in *Galaxies and the Universe* are: "Observing the Local Group of Galaxies", "The Galaxies of Canes Venatici", and "A Trio of Springtime Galaxy Groups."

Stars and Galaxies

Astronomy Magazine.

Astromedia, a division of Kalmbach Publishing Co., 21027 Crossroads Circle, P.O. 1612, Waukesha, WI 53187. 1992. 200 pages, Illus. Price $29.95 cloth (ISBN 0-913135-05-4).

Stars and galaxies are for everyone. Unlike many sciences, astronomy is a people's science in that anyone beneath a clear sky can participate in it. With a simple pair of binoculars or a small telescope, you can visit the cosmos from your own backyard. All you need is information on what to look at and how to interpret what you are seeing. *Stars and Galaxies* is intended to introduce you to several hundred of the brightest and most beautiful citizens of our Milky Way Galaxy and other galaxies beyond.

The book contains 37 articles reprinted from *Astronomy* magazine and is profusely illustrated with beautiful photographs, charts, and tables. Some examples of the articles are: "The Wonders of the Coma Cluster", "Observing the Andromeda Galaxy", "Explore the Virgo Cluster", and "The Art of Observing Planetaries."

A.L.P.O. VOLUNTEER TUTORS

Below are listed experienced A.L.P.O. members who are available to serve as volunteer tutors to correspond with less-experienced members interested in their specialities. There is no better way to learn than by such one-on-one education. If you want to brush up on any of our observing techniques, write to one of them; be sure to enclose a SASE.

Dr. Julius L. Benton, Jr.
305 Surrey Road
Savannah, GA 31410
Instrumentation and Equipment Selection

Mr. Gregory L. Bohemier
E Berkshire Road,
RR1 Box 193
Berkshire, NY 13736
Instrumentation and Equipment Selection

Mr. Richard E. Hill
Lunar & Planetary Lab.,
University of Arizona,
Tucson, AZ 85721
(Internet: rhill@hindmost.lpl.arizona.edu)
Solar

Mr. Harry D. Jamieson
P.O. Box 143, Heber Springs, AR 72543
Lunar; Instrumentation and Equipment Selection; Software—Astronomical Programming

Mr. Andrew Paul Johnson
1 York Lane, Knaresborough, North Yorkshire
United Kingdom HG5 0AJ
Lunar; Drawing Skills

Mr. Charles A. Kapral
6601 Hana Road
Edison, NJ 08817
Lunar; Photometry

Mr. Michael Mattei
11 Coughlin Road.
Littleton, MA 01460
Drawing Skills; Telescope Making or Enhancement

Mr. Frank J. Melillo
14 Glen Hollow Dr., Apt. E-16
Holtsville, NY 17742
Solar; Photometry

Mr. José Olivarez
1469 North Valleyview Ct., Wichita, KS 67212
Instrumentation and Equipment Selection; General Literature

Mr. Zac Pujic
6/64 Warren St.
St. Lucia 4067
Queensland, Australia
Planetary Observing

Mr. Peter Rasmussen
1210 W. Maple, Heber Springs, AR 72543
Instrumentation and Equipment Selection

Mr. Timothy J. Robertson
38121-25th St. E #h-101
Palmdale, CA 93550-1300
Drawing Skills; Comets

Mr. Andrew M. Sorenson
RR 4, Box 4A
Jefferson, IA 50129
Telescope Making or Enhancement

Mr. Brad Timerson
623 Bell Road.
Newark, NY 14513
Instrumentation and Equipment Selection

Mr. Daniel M. Troiani
629 Verona Ct.
Schaumburg, IL 60193
Mars; Video/CCD Imaging

ANNOUNCEMENTS

ASSOCIATION NEWS

(Asterisks indicate decisions made at the 1993 A.L.P.O. Business Meeting)

* *1994 Convention.*—We have accepted the kind invitation of Mr. Douglas Gegen of the Roper Mountain Science Center, Greenville, SC, to meet there on June 16-18, 1994. This, our 44th Convention, will include workshops for educators and for observing the Comet Shoemaker-Levy 9/Jupiter impact in July, 1994. Future issues of this Journal will carry more information about this meeting.

* *Paul Maxson and Daniel Troiani Promoted.*—Mr. Paul Maxson is now a permanent Recorder of the Solar Section, previously having been "Provisional." Likewise, Daniel Troiani is now a full Recorder in the Mars Section, having previously been Assistant Recorder. Their addresses are on the inside back cover.

* *New Mercury/Venus Transit Section.*—This new Provisional Section will concentrate on transits of the planets Mercury and Venus across the Sun. The Acting Recorder is John E. Westfall (address on inside back cover). This Section is concerned with observations of future transits and with historical studies of past transits. The 1993 NOV 06 Mercury Transit is described on pp. 84-85, and the forms of transit observation on pp. 86-89, of this issue.

* *No More Luna Incognita Program.*—As in government, it is unusual for us to end a Program simply because its work has been completed; but that is the case with the Luna Incognita Program, at least as far as earth-based observation is concerned. Thus this program is no longer listed; its ex-Recorder, John Westfall, continues to revise the Luna Incognita map on the basis of space-probe data.

* *Instrument Section Made Permanent.*–The Provisional Instrument Section has been given permanent status. Its Acting Recorder, Mr. Michael Mattei, is now a regular Recorder (his address is on the inside back cover).

A.L.P.O. Group Portraits Available.—Eight-by-ten inch color enlargements of the group portrait taken at the 1994 A.L.P.O. Convention in Las Cruces, shown as our front cover illustration, are available to our readers. Send an $8.00 check ($10.00 for those outside the United States), payable to "A.L.P.O.", to: A.L.P.O., P.O. Box 16131, San Francisco, CA 94116 U.S.A..

Back Issues of **J.A.L.P.O.** *Wanted.*—A.L.P.O. Recorder Richard Hill (address on inside back cover) needs back issues of *J.A.L.P.O.* from the last five years for the library of the Lunar and Planetary Laboratory at the University of Arizona. Mr. Hill writes: "At present there is no funding for future subscriptions so donations are needed. It may seem amazing, but this journal is not on the shelves here and needs to be if your observations are to get the exposure they deserve."

Opportunity to Obtain Schmidt Mirror Blanks.—Clyde Tombaugh informs us that he is offering for sale two 13-in Schmidt Mirror blanks, suitable for making 8.5-in f/1.0 cameras for wide-angle sky photography. For more information, write: Clyde W. Tombaugh, P.O. Box 396, Mesilla Park, NM 88047.

The A.L.P.O. Loses a Friend.— We regret to report that Clifford W. Holmes, Jr., died on September 8th. He had been an A.L.P.O. member for many years, but most amateur astronomers knew Cliff as the man who was instrumental in starting the annual Riverside Telescope Makers' Conference (RTMC) in 1969 and in managing it until 1992. Undoubtedly, thousands of persons were drawn into amateur astronomy by the RTMC. Cliff also had time for the Riverside Astronomical Society and the Western Amateur Astronomers, and received the G. Bruce Blair Medal in 1975 and the Astronomical League Service Award in 1988. Our avocation indeed owes much to him.

ELSEWHERE IN THE SOLAR SYSTEM

New Developments Regarding the K/T Event and Other Catastrophes in Earth History.—If you've wondered what can go wrong with the Earth, this conference is for you. It will be held in Houston, Texas, on February 9-12, 1994. For more information, contact: K/T Event, Publications and Program Services Department, Lunar and Planetary Institute, 3600 Bay Area Boulevard, Houston, TX 77058-1113; telephone 713-486-2149.

Twenty-fifth Annual Lunar and Planetary Science Conference.—This is one of the two major Solar-System conferences, having met each year since the Apollo-11 lunar landing. The 1994 meeting will consist of five days of paper and poster sessions. Some of the fields represented will be petrology, geochemistry, geophysics, geology, and astronomy. It will be held (as always) in Houston, Texas, on the dates of March 14-18, 1994. For more information about the program and logistics, contact: 25th LPSC, Publications and Program Services Department, Lunar and Planetary Institute, 3600 Bay Area Boulevard, Houston, TX 77058-1113; telephone 713-486-2166.

Astronomical Telescopes & Instrumentation for the 21st Century.—Hosted by the Society of Photo-Optical Instrumentation Engineers (SPIE), this meeting will be held March 13-18, 1994 at the Kona Surf Resort and Country Club in Kona, Hawaii. Tours of the large telescopes on Mauna Kea are planned. This conference will be held March 15-16.The non-SPIE member registration fee is $410; to find out more call SPIE at 206-676-3290.

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 A. Davis, 1700 Whipple Road, Apt 11A, Mt. Pleasant, SC 29464, USA

The A.L.P.O. Solar System Ephemeris: 1993. $7.00 in the United States, Canada, and Mexico; $9.50 elsewhere (airmail included). Contains 129 pages of tables, graphs, and maps describing the positions and appearances of the Sun, Moon, each major planet, the brighter 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 July, 1993.

◆◆

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--1992/93.*** *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 North America; $6.00 elsewhere. Continuously-updated list of members: alphabetically, and by location and by interest(s). Make payment to "A.L.P.O." *Provided at the discretion of the Membership Secretary.*

◆◆

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.
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); 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); 5-6 and 11-12 [each $2.50].
33 (1989); 1-3, 4-6, 7-9, and 10-12 [each $2.50]. *34* (1990); 2 and 4 [each $2.50].
35 (1991); 1, 2, and 3 [each $2.50]. *36* (1992); 1, 2, and 4 [each $2.50].
37 (1993); 1 [each $2.50]. ***Current Issue*** [*37*, 2]—$3.00.

KEEPING YOUR MEMBERSHIP CURRENT—

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., "37.2" means Vol. 37, No. 2). We include a *First Renewal Notice* in that issue, and a ***Final Notice*** in the next one.

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 about 600 members. Our dues include a subscription to the quarterly Journal, *The Strolling Astronomer*, and are $16.00 for one year ($26.00 for two years) for the United States, Canada, and Mexico; and $20.00 for one year ($33.00 for two years) for other countries. One-year Sustaining Memberships are $25.00; Sponsorships are $50.00. 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.

Our advertising rates are $85.00 for a full-page display Ad., $50.00 per half-page, and $35.00 per 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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