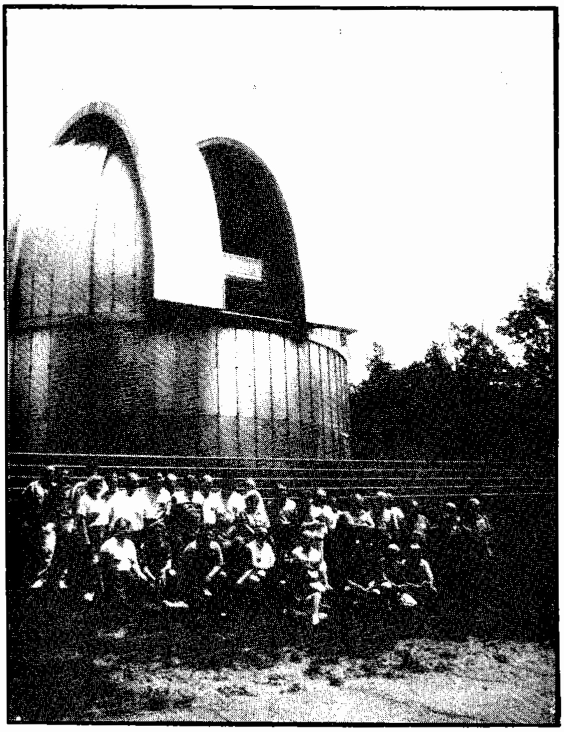
ISSN 0039-2502

The Journal Of The Association Of Lunar And Planetary Observers

The Strolling Astronomer

Volume 38, Number 1 Published October, 1994



About 50 of our members gathered at the 44th Convention of the Association of Lunar and Planetary Observers, held in Greenville, South Carolina, June 15-18, 1994. Behind the group is the dome of Roper Mountain Science Center's 23-inch Alvan Clark refractor, used by the group for several nights of observing. The results of the A.L.P.O. Board of Directors' Meeting held in Greenville are given on pages 40-41 of this issue

THE ASSOCIATION OF LUNAR
AND PLANETARY OBSERVERS
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Membership Secretary, Harry D. Jamieson
P.O. Box 143
Heber Springs, AR 72543 U.S.A.
Printed in the USA

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

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MAKE WAY FOR THE 1994-95 APHELIC APPARITION OF MARS

By Jeffrey D. Beish, A.L.P.O. Mars Recorder

INTRODUCTION

With the loss of the Mars Observer Spacecraft our plans for closeup surveillance of the Red Planet Mars are on hold. While the past accomplishments of American space missions throughout the Solar System have yielded extensive volumes of scientific information we nevertheless ponder many questions about the Earth-like planet Mars. Some of these remain unanswered: Are the polar climates static or are they changing over long periods of time? Can surface wind directions be inferred from cloud formations and movements? Are equatorial water clouds seasonal? If so, can their appearance and locations be predicted? What causes the secular (long-term) changes in dark albedo features? Are their locations topographically controlled or instead caused by unseasonably strong winds? These are just a few of the important questions remaining in the Martian mystery that the I.M.P. (A.L.P.O. Mars Section International Mars Patrol) can help solve [Capen *et al.* 1982].

Still an intriguing world, Mars offers both the casual and serious observer many challenges and delights. This planet offers astronomers a free laboratory to study another world‘s atmosphere, including the behavior of condensates and their effects. Mars is similar to Earth in that it has four seasons, exhibits global climates, changing weather patterns, annual thawing of polar caps, storm clouds of water vapor, howling dusty winds, and a variety of surface features which predictably change in color and size, and move around the surface over long periods of time.

Table 1. A.L.P.O. Mars Recorders; Past and Present; a historical listing of the A.L.P.O. Mars Section Recorders and Assistant Recorders from 1953 to the present date.

Recorder	Period	Years*
D.P. Avigliano	1953 Dec-1955 Nov	1.9
Frank R. Vaughn, Jr.	1955 Nov-1959 Nov	4.0
Ernst E. Both	1959 Nov-1964 Oct	4.9
Klaus R. Brasch	1964 Oct-1969 Feb	4.3
Charles F. Capen, Jr.	1969 Feb-1986 May	17.3
Donald C. Parker	1986 May-present	8.3
Jeffrey D. Beish	1986 May-present	8.3
Daniel Troiani	1993 Aug-present	1.1
Assistant Recorder		
Leonard B. Abbey, Jr.	1957 Dec-1963 Jan	5.1
Klaus R. Brasch	1963 Jan-1964 Oct	1.7
Richard E. Wend	1964 Oct -1966 Nov	2.1
Kenneth T. Chalk	1966 Nov -1969 Feb	2.2
Thomas R. Cave	1969 Apr-1974 Feb	4.8
Robert B. Rhoads	1974 Feb-1979 Jun	5.3
Donald C. Parker	1979 Jun-1986 May	6.9
Jeffrey D. Beish	1981 Jul-1986 May	4.8
Carlos Hernandez	1987 Nov- present	6.8
Daniel Troiani	1988 Aug-1993 Aug	5.0
Harry Cralle	1988 Aug-1993 Aug	5.0

* Average 6.3 years for Recorders, 4.5 years for Assistant Recorders.

It may be no surprise that the task of recording the history of Mars again falls into the hands of a few dedicated amateur astronomers organized by the A.L.P.O. International Mars Patrol.

THE A.L.P.O. AND THE I.M.P.

The Association of Lunar and Planetary Observers Mars Section‘s observing program is an international cooperative effort between individual observers and members of observing groups located around the world, such as the Terrestrial Planets Section of the British Astronomical Association (BAA), the Mars Section of the Oriental Astronomical Association (OAA), the Arbeitskreis Planetenbeobachter (Germany) and the Groupement International d‘Observateurs des Surfaces Planetaires (GIOSP).

The A.L.P.O. Mars Section has a long history of dedicated people who were willing to devote considerable amounts of time and energy to sorting, cataloging, correcting, and carefully studying many thousands of observations from all over the Earth. Included here is a table of the A.L.P.O. Mars Section Recorders and Assistant Recorders giving the periods of their post as Section leaders. (See *Table 1* to left).

Established in the late 1960‘s by Charles F. Capen, the I.M.P. has contributed almost 25,000 observations of Mars. Contained within the archives of the A.L.P.O./I.M.P. Mars Section library are the records of thirteen apparitions of Mars covering a span of 30 years (See *Table 2*, p. 2; and *Figures 1-4* on pp. 3-4).

The I.M.P. provides high-quality drawings, photographs, CCD images, and micrometer measurements of features on Mars and is a major contributor to man‘s knowledge about current weather and surface conditions on Mars. With a set of color filters and a high-quality telescope of 6 to 12 inches aperture, the amateur can produce professional quality telescopic work in planetary research.

As a result of diligent work of the observers and cooperation within the membership, the I.M.P. is privileged to participate in professional activities such as; providing observers for Lowell Observatory‘s International Planetary Patrol, work side-by-side with professional planetologists, publish scientific papers in the na-

Table 2. History of A.L.P.O./I.M.P. Observations from 1964 through 1994.

Given are the dates from the first to last observations, opposition date, planetocentric longitude of the Sun (Ls), Ls range, total span of Ls from first to last observation, actual number of degrees Ls observed (Act.), number of observers (Obs.), types of observations (Visual [Vis.], Photographic [Pho.], Micrometer [Mic.], and CCD), and total (Tot.) observations. All dates are in Universal Time (UT).

	Opposition		Ls (°)			No.	Number of Observations				
Observation Dates	Date	Ls	Range	Span	Act.	Obs.	Vis.	Pho.	Mic.	CCD	Tot.
1964 SEP 11-1965 AUG 25	1965 MAR 09	084	003-165	163	100	3	0	650	0	0	650
1968 NOV 22-1970 MAR 12	1969 MAY 31	165	075-336	262	120	31	415	631	0	0	1046
1970 NOV 29 -1972 FEB 18	1971 AUG 10	232	097-347	251	138	115	1633	846	0	0	2479
1973 FEB 24-1974 MAY 19	1973 OCT 25	306	160-050	251	163	78	1050	305	0	0	1355
1975 MAR 18-1976 JUL 19	1975 DEC 15	357	197-096	260	151	54	888	124	0	0	1012
1977 JUN 26-1978 AUG 05	1978 JAN 22	036	286-124	199	136	30	494	38	0	0	532
1979 JUN 06-1980 OCT 22	1980 FEB 25	070	300-187	248	162	41	1118	45	145	0	1308
1981 JUL 28-1983 JAN 01	1982 MAR 31	105	354-238	245	194	56	1551	143	309	0	2003
1983 AUG 11-1985 MAR 29	1984 MAY I1	145	021-331	311	218	59	1301	194	149	0	1644
1985 SEP 19-1987 JUN 22	1986 JUL 10	202	059-038	340	240	90	1623	555	172	0	2350
1987 NOV 09-1989 JUN 12	1988 SEP 28	280	100- 053	314	261	306	4818	2038	191	16	7063
1990 JAN 25-1991 SEP 20	1990 NOV 27	340	157-117	321	199	97	1411	556	22	44	2033
1992 APR 24-1993 NOV 14	1993 JAN 07	022	236-166	291	152	73	903	330	77	171	1481
Total				3456	2234	1033	17205	6455	1065	231	24956
Average				266	172	79	1323	497	82	18	1920

tion's leading astronomical journals, and provide high-quality photographs and images of Mars to the United States Geological Survey for creating maps of albedo features of the Red Planet. From the late 1960's, interested amateur and professional astronomers located in 44 foreign countries and American territories have cooperated in a 24-hour watch on the Red Planet Mars.

Furthermore, we encourage members to contribute high-quality visual observations of Mars because this method usually can be performed at those times when photography is difficult or impossible, such as when the seeing is only average or when Mars' apparent diameter is less than 10 or 12 arc-seconds. Visual observations of Martian meteorology can be carried out quite successfully when the planet's apparent size is only 6 to 7 arc-seconds, assuming reasonable seeing, sufficient telescope aperture, and proper use of color filters.

THE A.L.P.O./I.M.P. OBSERVING PROGRAM FOR MARS

The A.L.P.O./IMP Mars Section Recorders coordinate and instruct the cooperating observers in using visual observing, photography, photometry, CCD imaging, and micrometric techniques; and in employing color filters and standard methods for reporting their observations. These methods result in homogeneous sets of observing data that have good analytic value. Each apparition, the A.L.P.O. Mars Section receives thousands of individual observations consisting of visual disk drawings made with the aid of color filters, black-and-white and color photographs, electronic CCD camera images, intensity estimates of light and dark albedo features, color contrast estimates, and micrometer measurements of polar caps, cloud boundaries, and variable surface features during the 11- to 21-month observing period.

The chronological filing of this large quantity of data requires that the observation information obtained for each night (Universal Time) be recorded on one or two standard observing report forms! CCD video tapes should be prepared with a few minutes scheduled per image every half hour or so. Analyzing tapes with hours of continuous play of Mars is extremely difficult, to say the least! Using modern VCR frame-grabbing equipment and computer software, it is possible to select frames of Mars images for enhancement and further study. CCD images that are stored on magnetic disks can be sent as is to the Mars Recorders for immediate analysis. Remember, using multiple photographs, video frames, or CCD images of Mars during short periods of time is an excellent way to produce high-quality composites; however, it only takes three or four samples to produce successful composite images.

It is in this regard that a simple, efficient and standard Mars Observing Report Form has been prepared by the A.L.P.O. Mars Recorders. This standard form, or its format, can be used for reporting all types of observations, such as micrometry, transit timings, intensity estimates, and so forth. Photographs may also be attached to the top or back of the form and the relevant information blanks filled in at the telescope. Planetary aspect blanks can be filled in at other times than while observing.

Observational data consist of color-filter photography, visual disk drawings, visual photometry (intensity estimates on the standard A.L.P.O. scale: 10 = maximum polar brightness, 8 = desert mean brightness, 0 = night sky), micrometry, and CCD imaging. Great emphasis is placed on high-quality photographs in red- and blue-light, full-disk drawings using standard color filters, polar cap measurements made with the eyepiece mi-

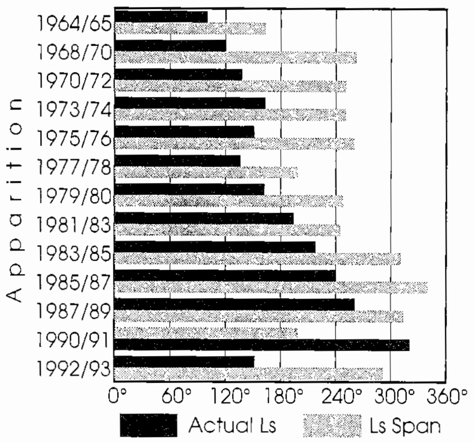


Figure 1. Observational coverage of Mars Apparitions, 1964/65-1992/93. Number of Ls degrees actually observed in black; total Ls span from the first to the last observation in grey.

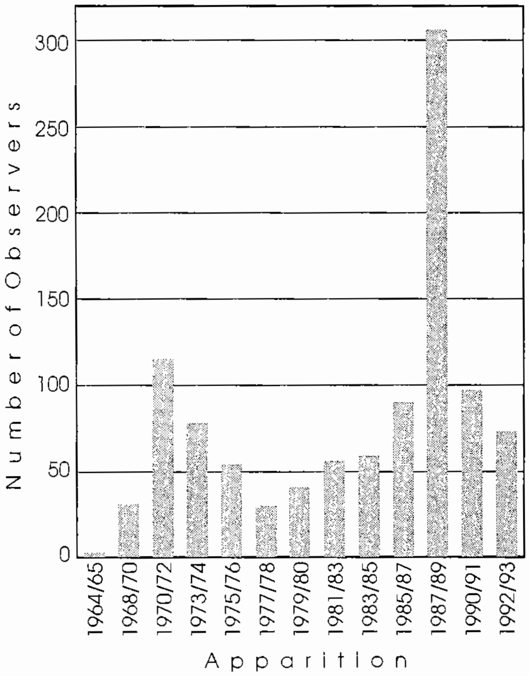


Figure 2. Number of observers contributing for each Mars Apparition, 1964/65-1992/93.

crometer, and also on modern observing techniques such as full-disk photometry and CCD imaging.

It is highly recommended that all observers, visual as well as photographers and CCD camera users, employ at least a basic set of tricolor filters according to the following guide: red or light red (W25 or W23A); green (W58); blue-green (W64); blue (W38A or W80A); and deep blue (W47). Observers with smaller telescopes, such as 3- to 6-in (8-15 cm) apertures may find that a yellow (W15) may provide better performance than the deep red filter. Those employing larger instruments, such as 8- to 16-in (20-40 cm) apertures, will find the deep red and blue filters most useful for fine surface details or atmospheric cloud detection. [Capen, 1984] (See *Table 3*, p. 5).

MARS IN 1994 AND 1995

For observers located in the Northern Hemisphere of Earth, Autumn 1994 and Winter and Spring 1995 will provide an opportune time to investigate the Martian Northern Hemisphere because the Red Planet will be favorably placed in the sky, north of the Celestial Equator throughout the entire 1994-95 Apparition (1994 APR 19-1995 JUL 23), with its Northern Hemisphere tilted toward us for most of that period.

The term "apparition" refers to the time span during which a planet is observable; from when one first can view the planet after it emerges from conjunction into the morning dawn sky to the time just before the next conjunction, when the planet is seen low in the western sky after sunset. Practically speaking, however, high-quality telescopic observations of Mars commence when its apparent diameter is greater than 6 arc-seconds (1994 OCT 04-1995 JUN 19).

When Mars is low in the sky atmospheric turbulence is usually severe, limiting telescopic observations. Despite these problems, A.L.P.O. astronomers are encouraged to make observations even at these times. A red (Wratten 25 or equivalent) filter lessens the adverse seeing effects, since red wavelengths are refracted less, and improves image contrast. While little or no fine detail can be discerned when the planet is low and of small apparent size, gross features, such as Syrtis Major, can be seen.

As a rule, the Martian atmosphere is relatively clear, especially when viewed in red light. We know from Earth-based and spacecraft observations that non-gaseous particles occasionally populate much of the Martian atmosphere and provide the necessary "embryo" for cloud formation. Clouds and hazes often obscure much of the Martian surface and at times a general blue-white veil covers the entire planet. It is believed that this veil is composed mainly of carbon dioxide ice crystals suspended in the atmosphere. Water vapor has been detected in the Martian atmosphere and, under the right conditions, is a major contributor to obscuring the planet's surface [Davies, D.W., 1981 and Farmer, C.B. et al, 1977].

1994-95 APPARITION CHARACTERISTICS

Mars has an average 15.8-year seasonal opposition cycle, which consists of three or four aphelic oppositions and three perihelic oppositions. The 1994-95 Apparition will be

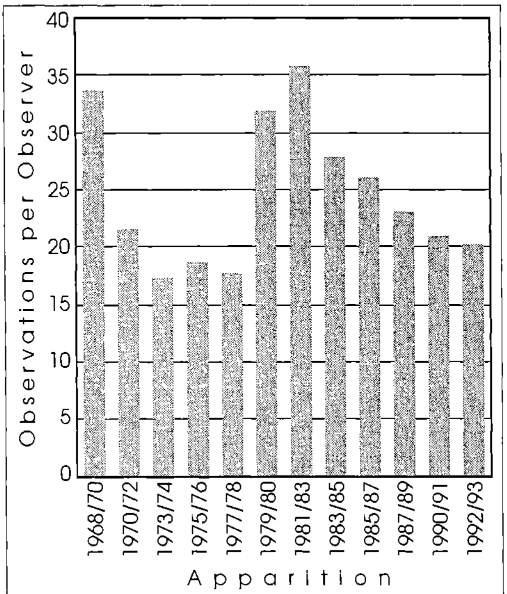


Figure 3. Mean number of Mars observations contributed per observer, 1968/70-1992/93 Mars Apparitions.

considered an aphelic apparition because opposition occurs only 12° before aphelion (070° Ls; see below). Mars will be closest to Earth on 1995 FEB 11 (057° Ls) with an apparent diameter of 13.85 arc-seconds at a distance of 0.67570 AU [Astronomical Units] or 62,810,113 miles (101,083,281 km) and will reach opposition on 1995 FEB 12 (058°Ls). (See *Figure 5*, p. 5)

Mars' North Pole will be tilted earthward during all of the Martian Northern Hemisphere spring and early summer. Thus astronomers can again study the regression of the NPC (North Polar Cap) and follow the Martian arctic meteorology. Unlike the last apparition when the summer polar cap was difficult to observe, this apparition should also allow careful scrutiny of the summer NPC remnant.

DAYS AND SEASONS ON MARS

The Martian solar day (sol) is about 40 minutes longer than a day on Earth. Thus Mars rotates through only 351° of longitude in 24 hours. An astronomer on Earth, who observes a particular surface feature on Mars on a particular night, sees the same feature 9° farther to its west (closer to its morning limb) at the same time the next night.

Mars and Earth have four comparable seasons because their axes of rotation are each tilted at about the same angle to their respective orbital planes. In describing Martian seasons, scientists use the term “Ls“ which stands for the areocentric celestial longitude of the Sun along Mars' ecliptic. (“areo-“ is a prefix often employed when referring to Mars or “Ares.“) Mars' axial tilt is 25°.2 as compared to 23°.5 for that of the Earth. The Martian year is 687 Earth days, nearly twice as long as ours, so that the Martian seasons are similarly longer. While Earth's seasons are nearly equal in duration, the length of a Martian season can vary by as much as 52 days because of the greater eccentricity of its orbit. (See *Table 4*, p. 6.)

The axis of Mars does not aim at our North Star, but is displaced about 40° towards Alpha Cygni. Because of this celestial dis-

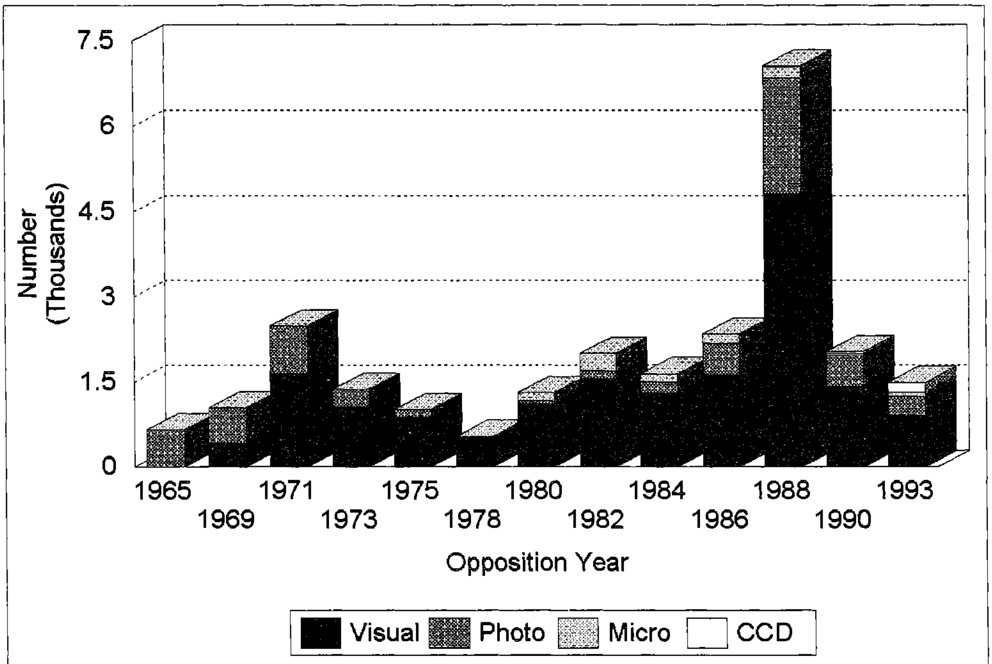


Figure 4. Number of observations by type for the 1964/65-1992/93 Mars Apparitions.

Table 3. Eastman Kodak Wratten Color Filters used by A.L.P.O. Observers: Characteristics for Mars Observations.

Yellow—W8, W12, W15. Brightens desert regions; darkens blue and brown features; improves astronomical seeing (especially for small apertures).

Orange-Light Red—W21, W23A. Further increases contrast between light and dark features; penetrates hazes and most clouds; limited ability for detection of dust clouds.

Red—W25, W29. Gives maximum contrast of surface features; enhances fine surface details, dust-cloud boundaries, and polar-cap boundaries.

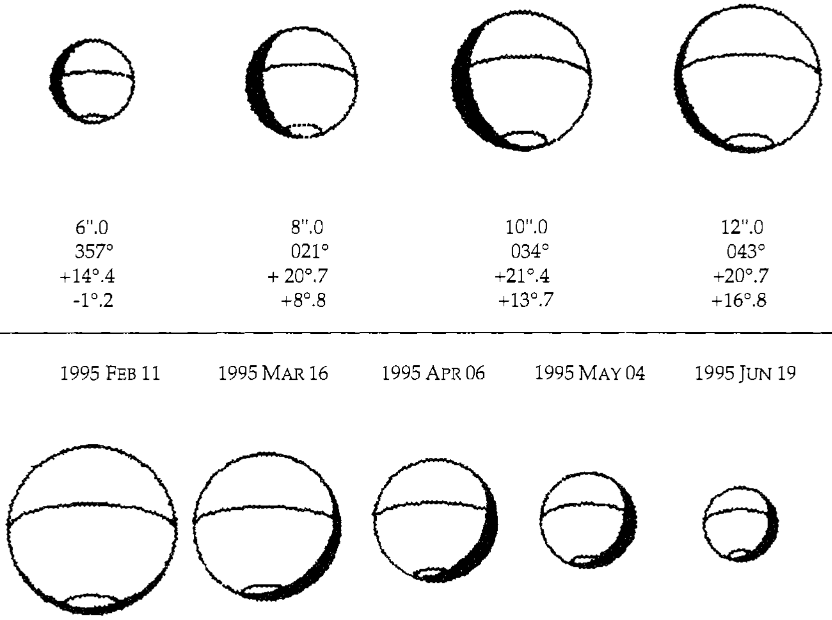
Green—W56, W57, W58. Darkens red and blue features; enhances frost patches, surface fogs,and polar projections.

Blue-Green—W64. Detects ice-fogs and polar hazes.

Blue—W80A, W38, W38A. Shows atmospheric clouds, discrete white clouds, and limb hazes; darkens reddish features.

Deep Blue—W47. Shows high-altitude clouds, limb hazes, equatorial cloud bands, polar cloud hoods, and volcanic ash clouds; detects violet-clearing phenomena.

Magenta—W30, W32. Enhances red and blue features and darkens green ones. Helps comparison of surface details to atmospheric cloud positions. Improves visibility of polar-region features.



	1994 Oct 04	1994 Nov 23	1994 Dec 21	1995 Jan 16
Dia.	6".0	8".0	10".0	12".0
Ls	357°	021°	034°	043°
De	+14°.4	+ 20°.7	+21°.4	+20°.7
Ds	-1°.2	+8°.8	+13°.7	+16°.8

	1995 Feb 11	1995 Mar 16	1995 Apr 06	1995 May 04	1995 Jun 19
Dia.	13".85	12".0	10".0	8".0	6".0
Ls	057°	071°	081°	093°	114°
De	+18°.2	+16°.5	+17°.4	+20°.2	+24°.8
Ds	+20°.7	+23°.5	+24°.5	+24°.7	+22.°.5

Figure 5. Apparent Diameter (Dia.) Phase, and Orientation (Ls = areocentric solar longitude, De = areocentric declination of Earth, Ds = areocentric declination of Sun) of Mars, 1994 Oct - 1995 Jun. As Mars approaches the Earth in late 1994 and early 1995 its angular diameter will increase, reaching 13".85 at closest approach on 1995 Feb 11, after which Mars diminishes in apparent size.

placement the Martian seasons are 85° out of phase with the terrestrial seasons, or about one season in advance of ours. Consequently, when you observe Mars in our Northern-Hemisphere winter and spring you will be seeing spring and summer respectively, in the Martian Northern Hemisphere.

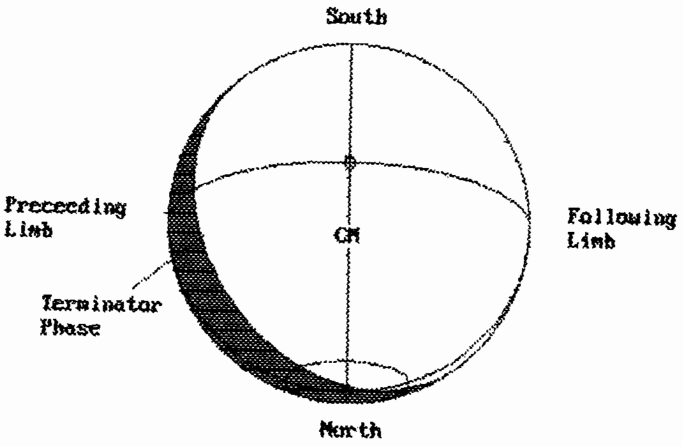


Figure 6. Orientation of the telescopic disk of Mars as seen near the celestial meridian in an inverting telescope in the Earth's Northern Hemisphere. Note the nomenclature used by planetary observers, as explained in the text. Planetary rotation is from right to left (i.e., from the following limb to the preceding limb).

MAKING OBSERVATIONS OF MARS

The Martian Disk and Useful Terms.—*Figure 6* (above) illustrates the orientation and nomenclature of the Martian globe as seen from the Northern Hemisphere of Earth through an astronomical telescope when near the meridian. The figure indicates a simple inverted view of the disk of Mars, where south is at the top, bottom is north, the right side is terrestrial east or the Martian west (morning limb), and the left side is terrestrial west or Martian east (evening limb). Mars appears to rotate from Martian west to east, or right to left. Most classical charts of Mars show this same orientation.

The *Terminator* is the line where daylight ends and night begins. The terminator phase, or defect of illumination, is given in arc-seconds on the apparent disk or degrees of phase angle (i) to define the amount of the geometrical Martian disk that is in darkness. The sunset terminator appears on the Martian east side, or evening limb, before opposition; after opposition, the terminator becomes the sunrise line on the morning limb on the Martian west side.

The *Central Meridian* (CM) is an imaginary line passing though the planetary poles of rotation and bisects the full disk. This line is used to describe the areographic longitude that is centered on the disk at the time of observation and is independent of any phase which may be present; when Mars presents a gibbous phase the CM will appear to be off center. The CM for a given Universal TIme (UT) can be calculated by adding 0°.24/min, or 14°.6/hr, to the daily CM for 0h UT for the date as listed in the *A.L.P.O. Solar System Ephemeris*.

The declination of the planet Earth (De) as seen from Mars defines the *Axial Tilt* of Mars relative to Earth. The De is also equal to the areographic latitude of the center of the full Martian disk, which is known as the subearth point. The latitude is positive if the North Pole is tilted toward Earth and negative if the South Pole is tilted toward us. This quantity is an important factor when drawing Mars or when trying to identify features.

Observing.—Even at its best, Mars is challenging to observe. The disk is tiny and its markings are blurred by the Earth's atmosphere. A telescope for planetary work should provide sharp images with the highest possible contrast. A long-focus refractor is frequently considered the best, followed by a long-focus Newtonian or Cassegrain reflector. Telescopes with large central obstructions do less well.

Anyone who observes Mars will find it rewarding to make a sketch of whatever is seen, both to create a permanent record and to help train the eye in detecting elusive detail. Start with a circle 1-2/3 inches (42 mm) in diameter. Draw the phase defect, if any, and the bright polar caps or cloud hoods. Next shade in the largest dark markings, being careful to place them in exactly the right locations on the disk. At this stage, record the Universal Time to the nearest minute. Now add the finer details, viewing through various color filters, starting at the planet's sunset limb. Finally, note the date, observer's name, the instrument(s), magnifications, and filters used, and any other relevant information.

Table 4. Earth/Martian yearly seasons.
Note: Days = 24h 00m 00s, Sols or Martian days = (24h 37m 22.665s), Ls = Areocentric longitude of the Sun.

	Martian Season		Length of Seasons		
	Northern	Southern	Mars		Earth
Ls	Hemis.	Hemis.	Sols	Days	Days
000°-090°	Spring	Autumn	194	199	92.9
090°-180°	Summer	Winter	178	183	93.6
180°-270°	Autumn	Spring	143	147	89.7
270°-360°	Winter	Summer	154	158	89.1
Total (Year)			669	687	365.25

DOES THE SURFACE OF MARS CHANGE?

The dark surface markings were at various past times thought by some astronomers to be great lakes, oceans, or vegetation, but space probes in the 1960's and 1970's revealed the markings to be vast expanses of rock and dust. Windstorms sometimes move the dust, resulting in both seasonal and long-term changes. (See *Figure 7*, p. 7.)

Figure 7. Albedo map of Mars on a cylindrical projection with south at top, prepared by Daniel Troiani.

Among the areas where yearly variations have been recorded are Trivium-Elysium, Solis Lacus, Syrtis Major, and Sabaeus-Meridiani. The Syrtis Major is the planet‘s most prominent dark area. Its eastern [Martian directions are used here and subsequently] side becomes streaked and shrinks during Martian Southern Spring, then widens in Autumn. Watch the Syrtis in our Northern Autumn to see if it widens on schedule. Solis Lacus, the “Eye of Mars,“ is notorious for undergoing major changes. In 1977 amateur observers discovered a new dark feature in the Aetheria desert at longitude 240° W, 25° N, between Nubis Lacus and Elysium. It was subsequently found on Viking Orbiter images taken in 1975, apparently having gone undetected by Viking scientists. This is an example of the importance of ground-based observations of the Solar System.

Other seasonal changes on the Martian surface appear to be caused by distribution of fine layers of surface dust by seasonal winds. An example is the predictable changes in shape of the Syrtis Major. This dark, wedge-shaped feature, always a favorite subject for observers, becomes narrow after perihelion passage (Ls 250°) and broad after aphelion (Ls 070°). In addition, this feature has undergone some rather dramatic long-term, or “secular,“ changes over the years. During recent apparitions, the Syrtis Major appears to have become narrower and blunted compared to its appearance in the 1950‘s, and the once-conspicuous region to the east, called Thoth-Nepenthes, has all but disappeared.

To the west of Solis Lacus lies a normally light ocher area called Daedalia-Claritas. During the 1970‘s this region underwent an intense darkening but has now returned to its normal intensity. It merits close scrutiny by amateur observers.

In 1978 a new dark area on the western side of the Elysium shield volcanoes was reported by A.L.P.O. Mars observers. It was subsequently confirmed on Viking Orbiter photographs. Capen named this the “Hyblaeus Extension,“ after the normally inconspicuous “canal“ Hyblaeus, which is located in this position. This darkening persisted into the 1980‘s, as well as other changes near Elysium, notably the lightening of the wedge-shaped feature, Trivium Charontis. This whole region near the huge Elysium volcanoes appears to be in a state of flux and should be monitored often.

Another recent surface change is the appearance of a very conspicuous dark band across Hesperia. This has been named for the faint “canal“ Cerberus III and was first detected in 1986.

Experience is obviously important in this research; however, even experienced observers begin early in Mars apparitions to reacquire observing skills and to familiarize themselves with current conditions on Mars. It will take an observer a little more than a month to see the entire surface of Mars. Because of the aforementioned 37-minute difference in the lengths of Mars’ and Earth’s days, a particular surface feature appears to back up about 9 degrees from night to night, causing an illusory retrograde rotation in about 40 days.

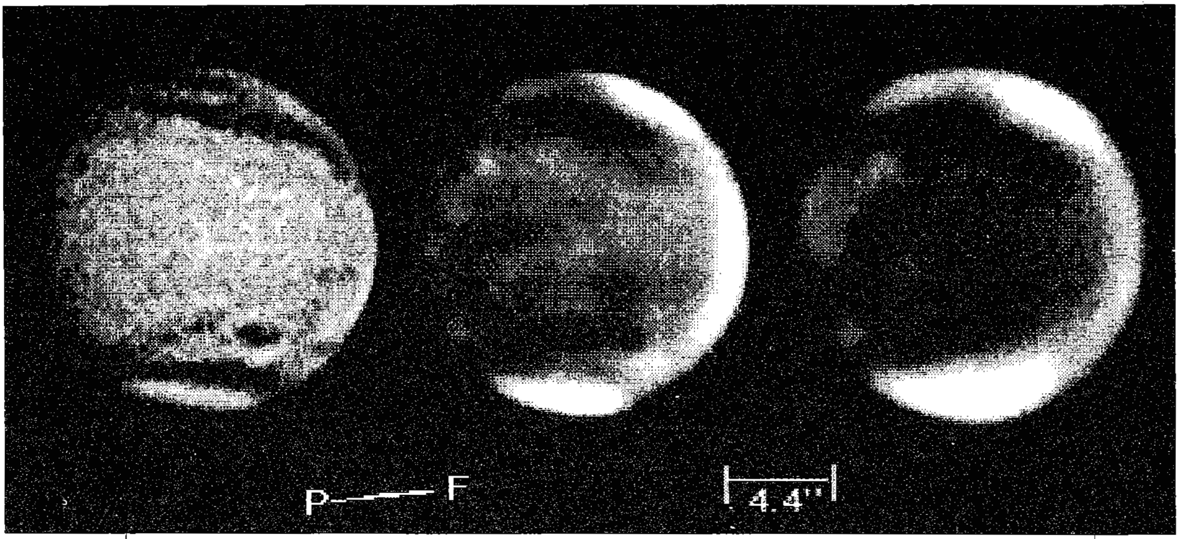


Figure 8. CCD image of Mars, 1992 Dec 21, 05h 07m UT, CM = 164°, south at top. This illustrates several types of meteorological features that appear during the Martian Northern-Hemisphere early spring. The well-known "W" clouds are partially shown on the left (evening) limb and over Olympus Mons (upper left). There is a discrete cloud over Panchaia (upper right near polar cap). Bright morning clouds form during early- to mid-morning on Mars in Northern-Hemisphere spring. To the south, a large cloud covers Eridania and Ausonia. The North Polar Region has haze and a light cloud band is visible across the equatorial zone.

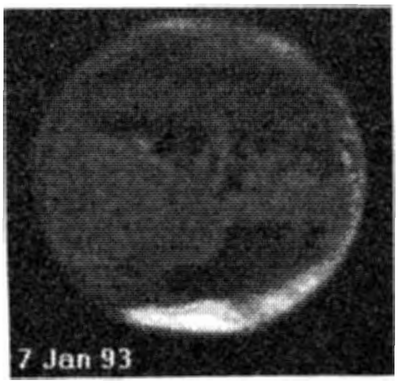


Figure 9. This CCD image taken on 1993 Jan 07 shows what appears to be a front or wave cloud near the edge of the hazy North Polar Cap. The morning (left), evening (right), and south (top) limbs are cloudy. Also, a bright discrete cloud is seen over Tempe on the morning limb.

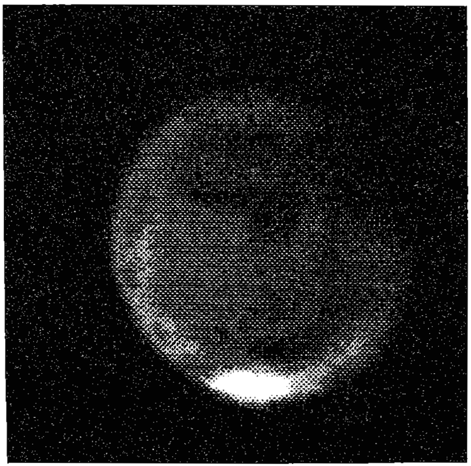


Figure 10. CCD image, 1993 Feb 11, south at top. Dense limb haze engulfs Syrtis Major on evening limb (left). Evening hazes extend from 50° north latitude southwards across the equator. Morning clouds above and south of Tempe extend 30° of longitude from the morning terminator. The North Polar Region is covered with a dense canopy mixed with clouds.

MARTIAN METEOROLOGY

Clouds and Hazes.—The Martian atmosphere is ever-changing. White water clouds, yellow dust clouds, bluish limb hazes, and bright surface frosts have been studied with increasing interest in the past two decades. Clouds appear to be related to the seasonal evaporation and condensation of polar-cap material. An intensive study of Martian weather is now in progress by the A.L.P.O. Mars Section using visual data, photographs, and CCD images from professional and amateur astronomers around the world. Statistical analysis indicates that blue- and white-cloud activity and near-surface fog occurrence is higher in the spring and summer of the Martian Northern Hemisphere than in the same seasons for the Southern Hemisphere. (See *Figures 8-10*, above and *Table 5* , "Calendar of Martian Events," on p. 10.)

White Clouds.—These features have been observed on Mars for over a century. In 1954, a remarkable W-cloud formation was found to be recurring each Northern-Hemisphere late-spring afternoon in the Tharsis-Amazonis region. A decade later, C.F. Capen proposed that the W-clouds are orographic (mountain-generated), caused by wind passing over high peaks. Indeed, in 1971 the Mariner 9 spacecraft probe showed them to be water clouds near the large volcanoes Olympus Mons (133° W, 18° N), Ascraeus Mons (104°W, 11°N), Pavonis Mons (112°W, 0°N), and Arsia Mons (120°W, 9°S). The W-clouds should be active may and June 1995 (90°-120° Ls). Although often observed without filters, they are best seen in blue light when they are high in Mars' atmosphere and in yellow or green light when very low.

Limb Brightening.—This aspect is caused by scattered light from dust and dry ice particles high in the Martian atmosphere. It should be present on both limbs often throughout the apparition and is also best seen in blue-green or blue light.

Morning Clouds.—Morning clouds are bright, isolated patches of surface fog or frosty ground near the morning limb (Mars' western edge as seen on Earth's sky). The fogs usually dissipate by mid-morning, while the frosts may persist most of the Martian day, depending on the season. These bright features are viewed best with a blue-green or blue filter. Occasionally, very low morning clouds can be seen in green or yellow light.

Evening Clouds.—These give the same appearance as morning clouds but are usually larger and more numerous than morning clouds. They appear as isolated bright patches over light desert regions in the late Martian afternoon and grow in size as they rotate into the late evening. They are best seen in blue light.

Equatorial Cloud Bands.—These features appear as broad, diffuse hazy bands along Mars' equatorial zone and are rare and difficult to observe. They are best detected visually through deep-blue (W47 and W47B) Wratten filters and may be photographed or imaged in blue or ultraviolet light.

New technologies, such as CCD cameras, sophisticated computer hardware and software, and large-aperture planetary telescopes have given rise to a virtual explosion in advanced techniques of studying our Solar System. Never before have we been able to readily detect the delicate wispy Martian Equatorial Cloud Bands so well as we do now with CCD imaging.

DUST CLOUDS

Dust storms usually begin every Martian year around the time of summer solstice in Mars' Southern Hemisphere. The dust-storm season might have started in Summer, 1994. Watch for a small, bright yellow cloud to appear overnight, perhaps in Serpentis-Noachis, Solis Lacus, or Chryse, sites where dust storms have been recorded before. The small cloud may soon evolve into a global obscuration that persists for months. When a dust storm reaches maturity, the planet's entire disk is a nearly uniform bright orange.

Identifying the places where dust storms begin is highly important to future Mars exploration missions. Dust clouds are best detected using a yellow, red, or magenta filter.

CALENDAR OF MARTIAN EVENTS

Table 5 (p. 10) provides an ephemeris of Mars' areocentric solar longitude (Ls), apparent angular diameter, areocentric declination of Earth (De, the latitude on Mars that is at the disk center), the geocentric declination of Mars (Dec.), and the geocentric elongation of Mars from the Sun (El.), for the 1994-1995 Apparition. It also predicts polar-cap and atmospheric appearances based on experience gathered over many apparitions.

Note that for much of the apparition, Mars' Northern Hemisphere will be turned toward the Earth, facilitating observations of the North Polar Cap and of meteorological phenomena in the Martian Arctic. Also, Mars will be well north of the Celestial Equator for the bulk of the apparition, favoring the study of Mars by observers in the terrestrial Northern Hemisphere.

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Table 5. Calendar of Martian Events, 1994-95.

Notes: Dia. = apparent diameter in arc-seconds ("); De = areocentric declination of Earth; Dec. = geocentric declination of Mars (declinations are positive when north, negative when south); El. = geocentric elongation from the Sun.

Earth Date	Ls	Phenomena
1994	°	
APR 03	250	Mars at Perihelion. Dia. 4".2; De -25.2°; Dec. -4°.6; El. 22°W.
APR 19	260	Dia. 4".2; De -24°.8; Dec. +0°.4; El. 25°W.
MAY 05	270	Northern Winter/Southern Summer Solstice. Dia. 4".3; De -23°.2; Dec. +5.3°; El. 29°W. Watch for Planetary System Cloud Bands across Equatorial Zone.
JUN 19	298	Dia. 4".5; De -13°.6; Dec. +17°.0; El. 38°W. Look for orographic clouds (deep-blue filter) over the Tharsis volcanoes—W-Cloud?
AUG 06	326	Dia. 4".9; De 0°.0; Dec +23°.3; El. 50°W. North Polar Cap (NPC) now tilted toward Earth. Wave or frontal cloud activity near NPC?
OCT 10	000	Northern Spring/Southern Autumn Equinox. Dia. 6".2; De +15°.6; Dec. +20.6°; El. 74°W. NPC large, hood present. Surface details beginning to become more visible. CC imaging possible for larger telescopes. Discrete (white) clouds and white areas should be seen.
DEC 20	034	Dia. 10".0; De +21°.4; Dec. +13°.8; El. 116°W. CCD imaging possible for 12.5- to 16-inch telescopes.
1995		
JAN 11	044	Dia. 12".0; De +21°.3; Dec. +14°.3; El. 138°W. High-resolution black-and-white and color photography and Tricolor CCD imaging possible.
FEB 11	057	Closest approach to Earth at 14h 18m UT. Dia. 13".85; De +19°.0; Dec +18°.0; El.174°W. Mars 62.8 million miles (101.1 million km) from Earth. Equatorial clouds and hazes on the increase.
FEB 12	058	Opposition to Sun at 02h 25m UT. Dia. 13".8; De +18°.7; Dec. +18°.2; El. 175°W. Early Northern-Hemisphere spring. Continue NPC measurements. Is North Cap fairly static or entering rapid-retreat phase? South polar regions becoming difficult to observe. Any signs of South Polar Hood (SPH)? NPC should appear to regrow as dense hood develops as the effects of the "Aphelic Chill" are observed.
MAR 12	070	Aphelion. Dia. 12".3; De +17°.0; Dec. +20°.3; El. 143°E. Northern-Hemisphere mid-Spring. Is NPC beginning rapid retreat? Are limb arcs increasing in frequency, intensity? Use filters! Antarctic hazes, hood? Cloud activity increases.
MAR 16	072	Dia. 12".0; De +17°.0; Dec. +20°.3; El. 139°E. NPC in rapid retreat. "Aphelic Chill" period over? End of high-resolution photography. Watch for a rift in the NPC. E. M. Antoniadi stated that with 12-in (30-cm) or larger telescopes the NPC may appear divided by a rift along the 140° and 320° areographic meridians near this Martian season.
APR 06	081	Dia. 10".0; De +17°.9; Dec. +19°.4 El. 119°E. NPC retreat extremely slow, should be a static summer remnant polar cap at this time. End of high-resolution visual work; CCD imaging still possible. Syrtis Major dark? Is Rima Tenuis visible in NPC? Clouds and frost prominent in north.
APR 27	090	Northern-Hemisphere Summer Solstice. Dia. 8".4; De +19°.9; Dec. +17°.3; El. 103°E. Orographic clouds over the Tharsis volcanoes—W-Cloud? NPC remnant? Local seasonal water clouds should wrap around Syrtis Major and be prominent in Libya. In 1982 and 1984 a brilliant icy patch, Lemuria, detached itself from the NPC, located 210° W; 82° N. Look for other detachments from NPC.
MAY 04	093	Dia. 8".0; De +20°.7; Dec. +16°.3; El. 98°E. Afternoon W-Clouds? Much white-cloud activity, ice-fogs appearing in Hellas? Numerous bright limb clouds near equatorial zone.
JUN 19	114	Dia. 6".0; De = +25°.4; Dec = +8°.0; El. 74°E. Mare Acidalium broad and dark. Tempe-Arcadia-Tharsis-Amazonis regions bright in a pattern appearing as the "domino effect." Many Martian discrete clouds on the disk.

THE UPCOMING APPARITION OF PERIODIC COMET DE VICO (1846 IV)

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

ABSTRACT

Periodic Comet de Vico was last seen in 1846; it eluded observation at its expected 1921-22 passage but is due back soon. Discussed here is the history of the comet, various orbital calculations, search suggestions, and search ephemerides.

INTRODUCTION

Sometime in the near future, a periodic comet will visit the inner Solar System, becoming visible in small telescopes for several months. Known as Periodic Comet de Vico, this comet makes this trip about every 76 years, but it has been observed during only one previous visit. Comet searchers are asked to search for the next return of this comet.

THE HISTORY OF PERIODIC COMET DE VICO

This comet was discovered on 1846 FEB 20 by Francesco de Vico (1805-1848) of the Observatory of Collegio Romano in Italy. [1] This was the fourth of six named comets discovered by de Vico during his short comet-hunting career (1844-47). He found four comets in 1846 alone (JAN 24, FEB 20, JUL 29 and SEP 23). His other two named discoveries were on 1844 AUG 23 and 1845 FEB 25. He also recovered two returning periodic comets, one in July 1845 and another in November 1845. Finally, he independently discovered two more comets, but found them too late to get his name attached to them: 1846 VII, Comet Brorsen, on 1846 MAY 02; and 1847 VI, Comet Mitchell, on 1847 OCT 04.

When discovered, Periodic Comet de Vico was at right ascension 01hr 03m, declination -07°, 40° from the Sun in the evening sky. The Moon was just past Last Quarter in the morning sky. The comet was moving northward at 1°.8 per day. [2]

Two independent discoveries were made of this comet. On February 26, George Phillips Bond found it, as did Theodor Brorsen on March 8. [3] At this same time, Periodic Comet Biela (the returning comet recovered by de Vico on 1845 NOV 26) and another comet (discovered by de Vico—1846 I) were also being observed. Periodic Comet Biela had been observed to split in mid-January, 1846. [4]

Comet de Vico was observed for three months. At discovery it shone at about magnitude +6 and brightened to naked-eye visibility near the time of perihelion (1846 MAR 06). When last seen (May 20) it was near magnitude +10 and did not always show a tail. [5]

Before we discuss orbital calculations for Periodic Comet de Vico, we need to take a brief look at comet orbits in general.

ORBITAL ELEMENTS

A comet's orbit is defined by six parameters, or elements:

The *Perihelion Date* is the time when the comet is at the point in its orbit closest to the Sun.

The *Perihelion Distance* is the minimum comet-Sun distance in astronomical units (AU), where 1.0 AU is the mean distance from the Earth to the Sun.

The Inclination is the angle the orbital plane of the comet makes with the Earth's orbital plane around the Sun. An inclination of 0° means it is in the Earth's orbital plane. An angle of 90° means its path is perpendicular to the Earth's orbit. An inclination of 180° means it is traveling around the Sun in the direction exactly opposite the Earth's motion.

Two parameters describing the location of the comet's perihelion point are the *Argument of the Perihelion*; the angle, in the plane of the comet's orbit, between the perihelion point and the *Ascending Node*. This latter element is expressed as the heliocentric longitude of the line of south-to-north crossing of the two orbital planes

The final parameter is the *Eccentricity*, or shape, of the comet's orbit. This can be a hyperbola, when eccentricity (E) is greater than 1.0; in this case the path does not close on itself and the comet will not return. Many orbits are assumed parabolic (E = 1.0), in which case the comet's path closes upon itself only at infinity and the comet does not return. Finally, a comet's orbit may be an ellipse (E < 1.0); then the comet will return in a finite amount of time.

ORBIT CALCULATIONS

Gary Kronk's *Cometography* lists early attempts to determine an orbit of the new Comet de Vico. Within a month after discovery, Jean Jacques Emile Goujon used three positions between 1846 FEB 20 and MAR 5 to calculate a parabolic orbit with a perihelion date of 1846 MAR 06.47, a perihelion distance of 0.663 AU, and an orbital inclination of 83°.6. This parabolic orbit implied that the comet would never return. He did suggest that the comet was similar to the comet of 1707. However, with a perihelion distance of 0.86 AU and an inclination of 88°.6, the comet of 1707 could not be the same as Periodic Comet de Vico.

Table 1. Early Parabolic Orbits Computed for Periodic Comet de Vico.

Computer Name	Observation Dates Used	Perihelion Date	Perihelion Dist.	Inclination
	(1846)	(1846)	(AU)	°
Goujon	Feb 20-Mar 05	Mar 06.47	0.663	83.6
Bond	Feb 26-Mar 04	Mar 06.04	0.667	84.8
Bradley	Mar 05-Mar 19	Mar 05.50	0.667	84.8

Within the next few weeks two more parabolic orbits were calculated. George Phillips Bond, an independent discoverer of this comet, calculated an orbit with a perihelion date of 1846 Mar 06.04, a perihelion distance of 0.667 AU, and an inclination of 84°.8. To do so, he used three positions between Feb 26 and Mar 04.

Finally, Francis Bradley used three positions between 1846 Mar 05 and Mar 19, and calculated the same perihelion distance and inclination as Bond, but a perihelion date of 1846 Mar 05.50. This information, from Gary Kronk's *Cometography,* is summarized in *Table 1* (above).

About a month after the comet was discovered, Benjamin Peirce determined that it was not following a parabolic orbit. He was the first to calculate an elliptical orbit, which showed a period of 94.91 years. Hugh Breen, also using three positions from March 1846, calculated an orbital period of 75.66 years. Some 40 years later, J. von Hepperger of Austria used 117 positions covering three months of observations. He took into account the gravitational pull of six planets and found an orbital period of 75.71 years. However, he believed that this value could be off by as much as three years. Nonetheless, such an orbit was used to try to find the comet on its next predicted return in late 1921.

Table 2. Elliptical Orbits Computed for Periodic Comet de Vico.

Computer Name	Year	Number of Positions	Orbital Period (years)		Date of Next Perihelion
Peirce	1846	3	94.91	±3	2035 Dec 31
Breen	1846	3	75.66	-	1997 Jul 01
Hepperger	1887	117	75.71	±3	1997 Aug 06
Buckley	1979	98	76.30	±2	1998 Oct 11
Hasegawa	1979	(A.D. 1391-1846)	75.826	-	1997 Oct 30
Carusi *et al.*	1985	(Buckley)	74.94	-	1996 Jan 23
Townsend	1986	(Buckley)	75.16	-	1996 Jul 03

Kronk also reports Buckley's work on this comet. In 1979 Buckley used 98 observations and the gravitational pull of seven planets to calculate an orbital period of 76.30 years. The new ephemeris narrowed the uncertainty down to two years.

Buckley's orbital work has become a basis for others' work on this comet. Ichiro Hasegawa suggests that Periodic Comet de Vico is the same as a comet observed in A.D. 1391. The orbit for the comet of 1391 has not been determined, but if it was Periodic Comet de Vico, then perihelion would have occurred on 1391 Mar 20. This yields a mean orbital period of 75.826 years, with the comet making five unobserved trips between 1391 and 1846. Kronk points out that the Comet of 1391 had an absolute magnitude much brighter than Periodic Comet de Vico, a topic we will discuss later in this article.

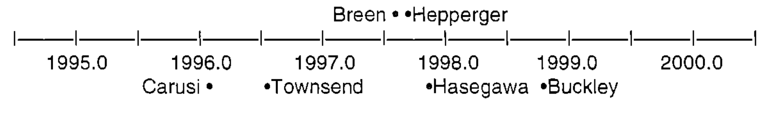

Figure 1. Predicted perihelion dates of Comet de Vico.

Kronk reports that another orbit determination leading to a predicted perihelion date was calculated in 1985 by A. Carusi, L. Kresak, E. Perozzi, and G. B. Valsecchi, who examined Buckley's orbital elements over several centuries of time. They predicted the next perihelion passage to occur on 1996 Jan 23.015, implying an orbital period of 74.94 years.

Charles Townsend and John Rogers, in 1986, predicted the next perihelion date of this comet to be 1996 Jul 03. They started with Buckley's orbit, then took all the planets into account. This suggests an orbital period of 75.16 years. **[6]**

Most of these orbital periods do not include path changes due to non-gravitational forces. These forces, caused by jetting action from the surface of the comet's nucleus, can alter the orbital period by several weeks. The extent and "direction" of these non-gravitational forces are not known until the comet has been observed for three passages around the Sun. The only orbital calculation in which this effect is included is that by Hasegawa, who suggested that Periodic Comet de Vico was also observed in 1391. *Table 2* (below) shows these orbits and the estimated time of return for the comet's next visit.

Figure 1 (below) shows perihelion passage times predicted from the above elliptical orbits. Some of these predictions carry a possible error of up to three years. Taking this into account, it becomes clear that the comet can come back at any time during the next eight years, with the greatest likelihood during the interval 1996-98.

Below is Buckley's orbit with both Equinox 1950 **[7]** and Equinox 2000 **[8]** elements, demonstrating the 1846 passage of the comet.

Element	1950.0	2000.0
Peri. Date, 1846:	Mar 06.0446	Mar 06.0446
Perihelion distance:	0.66044 AU	0.663802 AU.
Arg. of Perihelion:	12°.997	12°.9060
Ascending Node:	78°.892	79°.7107
Inclination:	85°.330	85°.1135
Eccentricity:	0.96283	0.963099

[The perihelion distance and eccentricity were revised for the Epoch-2000.0 orbit. Ed.]

To determine the approximate position of the comet for the present time, one can replace the perihelion date with the closest perihelion date. However, we do not know for sure when this comet will reach its next perihelion. On the other hand, we know all the other elements fairly accurately.

The high inclination means that the comet's path is nearly perpendicular to the Earth's orbit. It comes in from the south, reaches perihelion near where it passes northward through the Earth's orbital plane, then continues north and away from the Sun. If the comet comes to perihelion in mid-December, it will be on our side of the Sun at perihelion. If it comes to perihelion in mid-June, it will reach perihelion on the far side of the Sun. For roughly the first half of the year the comet is best seen in the evening sky; for the second half of the year it is best seen in the morning sky.

WHY WASN'T THE COMET SEEN IN 1921-22?

Periodic Comet de Vico was scheduled to return in 1921-1922. In early 1921, A.C.D. Cunningham pointed out that this comet was due back at perihelion around November, but added that this time was uncertain by three years. [9] He was probably using Hepperger's orbit for that prediction. as listed in *Table 3* (below). Yet the comet was not recovered. Why not?

Table 3. Elliptical Orbits Computed for Periodic Comet de Vico with 1921-22 Return Dates.

Computer Name	Computer Year	Number of Positions	Orbital Period (years)	Date of Next Perihelion
Peirce	1846	3	94.91 ±3	1941 Feb 01
Breen	1846	3	75.66 -	1921 Nov 02
Hepperger	1887	117	75.71 ±3	1921 Nov 21
Buckley	1979	98	76.30 ±2	1922 Jun 23
Hasegawa	1979	(A.D. 1391-1846)	75.826 -	1922 Jan 01
Carusi *et al.*	1985	(Buckley)	74.94 -	1921 Feb 12
Townsend	1986	(Buckley)	75.16 -	1921 May 03

I have learned that in comet hunting, three conditions must be met before a comet is discovered:

1) There must be someone searching at the right time.
2) The discoverer must be searching in the proper direction.
3) The comet must be bright enough to be seen by the comet hunter.

Let's begin with the first point as we examine the reason why Periodic Comet de Vico wasn't recovered. Were there comet hunters searching for comets during this time? Between 1919 and 1924 (late 1921 ±3 years), these were some of the comet hunters who were finding comets. The data below are taken from Kronk's *Comets, a Descriptive Catalog*, and from Rudenko's *Catalogue of Cometary Discovery Positions*.

Joel Metcalf: Metcalf (Vermont, USA) found five named comets between 1907 and 1919, with discovery magnitudes as faint as +9.5. Three of his finds were in the morning sky, at large elongations (156°, 164° and 66°). Two were in the evening sky at elongations of 100° and 58°.

William Reid: Searching for comets from the Cape of Good Hope, South Africa, this observer found six comets between 1918 and 1927. The comets he found were faint, with magnitudes from +8.0 to +10.5. His morning finds were at elongations 52°, 121° and 153°. His evening finds were at 66°, 51°, and 43°.

J.F. Skjellerup: Also searching from the Cape of Good Hope, South Africa, he discovered five comets between December 1919 and November 1927. Their discovery magnitudes ranged from +3 to +12. His morning finds were at elongations of 31°, 117°, 74° and 40°. His one evening find was at 61° elongation.

A.D. Dubiago: Located in Kazan, Russia, Dubiago discovered a comet on 1921 Apr 24 and another on 1923 Oct 12. The first was at magnitude +10 and in the evening sky, 62° from the Sun. The second was magnitude +8 and in the morning sky, 83° from the Sun.

These were the only comet hunters making multiple visual discoveries during this period, but several other observers were hunting for comets too. The following are mentioned in Kronk's *Comets, a Descriptive Catalog*: (1) Borrelly of Marseilles, France, who had found 12 comets (1873-1912), was still searching in August 1919 when he independently picked up a comet found by Metcalf. (2) C.J. Taylor of South Africa picked up a comet on 1920 Dec 08 that was later claimed by Skjellerup. (3) In 1923, Arturo Bernard of Madrid, Spain, co-discovered a comet found by Dubiago. (4) This same comet was independently discovered by F.J. Morshead of New Plymouth, New Zealand. (5) On 1924 SEP 15 Dr. P. Finsler used binoculars to find a fourth-magnitude comet 29° from the Sun in the evening sky.

Finally, Kronk mentions that comet hunters do not find every comet that passes through the sky, as illustrated by a remark in his book *Comets—A Descriptive Catalog*. In describing Comet Reid (1921 V), Kronk states that this comet could have been seen by Northern-Hemisphere observers long before Reid discovered it on 1922 Jan 20. A look at the ephemeris for this comet shows that it was discoverable in the morning sky, moving slowly southward. As it was doing so it was remaining about three hours of right ascension (about 40°) farther from the Sun than the path that Periodic Comet de Vico would have followed. One could assert that the few Northern-Hemisphere comet hunters were not thoroughly covering the sky since they missed discovering Comet Reid in late 1921. On the other hand, perhaps they missed Comet Reid because they were busy searching for comets closer to the Sun in the sky, including the intentional search for Periodic Comet de Vico.

From all this we can conclude that while there were a few comet hunters searching for comets during the first expected return of Periodic Comet de Vico, the facts that both celestial hemispheres were being covered, and that there were intentional searches for the comet, provided a fair chance for recovery of the comet. But this conclusion assumes that the comet had come by at the expected time and at the expected magnitude. Looking at *Table 3* (p. 13), we see that if Carusi or Townsend were correct, then the comet would have come and gone before Cunningham even suggested that a search be made.

In order to determine why Periodic Comet de Vico wasn‘t recovered in 1921-22, let‘s look at the other two factors hindering comet discovery.

First, were the comet hunters looking in the proper direction? With at least two active Southern-Hemisphere comet hunters, it appears that the comet could have been seen before perihelion in the morning sky at a convenient elongation and magnitude during September and October 1921, if the perihelion was in late November 1921, and if the comet behaved normally. If the comet‘s perihelion date was different than expected, and if the comet hunters were therefore drawn to the wrong locations, they would have missed Periodic Comet de Vico. That is unlikely, however, because the comet hunters probably continued their systematic comet searches; and the path of Periodic Comet de Vico would have placed it in the areas they were searching. Quite possibly non-comet hunters also joined in on the search for Periodic Comet de Vico.

The remaining factor affecting discovery is the question as to whether the comet was bright enough to see. It is not at all unusual for a comet to vary in brightness in ways that cannot be explained by its distance to the Sun and Earth alone. If Periodic Comet de Vico behaved irregularly, this could explain why the comet was missed until 1391 (if indeed it was observed then), then missed until 1846, then missed again in 1921-1922. Indeed, the comet was missed around the year 1770, when Charles Messier was searching for comets. Does this comet misbehave? We probably won‘t be certain of this until we observe it to misbehave, or else until we have seen it on several passages with no unusual changes.

Looking at the circumstances for 1921-2, we conclude that if the comet was unusually faint during this passage, it would not have been recovered no matter how many people were searching for it. Or, if it remained faint until perihelion, but brightened rapidly thereafter, then all the Southern-Hemisphere observers would have missed it before perihelion, and it would have been left to the Northern-Hemisphere observers to find it. However, the magnitude behavior of this comet is only speculative at this time.

IS PERIODIC COMET DE VICO A NORMAL COMET?

We already have some hints that de Vico may not be a normal comet. They relate to the brightness of the comet.

First, in 1846 it was observed only until May 20. If it had behaved normally it should have been visible through the end of July, when its elongation would have been 90° and its magnitude at +13.0. This doesn‘t mean it was dim for the whole apparition, because, according to Kronk‘s *Cometography*, Periodic Comet de Vico was at naked-eye visibility in late March, while if it behaved normally it would have been magnitude +6.2. Therefore the comet appears to have been very bright at perihelion, and very dim only three months later. What happened?

One factor is the comet‘s absolute magnitude, (the brightness of the comet were it 1.0 AU from both the Earth and Sun). However, another factor determining how bright a comet will be is the magnitude coefficient (N), a logarithmic function of the rate at which the comet brightens or dims as it nears or recedes from the Sun. The mean N for all comets is +3.3, but for most comets the assumption is that it is +4.0. The higher this value, the more the comet brightens and dims as its distance from the Sun varies.

Kronk‘s *Cometography* states that his guess of an absolute magnitude of +6.9 was based on only two discordant estimates. He assumed an N of +4. Perhaps the magnitude coefficient was very different than +4, and this caused the absolute magnitude estimate to also be incorrect. Could this comet have a large "N" value? The result would be a comet that remains faint while far from the Sun. It would obtain discoverable brightness only while near perihelion, and this would often occur when it was near the Sun in the sky. As a result, the discovery window would be small, lasting only a few weeks. This could easily explain why the comet was missed in 1770 and 1921. Just as important, it would explain why the comet, when seen in 1846, was very bright at perihelion but invisible after only ten more weeks.

In addition, the absolute magnitude itself needs to be called into question. We have seen that Kronk had trouble arriving at a consistent absolute magnitude, possibly due to an N value larger than he assumed. Perhaps the comet had an outburst shortly before discovery in 1846. Perhaps it doesn‘t have an outburst on every orbit, but only on some of its passages. This would explain why it hasn‘t been seen on every passage.

AN ANNUAL SEARCH EPHEMERIS FOR PERIODIC COMET DE VICO

Those using the search ephemerides that follow are cautioned that the comet may be fainter than predicted here. It may vary in brightness from night to night; it may even outburst by several magnitudes overnight. Or it may be normal. Following the perihelion date, the brightness of the comet is the most uncertain factor affecting the search.

When within 100 days of perihelion, the diameter of the comet should be between 1 and 4 arcminutes. Its position should be within 2° of the location indicated in the search ephemerides. The comet is usually south of the Sun before perihelion and north of the Sun after perihelion.

Could the comet have already come by? From the orbital predictions, it seems likely it will not come before 1995. Moreover, we presently have a thorough crew of comet hunters who probably would have picked it up if it had attempted an unannounced visit.

In order to facilitate a search for this comet, I have constructed the search ephemerides given in *Table 4* (below and pp. 16-17). They can be used for any year as they simply state, for evenly-spaced dates throughout the year, where the comet will be in the sky if the actual (and yet unknown) perihelion date is near the search date. On any search date, sweep the path in the sky that can be constructed by plotting each search position, and drawing a line from each position to the next.

The data in *Table 4* are as follows:

PERI: In the left side of the table, each column provides data assuming that the search date is 80, 60, 40, 20, and 10 days before the perihelion date (negative values), along with the assumption that the perihelion is on the search date itself ("0 days"). The right side of the table (positive values) provides data when the search date is 10, 20, 40, and 60 days after the perihelion date.

RA and DEC: The positions are for Equinox 2000.0, with RA in hh:mm and DEC in degrees. The positions should be accurate to within 2°. You will have to interpolate for dates between the given dates.

EL/SKY: The Elongation (EL) is the distance in degrees that the comet is from the Sun as seen from the Earth. For SKY, "E" means evening, while "M" denotes morning. Note that in many cases the comet would be visible in both skies: low in the west after Sunset, and low in the east before Sunrise.

MAG: The apparent visual magnitude of the comet if it behaves normally. The magnitude given assumes an absolute magnitude of +6.5 and an *N* of +4.0.

R, D: The distance in Astronomical Units from the comet to the Sun (R) and from the comet to the Earth (D).

If you do find this or any other comet, please notify the Central Bureau for Astronomical Telegrams at the Smithsonian Astrophysical Observatory in Cambridge, MA, 02318 (telephone 617-495-7244/7440).

Table 4. Recovery Paths for Periodic Comet de Vico.

On JANUARY 01, the comet should be along this path.

PERI	-80d	-60d	-40d	-20d	-10d	0 days	+10d	+20d	+40d	+60d
RA	21:30	22:23	22:56	22:28	21:35	20:28	19:31	18:54	18:18	18:02
DEC	-78.2	-76.4	-71.4	-56.1	-33.7	+00.5	+20.1	+25.6	+25.2	+22.0
EL/SKY	58 E	60 E	60 E	52 E	39 E	35 E	45 E	49 E	49 M	46 M
MAG	+9.9	+8.6	+6.8	+4.4	+3.2	+3.0	+3.9	+5.2	+7.3	+9.0
R (AU)	1.61	1.32	1.03	0.78	0.69	0.66	0.69	0.78	1.03	1.32
D (AU	1.89	1.50	1.08	0.62	0.45	0.45	0.64	0.89	1.37	1.79

On JANUARY 21, the comet should be along this path.

PERI	-80d	-60d	-40d	-20d	-10d	0 days	+10d	+20d	+40d	+60d
RA	23:16	23:48	00:05	23:50	23:20	22:28	21:26	20:30	19:22	18.49
DEC	-70.3	-65.3	-56.0	-36.0	-17.6	+04.5	+20.5	+27.1	+27.6	+24.4
EL/SKY	57 E	57 E	56 E	50 E	45 E	42 E	45 E	48 E	49 M	49 M
MAG	+10.0	+8.7	+7.0	+4.9	+4.0	+3.8	+4.3	+5.3	+7.3	+8.9
R (AU)	1.61	1.32	1.03	0.78	0.69	0.66	0.69	0.78	1.03	1.32
D (AU)	1.91	1.56	1.18	0.80	0.67	0.65	0.76	0.95	1.36	1.74

On FEBRUARY 10, the comet should be along this path.

PERI	-80d	-60d	-40d	-20d	-10d	0 days	+10d	+20d	+40d	+60d
RA	00:20	00:42	00:53	00:44	00:24	23:47	22:55	21:57	20:27	19:37
DEC	-62.2	-54.9	-43.0	-22.3	-07.2	+09.2	+22.5	+29.5	+32.0	+28.7
EL/SKY	56 E	54 E	51 E	46 E	43 E	41 E	42 E	45 E	49 M	52 M
MAG	+10.0	+8.7	+7.2	+5.4	+4.7	+4.4	+4.8	+5.5	+7.3	+8.8
R (AU)	1.61	1.32	1.03	0.78	0.69	0.66	0.69	0.78	1.03	1.32
D (AU)	1.93	1.62	1.30	1.01	0.91	0.88	0.93	1.05	1.36	1.68

On MARCH 01, the comet should be along this path.

PERI	-80d	-60d	-40d	-20d	-10d	0 days	+10d	+20d	+40d	+60d
RA	01:13	01:29	01:37	01:30	01:16	00:49	00:08	23:15	21:33	20:24
DEC	-54.6	-45.7	-32.5	-12.6	+00.3	+13.7	+25.4	+33.4	+37.9	+35.0
EL/SKY	55 E	51 E	46 E	40 E	38 E	37 E	38 E	41 E	49 M	55 M
MAG	+10.0	+8.8	+7.4	+5.8	+5.2	+4.9	+5.1	+5.7	+7.3	+8.7
R (AU)	1.61	1.32	1.03	0.78	0.69	0.66	0.69	0.78	1.03	1.32
D (AU)	1.95	1.69	1.43	1.21	1.13	1.10	1.11	1.16	1.37	1.62

(Continued on pp. 16-17)

Table 4. Recovery Paths for Periodic Comet de Vico—*Continued.*

On MARCH 21, the comet should be along this path.

PERI	-80d	-60d	-40d	-20d	-10d	0 days	+10d	+20d	+40d	+60d
RA	02:02	02:13	02:19	02:15	02:04	01:45	01:12	00:28	22:40	21:11
DEC	-47.9	-37.9	-24.1	-05.3	+06.1	+17.8	+28.7	+37.2	+44.2	+43.2
EL/SKY	55 E	49 E	41 E	33 E	31 E	31 E	33 E	37 E	48 M	58 M
MAG	+10.0	+8.9	+7.6	+6.1	+5.5	+5.3	+5.4	+6.0	+7.3	+8.7
R (AU)	1.61	1.32	1.03	0.78	0.69	0.66	0.69	0.78	1.03	1.32
D (AU)	1.96	1.74	1.54	1.38	1.33	1.29	1.27	1.28	1.38	1.55

On APRIL 10, the comet should be along this path.

PERI	-80d	-60d	-40d	-20d	-10d	0 days	+10d	+20d	+40d	+60d
RA	02:49	02:57	03:02	02:58	02:51	02:37	02:13	01:37	23:53	22:00
DEC	-42.3	-31.6	-17.6	+00.3	+10.7	+21.5	+31.9	+40.8	+52.0	+53.0
EL/SKY	55 E	46 E	37 E	27 E	24 E	24 E	27 E	33 E	47 M	60 M
MAG	+10.0	+9.0	+7.7	+6.3	+5.8	+5.5	+5.7	+6.1	+7.4	+8.6
R (AU)	1.61	1.32	1.03	0.78	0.69	0.66	0.69	0.78	1.03	1.32
D (AU)	1.96	1.79	1.64	1.53	1.48	1.44	1.41	1.39	1.41	1.50

On APRIL 30, the comet should be along this path.

PERI	-80d	-60d	-40d	-20d	-10d	0 days	+10d	+20d	+40d	+60d
RA	03:36	03:41	03:44	03:42	03:37	03:28	03:12	02:47	01:18	22:56
DEC	-37.9	-26.7	-12.8	+04.4	+14.2	+24.5	+34.6	+44.1	+58.8	+64.1
EL/SKY	55 E	45 E	33 E	21 E	16 E	17 E	22 E	30 E	46 M	61 M
MAG	+10.0	+9.0	+7.8	+6.5	+5.9	+5.7	+5.8	+6.3	+7.4	+8.5
R (AU)	1.61	1.32	1.03	0.78	0.69	0.66	0.69	0.78	1.03	1.32
D (AU)	1.96	1.82	1.72	1.64	1.60	1.56	1.52	1.48	1.43	1.46

On MAY 20, the comet should be along this path.

PERI	-80d	-60d	-40d	-20d	-10d	0 days	+10d	+20d	+40d	+60d
RA	04:23	04:26	04:28	04:27	04:24	04:20	04:11	03:58	03:02	00:18
DEC	-35.0	-23.5	-09.5	+07.2	+16.7	+26.6	+36.8	+46.6	+64.3	+75.7
EL/SKY	56 E	44 E	31 E	16 E	09 E	10 E	18 E	27 E	45 M	62 M
MAG	+10.0	+9.0	+7.9	+6.6	+6.0	+5.8	+5.9	+6.3	+7.4	+8.5
R (AU)	1.61	1.32	1.03	0.78	0.69	0.66	0.69	0.78	1.03	1.32
D (AU)	1.94	1.83	1.76	1.70	1.67	1.64	1.61	1.54	1.46	1.45

On JUNE 09, the comet should be along this path.

PERI	-80d	-60d	-40d	-20d	-10d	0 days	+10d	+20d	+40d	+60d
RA	05:11	05:12	05:12	05:13	05:12	05:12	05:12	05:11	05:09	04:51
DEC	-33.6	-21.9	-07.9	+08.6	+18.2	+28.1	+38.1	+48.1	+66.9	+84.2
EL/SKY	57 E	45 E	31 E	14 E	05 E	05 E	15 E	25 E	44 M	61 M
MAG	+10.0	+9.0	+7.9	+6.6	+6.1	+5.8	+6.0	+6.4	+7.5	+8.5
R (AU)	1.61	1.32	1.03	0.78	0.69	0.66	0.69	0.78	1.03	1.32
D (AU)	1.92	1.83	1.76	1.72	1.70	1.67	1.62	1.57	1.48	1.46

On JUNE 29, the comet should be along this path.

PERI	-80d	-60d	-40d	-20d	-10d	0 days	+10d	+20d	+40d	+60d
RA	06:00	05:57	05:56	05:58	06:00	06:05	06:13	06:25	07:19	10:09
DEC	-33.8	-22.0	-07.8	+09.1	+18.6	+28.5	+35.6	+48.3	+65.8	+77.2
EL/SKY	58 M	46 M	32 M	17 M	09 M	08 M	16 M	25 M	43 E	60 E
MAG	+10.0	+9.0	+7.9	+6.6	+6.0	+5.8	+6.0	+6.4	+7.5	+8.6
R (AU)	1.61	1.32	1.03	0.78	0.69	0.66	0.69	0.78	1.03	1.32
D (AU)	1.90	1.80	1.73	1.70	1.68	1.65	1.61	1.57	1.50	1.50

On JULY 19, the comet should be along this path.

PERI	-80d	-60d	-40d	-20d	-10d	0 days	+10d	+20d	+40d	+60d
RA	06:48	06:43	06:41	06:44	06:49	06:58	07:14	07:39	09:10	11:36
DEC	-35.8	-24.0	-09.5	+08.1	+17.9	+28.1	+38.1	+47.4	+61.6	+66.5
EL/SKY	59 M	48 M	35 M	21 M	16 M	15 M	19 M	27 M	43 E	58 E
MAG	+9.9	+8.9	+7.8	+6.5	+6.0	+5.7	+5.9	+6.3	+7.5	+8.6
R (AU)	1.61	1.32	1.03	0.78	0.69	0.66	0.69	0.78	1.03	1.32
D (AU)	1.88	1.76	1.68	1.63	1.61	1.59	1.57	1.54	1.51	1.55

On AUGUST 08, the comet should be along this path.

PERI	-80d	-60d	-40d	-20d	-10d	0 days	+10d	+20d	+40d	+60d
RA	07:37	07:29	07:26	07:29	07:37	07:52	08:16	08:52	10:37	13:31
DEC	-39.5	-27.8	-12.9	+05.6	+16.1	+26.8	+36.8	+45.4	+55.6	+56.2
EL/SKY	60 M	51 M	39 M	28 M	23 M	22 M	24 M	30 M	43 E	55 E
MAG	+9.9	+8.9	+7.6	+6.3	+5.8	+5.6	+5.8	+6.3	+7.5	+8.7
R (AU)	1.61	1.32	1.03	0.78	0.69	0.66	0.69	0.78	1.03	1.32
D (AU)	1.85	1.70	1.59	1.52	1.50	1.49	1.48	1.48	1.51	1.61

(Continued on p. 17)

Table 4. Recovery Paths for Periodic Comet de Vico—*Continued.*

On AUGUST 28, the comet should be along this path.

PERI	-80d	-60d	-40d	-20d	-10d	0 days	+10d	+20d	+40d	+60d
RA	08:27	08:15	08:10	08:15	08:26	08:46	09:18	10:03	11:50	13:18
DEC	-44.7	-33.5	-18.4	+01.6	+13.0	+24.5	+34.7	+42.4	+48.9	+47.1
EL/SKY	61 M	53 M	44 M	34 M	30 M	28 M	30 M	33 M	43 E	52 E
MAG	+9.9	+8.9	+7.5	+6.1	+5.6	+5.4	+5.6	+6.1	+7.5	+8.8
R (AU)	1.61	1.32	1.03	0.78	0.69	0.66	0.69	0.78	1.03	1.32
D (AU)	1.83	1.64	1.48	1.38	1.35	1.35	1.36	1.39	1.51	1.67

On SEPTEMBER 17, the comet should be along this path.

PERI	-80d	-60d	-40d	-20d	-10d	0 days	+10d	+20d	+40d	+60d
RA	09:17	09:02	08:54	09:01	09:16	09:42	10:23	11:14	12:54	14:02
DEC	-51.3	-41.1	-26.2	-04.5	+08.6	+21.5	+32.1	+38.9	+42.4	+39.2
EL/SKY	62 M	56 M	49 M	40 M	36 M	35 M	35 M	37 M	43 E	49 E
MAG	+9.9	+8.7	+7.3	+5.8	+5.2	+5.1	+5.3	+6.0	+7.5	+8.9
R (AU)	1.61	1.32	1.03	0.78	0.69	0.66	0.69	0.78	1.03	1.32
D (AU)	1.82	1.58	1.36	1.20	1.16	1.17	1.21	1.29	1.49	1.73

On OCTOBER 07, the comet should be along this path.

PERI	-80d	-60d	-40d	-20d	-10d	0 days	+10d	+20d	+40d	+60d
RA	10:10	09:50	09:39	09:48	10:08	10:43	11:32	12:27	13:54	14:45
DEC	-58.9	-50.5	-36.6	-13.2	+02.3	+17.6	+29.1	+35.1	+36.3	+32.6
EL/SKY	62 M	59 M	54 M	46 M	42 M	39 M	40 M	41 M	44 E	47 E
MAG	+9.9	+8.6	+7.1	+5.4	+4.8	+4.6	+5.0	+5.8	+7.5	+9.0
R (AU)	1.61	1.32	1.03	0.78	0.69	0.66	0.69	0.78	1.03	1.32
D (AU)	1.82	1.52	1.23	1.00	0.95	0.96	1.04	1.17	1.47	1.78

On OCTOBER 27, the comet should be along this path.

PERI	-80d	-60d	-40d	-20d	-10d	0 days	+10d	+20d	+40d	+60d
RA	11:12	10:43	10:27	10:41	11:08	11:54	12:52	13:45	14:54	15:32
DEC	-67.3	-61.3	-49.9	-26.2	-06.8	+13.2	+26.2	+31.4	+31.1	+27.4
EL/SKY	62 M	61 M	58 M	50 M	44 M	42 M	43 M	45 M	45 E	45 E
MAG	+9.9	+8.5	+6.9	+4.9	+4.2	+4.1	+4.6	+5.5	+7.4	+9.0
R (AU)	1.61	1.32	1.03	0.78	0.69	0.66	0.69	0.78	1.03	1.32
D (AU)	1.82	1.48	1.12	0.80	0.72	0.74	0.87	1.05	1.45	1.82

On NOVEMBER 16, the comet should be along this path.

PERI	-80d	-60d	-40d	-20d	-10d	0 days	+10d	+20d	+40d	+60d
RA	12:41	11:54	11:28	11:50	12:33	13:34	14:31	15:11	15:55	16:15
DEC	-75.7	-72.9	-66.0	-46.2	-21.9	+07.8	+23.7	+28.3	+27.2	+23.8
EL/SKY	61 M	62 M	61 M	52 M	41 M	38 M	45 M	47 M	47 E	44 E
MAG	+9.9	+8.5	+6.7	+4.4	+3.4	+3.3	+4.2	+5.3	+7.4	+9.0
R (AU)	1.61	1.32	1.03	0.78	0.69	0.66	0.69	0.78	1.03	1.32
D (AU)	1.84	1.46	1.05	0.62	0.49	0.53	0.71	0.95	1.42	1.83

On DECEMBER 06, the comet should be along this path.

PERI	-80d	-60d	-40d	-20d	-10d	0 days	+10d	+20d	+40d	+60d
RA	15:55	15:11	14:22	15:00	15:45	16:17	16:37	16:47	16:57	17:02
DEC	-82.2	-83.3	-82.6	-71.9	-44.8	+01.8	+21.7	+26.2	+25.1	+21.8
EL/SKY	60 M	62 M	62 M	52 M	26 M	26 M	44 E	49 E	48 E	44 E
MAG	+9.9	+8.5	+6.7	+4.1	+2.6	+2.6	+3.9	+5.2	+7.4	+9.0
R (AU)	1.61	1.32	1.03	0.78	0.69	0.66	0.69	0.78	1.03	1.32
D (AU)	1.86	1.46	1.02	0.54	0.34	0.38	0.62	0.89	1.39	1.83

On DECEMBER 26, the comet should be along this path.

PERI	-80d	-60d	-40d	-20d	-10d	0 days	+10d	+20d	+40d	+60d
RA	20:45	21:07	22:25	21:49	20:49	19:44	18:56	18:28	18:01	17:49
DEC	-80.0	-79.2	-75.7	-62.5	-39.1	-00.1	+20.2	+25.6	+24.9	+21.7
EL/SKY	59 E	60 E	60 E	52 E	35 E	31 E	45 E	49 E	49 E	46 M
MAG	+9.9	+8.6	+6.8	+4.3	+2.9	+2.8	+3.9	+5.1	+7.3	+9.0
R (AU)	1.61	1.32	1.03	0.78	0.69	0.66	0.69	0.78	1.03	1.32
D (AU)	1.88	1.49	1.06	0.59	0.40	0.42	0.62	0.88	1.37	1.80

Finally, *Table 5* (p. 18) provides a search ephemeris for Periodic Comet de Vico for the period 1995 AUG - 1996 FEB under the assumption that the orbit computed by Carusi *et al.* is the correct one, with a date of perihelion passage of 1996 JAN 23.

Table 5. Search Ephemeris Assuming a 1996 JAN 23 Perihelion Passage.

Below is an ephemeris for Periodic Comet de Vico should it follow the orbit computed by Carusi *et al.*, with a perihelion date of 1996 JAN 23. Three positions are included for each date. In order, they assume that perihelion passage will be 20 days early (1996 JAN 03), that it will be "on time" (1996 JAN 23), and that it will be 20 days late (1996 FEB 12). Other data, for the "On Time" date, are as in *Table 4*.

Date (00UT)	Coordinates (2000.0): R.A., DEC.	R (AU)	D (AU)	Elong.	Mag.
	20d Early / On Time / 20d Late				
1995 08 01	08h07.6m, -64°18'/08h27.9m, -68°20'/08h52.2m, -71°34'	2.85	2.72	087°	+13.2
1995 08 06	08h19.8m, -63°33'/08h40.8m, -67°37'/09h05.4m, -70°50'	2.79	2.70	085°	+13.1
1995 08 11	08h31.4m, -62°52'/08h53.0m, -66°58'/09h18.1m, -70°10'	2.73	2.67	083°	+13.0
1995 08 16	08h42.6m, -62°16'/09h04.7m, -66°23'/09h30.1m, -69°35'	2.67	2.64	081°	+12.9
1995 08 21	08h53.3m, -61°44'/09h15.9m, -65°54'/09h41.7m, -69°05'	2.61	2.61	079°	+12.7
1995 08 26	09h03.6m, -61°18'/09h26.7m, -65°29'/09h52.9m, -68°39'	2.54	2.58	077°	+12.6
1995 08 31	09h13.6m, -60°56'/09h37.2m, -65°09'/10h03.8m, -68°19'	2.48	2.55	075°	+12.5
1995 09 05	09h23.2m, -60°40'/09h47.4m, -64°55'/10h14.4m, -68°04'	2.42	2.51	073°	+12.3
1995 09 10	09h32.6m, -60°29'/09h57.3m, -64°47'/10h24.7m, -67°54'	2.35	2.47	071°	+12.2
1995 09 15	09h41.7m, -60°23'/10h07.0m, -64°44'/10h34.9m, -67°50'	2.29	2.43	070°	+12.0
1995 09 20	09h50.5m, -60°24'/10h16.4m, -64°48'/10h45.0m, -67°52'	2.22	2.39	068°	+11.9
1995 09 25	09h59.2m, -60°30'/10h25.8m, -64°57'/10h55.0m, -68°00'	2.16	2.34	067°	+11.7
1995 09 30	10h07.6m, -60°42'/10h35.0m, -65°12'/11h05.0m, -68°14'	2.09	2.29	066°	+11.5
1995 10 05	10h16.0m, -61°01'/10h44.1m, -65°34'/11h15.0m, -68°34'	2.02	2.24	065°	+11.3
1995 10 10	10h24.2m, -61°26'/10h53.2m, -66°03'/11h25.1m, -69°00'	1.96	2.18	064°	+11.1
1995 10 15	10h32.3m, -61°58'/11h02.3m, -66°39'/11h35.4m, -69°33'	1.89	2.12	063°	+10.9
1995 10 20	10h40.4m, -62°38'/11h11.4m, -67°23'/11h46.0m, -70°12'	1.82	2.06	062°	+10.7
1995 10 25	10h48.7m, -63°26'/11h20.8m, -68°15'/11h57.0m, -70°59'	1.75	1.98	061°	+10.4
1995 10 30	10h57.2m, -64°22'/11h30.5m, -69°15'/12h08.5m, -71°53'	1.68	1.91	061°	+10.1
1995 11 04	11h06.2m, -65°29'/11h40.6m, -70°25'/12h21.0m, -72°56'	1.61	1.83	061°	+9.9
1995 11 09	11h16.1m, -66°48'/11h51.7m, -71°46'/12h34.7m, -74°06'	1.54	1.74	061°	+9.6
1995 11 14	11h27.7m, -68°22'/12h04.1m, -73°19'/12h50.3m, -75°25'	1.46	1.65	061°	+9.2
1995 11 19	11h42.3m, -70°12'/12h18.9m, -75°06'/13h08.8m, -76°54'	1.39	1.56	061°	+8.9
1995 11 24	12h02.9m, -72°22'/12h38.0m, -77°07'/13h32.2m, -78°31'	1.32	1.46	062°	+8.5
1995 11 29	12h36.2m, -74°53'/13h05.8m, -79°24'/14h04.3m, -80°15'	1.25	1.36	062°	+8.1
1995 12 04	13h38.6m, -77°31'/13h53.9m, -81°53'/14h52.5m, -82°01'	1.17	1.25	062°	+7.7
1995 12 09	15h41.1m, -78°44'/15h35.1m, -84°06'/16h11.7m, -83°32'	1.10	1.14	062°	+7.2
1995 12 14	18h11.5m, -74°32'/18h38.5m, -84°12'/18h13.5m, -84°03'	1.03	1.03	061°	+6.7
1995 12 19	19h39.3m, -62°10'/20h54.4m, -80°35'/20h19.1m, -82°45'	0.96	0.92	060°	+6.1
1995 12 24	20h18.5m, -41°44'/21h54.7m, -74°12'/21h42.7m, -79°41'	0.89	0.82	059°	+5.6
1995 12 29	20h35.5m, -18°04'/22h23.3m, -65°21'/22h32.3m, -75°19'	0.83	0.72	056°	+5.0
1996 01 03	20h42.3m, +00°41'/22h37.7m, -53°44'/23h03.4m, -69°46'	0.78	0.64	052°	+4.4
1996 01 08	20h43.8m, +12°39'/22h44.1m, -39°19'/23h24.2m, -63°00'	0.73	0.59	048°	+4.0
1996 01 13	20h42.8m, +19°55'/22h45.2m, -23°15'/23h38.7m, -54°51'	0.69	0.58	044°	+3.7
1996 01 18	20h40.8m, +24°21'/22h42.3m, -07°51'/23h48.8m, -45°18'	0.67	0.61	042°	+3.7
1996 01 23	20h38.7m, +27°09'/22h36.7m, +04°52'/23h55.3m, -34°26'	0.66	0.68	042°	+3.8
1996 01 28	20h36.8m, +29°02'/22h29.4m, +14°25'/23h58.8m, -22°45'	0.67	0.77	043°	+4.2
1996 02 02	20h35.2m, +30°22'/22h21.0m, +21°23'/23h59.5m, -10°59'	0.69	0.86	043°	+4.6
1996 02 07	20h33.9m, +31°26'/22h12.5m, +26°23'/23h57.4m, +00°01'	0.73	0.96	044°	+5.0
1996 02 12	20h32.8m, +32°19'/22h04.3m, +30°01'/23h53.2m, +09°34'	0.78	1.06	044°	+5.5

ACKNOWLEDGEMENTS

The author wishes to thank Gary Kronk for the background information concerning Periodic Comet de Vico. I also wish to thank Dr. Brian Marsden, who supplied updated information on the orbit of Periodic Comet de Vico, and to Dr. John Westfall and the Association of Lunar and Planetary Observers (A.L.P.O.) for their support and publication of this report.

FOOTNOTES

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COMET CORNER

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

COMET DISCOVERIES AND RECOVERIES DURING THE FIRST HALF OF 1994

Periodic Comet Kushida (1994a).—Yoshio Kushida of Japan, an amateur, discovered this comet on films exposed on 1994 JAN 08. Then at magnitude +11 in the morning sky, the comet was moving southeastward. Perihelion had occurred on 1993 DEC 12 at a distance of 1.37 AU from the Sun. The orbital period is 7.40 years.

Periodic Comet Wild 3 (1994b).—J.V. Scotti (our Assistant A.L.P.O. Comets Recorder) and T. Gehrels of the Lunar and Planetary Laboratory recovered this returning comet from Kitt Peak on 1994 FEB 10.. It was at magnitude +20, reached perihelion on 1994 JUL 24, and is now dimming. It orbits the Sun every 6.9 years.

Comet Mueller (1994c).—Jean Mueller found her tenth comet on 1994 MAR 10 on plates exposed during the course of the Second Palomar Sky Survey. The comet was at magnitude +16 when found and continued to dim after discovery. Its perihelion was on 1993 DEC 03 at 1.8 AU.

Comet Shoemaker-Levy (1994d).—The team of Carolyn Shoemaker, David Levy and D. Williams found this comet on plates exposed 1994 MAR 14. Perihelion was on 1994 MAY 27 at 1.16 AU. The comet brightened to magnitude +14.

Periodic Comet Russell 2 (1994e).—Jim Scotti recovered this comet on 1994 APR 05. This faint object did not brighten much after recovery, with perihelion in late October 1994 at 2.3 AU. The orbital period is 7.4 years.

Comet Takamizawa-Levy (1994f).—The first visual comet discovery in 16 months occurred in mid-April. First, Kesao Takamizawa of Japan photographically discovered this 11th-magnitude comet in the eastern morning sky. The next day David Levy of Tucson, Arizona, visually picked it up using his 0.41-m reflector. This is Takamizawa's first photographic find, his third overall, and Levy's eighth visual find. The comet reached perihelion on 1994 MAY 22 at 1.13 AU, attaining eighth magnitude by late May.

Periodic Comet Harrington (1994g).—Jim Scotti also recovered this comet, on 1994 MAY 01 at magnitude +19. It was expected to brighten to perhaps magnitude +14 by September 1994, and takes 6.8 years to orbit the Sun.

Periodic Comet Maury (1994h).—Scotti recovered this comet as well, on 1994 MAY 03. It takes 8.7 years to orbit the Sun and will remain faint.

Comet Takamizawa (1994i).—Kesao Takamizawa used his camera to find this comet on 1994 MAY 06. When found, the object was near opposition at magnitude +11. We now know that perihelion occurred on 1994 JUN 29 at 1.9 AU. The comet remained at tenth magnitude through June.

Periodic Comet Brooks 2 (1994j.—Both T. Seki and A. Nakamura of Japan recovered this comet in early May at magnitude +18. It has an orbital period of 6.9 years and will brighten to magnitude +14 by the end of 1994.

Comet Shoemaker (1994k).—Carolyn Shoemaker found this, her 32nd comet, on plates exposed 1994 MAY 14. It has an orbital period of 15.45 years and a large perihelion distance of 2.92 AU.

Periodic Comet Borrelly (1994l).—A. Gilmore and P. Kilmartin of Mt. John Observatory in New Zealand and G. Garradd of Siding Spring Observatory in Australia recovered this comet in mid-June. Perihelion is on 1994 NOV 01 at 1.36 AU. This will be one of the brightest comets of the year. The orbital period is 6.9 years.

PRESENT COMET ACTIVITY

Quite a few comets have been visible in recent months. Most of these are gone now; including Periodic Comet Shoemaker-Levy 9, which slammed into Jupiter during the week of 1994 JUL 16-22. Late 1994 and early 1995 are expected to feature only three known comets, although one never knows when a new bright comet will be found.

Periodic Comet Schwassmann-Wachmann 1.—This comet remains about 5 AU from the Sun and usually remains faint. However, occasionally it outbursts and attains magnitude +9-12. We encourage observers to monitor it for such changes.

Periodic Comet Borrelly.—This comet will be visible in binoculars during late 1994. It takes 6.9 years to orbit the Sun and reaches perihelion on 1994 NOV 01 at 1.36 AU. During early 1995 it will remain high in the northern sky, where it will dim to invisibility.

Comet Nakamura-Nishimura-Machholz (1994m).—Discovered in the northern polar region in July 1994, this object reached perihelion shortly after discovery. It approached to within 0.4 AU of the Earth in early September, 1994, and is now fading as it recedes from both the Earth and the Sun.

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. Orbital elements follow our ephemerides for those who wish to compute their own ephemerides.

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

1994-95	2000.0 Coörd.		Elongation	Total
UT Date	R.A.	Decl.	from Sun	Mag.
(0h UT)	h m	° '	°	
Oct 05	09 09.6	+17 19	057 M	+18.0
10	09 12.2	+17 05	061 M	+18.0
15	09 14.6	+16 52	066 M	+18.0
20	09 16.8	+16 39	070 M	+18.0
25	09 18.8	+16 27	074 M	+17.9
30	09 20.6	+16 17	079 M	+17.9
Nov 04	09 22.2	+16 07	084 M	+17.9
09	09 23.6	+15 57	088 M	+17.9
14	09 24.7	+15 50	093 M	+17.8
19	09 25.5	+15 43	098 M	+17.8
24	09 26.1	+15 37	103 M	+17.8
29	09 26.4	+15 33	108 M	+17.8
Dec 04	09 26.4	+15 30	112 M	+17.7
09	09 26.2	+15 28	118 M	+17.7
14	09 25.6	+15 27	123 M	+17.7
19	09 24.8	+15 27	128 M	+17.6
24	09 23.8	+15 29	134 M	+17.6
29	09 22.4	+15 31	139 M	+17.6
Jan 03	09 20.9	+15 35	144 M	+17.6
08	09 19.1	+15 39	150 M	+17.6
13	09 17.2	+15 45	156 M	+17.6
18	09 15.0	+15 50	161 M	+17.6
23	09 12.8	+15 56	167 M	+17.5
28	09 10.4	+16 03	172 M	+17.5
Feb 02	09 08.0	+16 10	178 M	+17.5
07	09 05.6	+16 17	176 E	+17.5
12	09 03.2	+16 23	171 E	+17.5
17	09 00.9	+16 30	165 E	+17.5
22	08 58.7	+16 35	159 E	+17.6
27	08 56.6	+16 41	154 E	+17.6
Mar 04	08 54.6	+16 45	148 E	+17.6
09	08 52.9	+16 49	143 E	+17.6
14	08 51.4	+16 52	138 E	+17.6
19	08 50.2	+16 54	132 E	+17.6
24	08 49.2	+16 55	127 E	+17.7
29	08 48.4	+16 55	122 E	+17.7

Table 2. Ephemeris of Periodic Comet Borrelly (1994L).

1994-95	2000.0 Coörd.		Elongation	Total
UT Date	R.A.	Decl.	from Sun	Mag.
(0h UT)	h m	° '	°	
Oct 05	06 29.8	+02 17	093 M	+ 8.5
10	06 42.7	+04 07	095 M	+ 8.4
15	06 55.7	+06 08	097 M	+ 8.2
20	07 08.7	+08 22	099 M	+ 8.1
25	07 21.7	+10 50	101 M	+ 8.0
30	07 34.8	+13 33	103 M	+ 7.9
Nov 04	07 47.9	+16 32	106 M	+ 7.8
09	08 00.9	+19 47	108 M	+ 7.7
14	08 13.9	+23 17	111 M	+ 7.7
19	08 26.7	+27 01	114 M	+ 7.6
24	08 39.2	+30 57	117 M	+ 7.6
29	08 51.5	+34 59	120 M	+ 7.7
Dec 04	09 03.2	+39 05	122 M	+ 7.7
09	09 14.3	+43 09	125 M	+ 7.8
14	09 24.4	+47 06	127 M	+ 7.9
19	09 33.5	+50 51	129 M	+ 8.0
24	09 41.1	+54 20	130 M	+ 8.2
29	09 47.0	+57 30	131 M	+ 8.4
Jan 03	09 51.0	+60 18	132 M	+ 8.5
08	09 52.9	+62 44	132 M	+ 8.7
13	09 52.4	+64 46	131 M	+ 8.9
18	09 49.8	+66 24	131 M	+ 9.2
23	09 45.3	+67 38	130 M	+ 9.4
28	09 39.3	+68 28	129 M	+ 9.6
Feb 02	09 32.5	+68 56	127 M	+ 9.8
07	09 25.7	+69 03	126 M	+10.1
12	09 19.5	+68 52	125 E	+10.3
17	09 14.3	+68 25	123 E	+10.5
22	09 10.6	+67 44	122 E	+10.8
27	09 08.3	+66 52	120 E	+11.0
Mar 04	09 07.4	+65 51	118 E	+11.2
09	09 08.0	+64 42	116 E	+11.4
14	09 09.7	+63 28	114 E	+11.6
19	09 12.5	+62 09	112 E	+11.9
24	09 16.2	+60 46	110 E	+12.1
29	09 20.5	+59 21	107 E	+12.3

Table 3. Ephemeris of Comet Nakamura-Nishimura-Machholz (1994m).

1994	2000.0 Coörd.		Elongation	Total
UT Date	R.A.	Decl.	from Sun	Mag.
(0h UT)	h m	° '	°	
Oct 05	20.55.2	-41 09	111 E	+10.6
10	20 54.2	-42 47	106 E	+11.0
15	20.54.5	-44 17	101 E	+11.3
20	20.56.1	-45 17	096 E	+11.7
25	20 58.5	-46 01	092 E	+12.0
30	21 01.8	-46 36	088 E	+12.3

Table 4. Orbital Elements of Current Comets.

	Perihelion			Longitude of	Inclina-	Eccen-
Comet Designation	Passage (T)	Dist. (q: AU)	Argument (ϖ)	Asc. Node (Ω)	tion (i)	tricity (e)
Schwass.-Wach. 1*	1989 Oct 26.7	5.771759	049°.897	312°.123	009°.267	0.04466
Nakamura-Nishimura-Machholz (1994m)†	1994 Jul 12.9	1.14088	123°.005	159°.960	094°.388	1.00000
Borrelly (1994L)*	1994 Nov 01.5	1.365115	353°.346	074°.736	030°.270	0.62280

* 1950.0 Equinox. † 2000.0 Equinox.

METEORS SECTION NEWS

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

JANUARY-JUNE 1994 METEOR OBSERVATIONS

The **Quadrantids** of early January occurred with a bright last-quarter Moon and were not well seen this year. Observations were received from five observers, indicating nothing exceptional from this year's display as seen from the western United States and Hawaii. The best rates were probably seen over Asia late on January 3rd UT (Universal Time).

Many minor showers were followed by observers during the lean months of January, February, and March. The strongest of these minor showers was the **Coma Berenicids**, which was visible throughout January. We thank George Zay, David Holman, John Swatek, John Gallagher, Michael Morrow, Mark Davis, and Richard Taibi for braving the cold weather to provide valuable data on these obscure showers.

The **Lyrids** provided a pleasant surprise on the morning of April 22. Despite a nearly full Moon, rates as high as 25 Lyrids per hour were seen. Reports of several Lyrid fireballs (meteors -4 stellar magnitude or brighter) were also received. Most observers commented that the average Lyrid had a short path and was faint, regardless of how far the meteor appeared from the radiant.

A bright waning crescent Moon interfered with observations of the **Eta Aquarids** during the first week of May. Despite the moonlight, rates as high as 22 meteors per hour were reported from this radiant. Several observers commented that they were able to see the shower better by facing westward with the Moon beind them. Many shower members streaked overhead and into the western half of the sky where they were seen with less lunar interference.

During the last two months of this period activity from the many minor showers dominated the scene. The **Tau Herculids** of early June appear to have been the most active of these showers with nine shower members being seen. The remainder of these radiants produced very low rates and were often difficult to distinguish from the sporadic background.

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)
AUG 11	Michael Bakich, KS	02:38-04:51	62 PER,10 SPO	+5.8; 30% cloudy
	Chen Dong Hua, CHINA	18:35-20:05	14 PER, 6 SPO	+5.2
12	Michael Bakich, KS	02:31-05:56	139 PER, 8 SPO	+4.2
	Chen Dong Hua, CHINA	14:40-18:20	16 PER, 7 SPO	+5.1
13	Michael Bakich, KS	02:58-05:16	44 PER, 6 SPO	+5.5
SEP 10	Frank Melillo, NY	03:20-04:10	1 SPI, 1 SPO	+4.0
13	Richard Taibi, MD	05:03-07:27	2 KAQ, 2 SPI, 5 DAU, 10 SPO	+6.3
20	Frank Melillo, NY	03:50-05:20	*None Seen*	+4.5
25	Frank Melillo, NY	05:00-06:30	1 SPI, 2 SPO	+4.5
OCT 07	John Gallagher, NJ	04:45-06:45	2 NPI, 1 STA, 1 AND, 1 DAU, 1 EGE, 3 SPO	+6.6
07-	Daniel Rhone, NJ	23:45-01:00	6 OCG, 3 SPO	+4.3
08	" " "	01:35-02:20	4 OCG	+4.4
11	John Gallagher, NJ	04:25-06:36	1 DAU, 1 OCE, 1 ORI, 1 GPI, 3 SPO	+6.7
13	George Zay, CA	02:12-12:54	3 SPI, 2 SOR, 2 ORI, 4 NTA, 4 STA, 42 SPO	+5.7
	Robert Lunsford, CA	07:00-13:00	2 ORI, 1 NPI, 1 DAU, 1 EGE, 1 STA, 1 SOR, 34 SPO	+6.5
14	John Gallagher, NJ	04:40-06:47	3 ORI, 1 OAR, 2 SPO	+7.0
18	John Swatek, HA	12:20-15:00	46 ORI, 6 EGE, 54 SPO	+6.0
	Michael Morrow, HA	12:30-14:00	3 ORI, 27 SPO	+6.0
19	Robert Lunsford, CA	08:00-13:00	81 ORI, 3 OAR, 7 EGE, 7 STA, 1 DAU, 1 SOR, 52 SPO	+6.4
	Michael Morrow, HA	11:30-13:30	4 ORI, 1 STA, 1 OCE, 16 SPO	+4.8; 75% cloudy
	John Swatek, HA	12:00-14:00	11 ORI, 1 EGE, 17 SPO	+4.1; 75% cloudy

------------------------------------ Table 1 continued on pp. 22-27 with notes on p. 27 --------------------------------

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)
OCT 20	Robert Lunsford, CA	08:00-13:00	99 ORI, 12 STA, 3 NTA, 3 SOR, 3 EGE, 2 DAU, 65 SPO	+6.4
	Michael Morrow HA	12:30-14:30	8 ORI, 1 EGE, 30 SPO	+6.0; 10% cloudy
	John Swatek, HA	12:30-15:00	43 ORI, 6 NTA, 7 EGE, 44 SPO	+6.0
21	Phyllis Eide, HA	08:10-09:15	2 SPO	+4.0; 50% cloudy
	Robert Lunsford, CA	08:30-13:00	59 ORI, 4 STA, 4 EGE, 1 NTA, 1 DAU, 1 SOR, 53 SPO	+6.1
22	Robert Hays, IL	08:00-09:00	25 ORI, 1 NTA, 3 STA, 7 SPO	+6.5
	J. Kenneth Eakins, CA	09:00-11:00	17 ORI, 4 SPO	+5.4
	Michael Morrow, HA	11:15-13:15	57 ORI, 28 SPO	+5.2
	John Swatek, HA	11:30-15:15	64 ORI, 14 NTA, 11 EGE, 72 SPO	+6.0
23	John Gallagher, NJ	04:25-07:50	2 DAU, 2 EGE, 7 ORI, 1 GPI, 3 NTA, 2 SPP, 8 SPO	+6.7
	Richard Taibi, MD	06:04-08:57	9 ORI, 2 NTA, 2 EGE, 9 SPO	+5.8
	George Gliba, MD	06:55-08:55	25 ORI, 3 STA, 4 SPO	+5.5
	Robert Hays, IL	07:00-09:00	38 ORI, 6 STA, 1 NTA, 18 SPO	+6.7
	George Zay, CA	07:12-13:03	55 ORI, 27 SPO	+5.6
	Robert Lunsford, CA	07:15-13:00	86 ORI, 3 STA, 2 EGE, 48 SPO	+6.4
	Frank Melillo, NY	08:05-09:05	9 ORI, 3 EGE, 1 SPO	+4.5
	J. Kenneth Eakins, CA	12:00-13:00	6 ORI, 2 SPO	+5.3
	John Swatek, HA	12:30-15:00	10 ORI, 1 EGE, 30 SPO	+3.9
	Michael Morrow, HA	12:30-13:30	1 ORI, 4 SPO	+5.0
	Phyllis Eide, HA	12:30-13:30	1 ORI, 5 SPO	+4.5
24	John Gallagher, NJ	05:15-07:30	1 AND, 2 DAU, 2 EGE, 1 OCE, 6 ORI, 1 SPP, 2 SPO	+6.7
25	Richard Taibi, MD	06:59-09:21	6 ORI, 1 STA, 5 EGE, 14 SPO	+5.9
26	Robert Lunsford, CA	12:00-13:00	1 STA, 3 SPO	+5.4
27	Robert Lunsford, CA	12:00-13:00	4 SPO	+5.6
	John Swatek, HA	13:30-15:30	19 ORI, 3 NTA, 36 SPO	+5.8
NOV 02	John Gallagher, NJ	06:20-08:30	1 STA, 2 SPO	+5.5
04	Frank Melillo, NY	05:10-06:10	2 ORI	+4.0
05	George Zay , CA	04:43-07:02	1 ORI, 2 STA, 4 NTA, 6 SPO	+5.3
06	George Zay , CA	01:44-07:07	3 STA, 4 NTA, 16 SPO	+5.5
07	Mark Davis, SC	03:28-04:28	6 SPO	+5.5
08	Mark Davis, SC	03:30-05:00	10 SPO	+4.9
	Richard Taibi, MD	03:32-05:39	1 STA, 1 NTA, 3 SPO	+5.7
	John Gallagher, NJ	04:45-07:27	1 STA, 2 BIE, 1 DER, 1 LEO	+6.5
09	Earl Mead, CO	03:05-03:45	3 SPO	+4.8
	Frank Melillo, NY	04:05-05:35	2 NTA, 1 SPO	+4.5
	John Gallagher, NJ	05:30-07:44	1 DER, 1 LEO, 1 NTA, 12 SPO	+6.9
	Robert Lunsford, CA	09:15-13:15	5 STA, 6 NTA, 2 TAU, 45 SPO	+6.3
10	Earl Mead, CO	03:30-04:30	5 NCP, 3 SPO	+5.0
	Mark Davis, SC	04:00-06:00	3 STA, 1 NTA, 9 SPO	+5.0; 15% cloudy
	Frank Melillo, NY	04:05-05:35	1 NTA	+4.5
11	Frank Melillo, NY	04:25-05:30	1 NTA	+4.5
13	John Gallagher, NJ	01:20-08:30	3 STA, 1 LEO, 5 SPO	+6.0; 3:10 Break
	Frank Melillo, NY	04:55-06:05	1 NTA, 2 SPO	+4.5
14	Phyllis Eide, HA	08:00-10:45	1 STA, 14 SPO	+5.5
	John Swatek, HA	08:00-10:45	6 NTA, 3 STA, 23 SPO	+6.0
	JoAnn Hornsany , HA	08:00-10:45	8 SPO	+5.0
	Michael Morrow , HA	08:00-10:45	3 LEO, 1 NTA, 1 STA, 12 SPO	+5.0
	Betty Yee, HA	08:09-10:45	11 NTA, 1 LEO, 18 SPO	+5.0
15	Mark Davis, SC	05:30-06:30	1 STA, 2 LEO, 6 SPO	+5.0
	" " "	06:40-07:40	2 LEO, 6 SPO	+5.0
	" " "	08:00-09:00	1 STA, 1 NTA, 4 LEO, 6 SPO	+5.1
	" " "	09:05-10:05	5 LEO, 1 STA, 1 NTA, 7 SPO	+5.2

------------------------------------- Table 1 continued on pp. 23-27 with notes on p. 27 --------------------------------

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)
Nov 16	George Zay, CA	05:10-12:32	6 LEO, 5 NTA, 3 STA, 2 AMO, 28 SPO	+5.6
	John Gallagher, NJ	05:55-09:14	2 LEO, 1 TAU, 11 SPO	+6.7
	Robert Lunsford, CA	10:00-13:00	8 LEO, 1 NTA, 2 STA, 26 SPO	+6.0
17	John Gallagher, NJ	06:55-09:07	4 LEO, 1 NTA, 1 SPO	+5.6
	Phyllis Eide , HA	10:15-11:00	2 LEO, 2 SPO	+3.5
	John Swatek, HA	13:15-15:15	8 LEO, 14 SPO	+5.3
18	Rett Alonzi, KS	10:30-11:45	6 LEO, 4 SPO	+4.8
19	John Gallagher, NJ	05:15-06:57	1 NTA, 2 SPO	+7.0
20	George Zay, CA	01:47-13:26	1 AMO, 10 NTA, 6 STA, 54 SPO	+5.3
21	John Gallagher, NJ	05:50-08:31	2 LEO, 1 NTA, 1 AMO, 7 SPO	+6.8
22	John Gallagher, NJ	04:55-06:00	3 SPO	+6.8
23	John Gallagher, NJ	05:30-08:15	1 TAU, 1 AMO, 1 DAR, 1 ZPU, 2 SPU, 6 SPO	+7.0
	Phyllis Eide, HA	12:30-13:30	6 SPO	+4.5
29	John Gallagher, NJ	05:20-08:06	2 LEO, 2 ORN, 4 SPO	+6.7
Dec 01	John Gallagher, NJ	05:20-07:25	1 BIE ,3 SPO	+5.8
07	Mark Davis, SC	03:05-04:35	1 MON, 2 GEM, 8 SPO	+5.7
	Robert Lunsford, CA	10:30-13:45	2 MON, 3 GEM, 1 DAR, 31 SPO	+6.1
08	Mark Davis, SC	03:00-05:00	1 MON, 4 GEM, 1 HYD, 8 SPO	+5.4
09	Frank Melillo, NY	04:30-05:35	1 MON, 4 GEM, 2 SPO	+4.5
	John Gallagher, NJ	05:05-07:13	2 GEM, 1 COM, 1 DAR, 4 SPO	+7.1
10	John Gallagher, NJ	05:25-07:15	4 GEM, 1 HYD, 1 SPO	+6.8
	David Holman, NV	09:14-13:54	2 MON, 19 GEM, 5 HYD, 1 ORN,104 SPO	+6.3
11	Michael Morrow , HA	07:30-09:00	1 GEM, 8 SPO	+7.0
	Phyllis Eide, HA	07:30-09:00	2 GEM, 6 SPO	+7.0
12	Vic Winter, KS	00:00-07:25	56 GEM, 7 SPO	+4.4
	David Preston, KS	03:10-04:05	12 GEM, 4 SPO	+4.0; 25% cloudy
	Keith Green, KS	03:10-04:05	6 GEM, 2 SPO	+4.5
	Robert Doe, KS	03:10-04:05	10 GEM, 4 SPO	+4.0; 25% cloudy
	Debbie Harrelson, KS	03:10-04:05	9 GEM, 3 SPO	+4.3; 5% cloudy
	Kathy Machin, KS	03:10-05:25	27 GEM, 6 SPO	+4.8
	David Preston, KS	04:30-05:25	11 GEM, 3 SPO	+4.8
	Keith Green, KS	04:30-05:25	11 GEM	+4.5; 5% cloudy
	Debbie Harrelson, KS	04:30-05:25	12 GEM, 4 SPO	+4.8
	Robert Hays, IN	05:50-06:50	19 GEM, 1 MON, 1 COM, 5 SPO	+6.4
	Michael Morrow, HA	07:45-10:15	10 GEM, 2 HYD, 33 SPO	+7.0
	Phyllis Eide, HA	07:45-10:15	8 GEM, 25 SPO	+7.0
	David Holman, NV	12:15-13:57	25 GEM, 1 MON, 1 HYD, 49 SPO	+6.3
13	George Zay, CA	01:46-13:41	298 GEM	+5.6
	Mark Davis, SC	03:30-04:30	14 GEM, 2 MON, 1 HYD, 18 SPO	+5.6
	John Gallagher, NJ	03:50-10:05	160 GEM, 2 COM, 13 SPO	+7.1
	Frank Melillo, NY	03:55-05:30	20 GEM, 1 SPO	+4.5
	Roger Venable, GA	04:00-05:00	41 GEM, 3 MON, ICOM	+6.3
	Richard Taibi, MD	04:29-09:11	90 GEM, 7 MON, 2 COM, 3 HYD, 22 SPO	+6.0
	George Gliba, MD	04:34-06:34	52 GEM, 1 MON, 1 HYD, 1 ORS	+5.4
	Mark Davis, SC	04:39-05:39	39 GEM, 3 MON, 2 HYD, 19 SPO	+5.6
	Roger Venable, GA	05:02-06:02	61 GEM, 1 MON, 2 HYD, 3 COM, 1 ORS, 1 ORN, 3 SPO	+6.4
	Mark Davis, SC	05:45-06:45	44 GEM, 2 MON, 2 HYD ,17 SPO	+5.7
	Roger Venable, GA	06:11-07:10	70 GEM, 4 MON, 2 HYD, 6 COM, 2 ORS, 7 SPO	+6.5
	Phyllis Eide, HA	06:45-10:00	36 GEM, 3 HYD, 50 SPO	+6.8
	Michael Morrow, HA	06:45-10:00	36 GEM, 2 HYD, 42 SPO	+6.7
	David Holman, CA	06:45-11:55	86 GEM, 6 MON, 2 HYD, 60 SPO	+5.3; 5% cloudy
	Roger Venable, GA	07:11-08:10	80 GEM, 6 HYD, 3 MON, 4 COM, 4 ORS, 9 SPO	+6.5

------------------------------------ Table 1 continued on pp. 24-27 with notes on p. 27 --------------------------------

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

1993-94 UT Date	Observer and Location	Universal Time	Number and Type* of Meteors Seen	Comments (+*N* = Limiting Magnitude)
1993				
DEC 13	Robert Lunsford, CA	08:00-14:00	371 GEM, 1 MON, 2 ORN, 9 COM, 9 HYD, 62 SPO	+6.4
	Roger Venable, GA	08:14-09:13	73 GEM, 7 COM, 1 MON, 2 HYD, 10RS, 8 SPO	+5.9
	Johan Warell, SWEDEN	20:30-22:46	102 GEM, 4 SPO	+5.5; 35% cloudy
	Lars Hermansson, SWEDEN	20:30-22:46	70 GEM, 6 SPO	+5.5; 35% cloudy
14	George Zay, CA	02:20-03:22	7 GEM, 2 SPO	+5.4
	George Gliba, MD	02:50-03:50	38 GEM, 1 ORS, 1 MON, 2 SPO	+5.3
	George Zay, CA	03:23-04:26	16 GEM, 1 SPO	+5.6
	" " "	04:27-05:42	18 GEM, 5 SPO	+5. 6
	Robert Lunsford, CA	05:15-06:15	27 GEM, 1 ORS, 2 SPO	+5.9
	George Zay, CA	05:43-07:03	37 GEM, 1 SPO	+5.6
	John Gallagher, NJ	06:15-07:00	25 GEM	+7.5; 60% cloudy
	Robert Lunsford, CA	06:15-07:15	68 GEM, 1 SPO	+6.1
	Richard Schmude, TX	06:43-07:43	41 GEM, 2 SPO	+6.0
	Danny Bruton, TX	06:43-07:43	38 GEM, 2 SPO	+6.0
	George Zay, CA	07:04-08:18	48 GEM, 5 SPO	+5.7
	Robert Lunsford, CA	07:15-08:15	76 GEM, 1 COM, 6 SPO	+6.5
	David Holman, CA	07:55-09:00	90 GEM, 3 MON, 50 SPO	+6.3
	Robert Lunsford, CA	08:15-09:15	42 GEM, 1 HYD, 5 SPO	+4.9
	George Zay, CA	08:19-10:07	60 GEM, 8 SPO	+5.0
	John Gallagher, NJ	08:30-11:15	66 GEM, 5 SPO	+7.1
	Michael Morrow, HA	08:50-12:00	65 GEM, 5 HYD, 79 SPO	+6.7
	Phyllis Eide, HA	08:50-12:00	60 GEM, 13 HYD, 136 SPO	+7.0
	Robert Lunsford, CA	09:15-10:15	85 GEM, 1 COM, 8 SPO	+6.5
	David Holman, CA	09:20-10:00	53 GEM, 1 MON, 23 SPO	+6.5
	George Zay, CA	10:08-11:25	59 GEM, 11 SPO	+5.7
	David Holman, CA	10:00-11:06	69 GEM, 1 ORS, 54 SPO	+6.5
	Robert Lunsford, CA	10:15-11:15	62 GEM, 1 ORS, 5 COM, 4 HYD, 12 SPO	+6.4
	Earl Mead, CO	11:10-12:10	21 GEM, 2 ORS, 3 CMI, 5 SPO	+5.0
	Robert Lunsford, CA	11:15-12:15	57 GEM, 6 COM, 7 SPO	+6.4
	George Zay, CA	11:26-12:38	40 GEM, 15 SPO	+5.7
	David Holman, CA	11:42-12:54	67 GEM, 1 ORS, 43 SPO	+6.5
	Robert Lunsford, CA	12:15-13:15	39 GEM, 3 COM, 4 HYD, 11 SPO	+6.1
	George Zay, CA	12:39-13:45	28 GEM, 10 SPO	+5.1
	David Holman, CA	12:54-13:39	31 GEM, 1 HYD, 22 SPO	+6.3; 5% cloudy
	Robert Lunsford CA	13:15-13:45	9 GEM, 1 COM, 2 SPO	+5.6
17	Mark Davis, SC	02:55-03:55	13 SPO	+5.4
	John Gallagher, NJ	05:30-07:36	1 GEM, 1 OCM, 6 SPO	+7.0
20	John Gallagher, NJ	05:10-07:18	3 COM, 1 ORS, 3 SPO	+6.6; 5% cloudy
22	Richard Taibi, MD	07:05-08:07	4 URS, 2 COM, 3 SPO	+6.0
	" " "	08:24-09:26	7 URS, 4 COM, 7 SPO	+6.0
	Robert Lunsford, CA	09:00-10:00	11 URS, 2 COM, 7 SPO	+7.1
	Richard Taibi, MD	09:34-10:37	5 URS, 1 COM, 6 SPO	+6.0
	Robert Lunsford, CA	10:00-11:00	7 URS, 9 SPO	+7.0
	" " "	11:00-12:00	16 URS, 2 COM, 12 SPO	+6.9
	" " "	12:00-13:00	26 URS, 1 COM, 21 SPO	+6.8
	David Holman, CA	12:53-14:00	9 SPO	+5.4
	Robert Lunsford, CA	13:00-14:00	21 URS, 5 COM, 10 SPO	+5.7
23	George Zay, CA	01:44-13:52	5 URS, 8 COM, 27 SPO	+5.4
	Vic Winter, KS	04:59-10:05	24 URS ,11 SPO	+4.7
24	John Gallagher, NJ	05:55-08:02	2 COM, 3 URS, 2 SPO	+7.0
1994				
JAN 03	George Zay, CA	01:50-13:52	40 QUA, 31 SPO	+5.4
	David Holman, CA	02:35-04:00	8 SPO	+5.3
	Robert Lunsford, CA	09:47-13:47	59 QUA, 2 COM, 22 SPO	+6.0
	David Holman, CA	12:31-14:10	12 QUA, 9 SPO	+5.4
	John Swatek, HA	13:00-16:30	48 QUA, 19 SPO	+4.3
	Michael Morrow, HA	12:30-16:30	19 QUA, 26 SPO	+4.3

------------------------------------ Table 1 continued on pp. 25-27 with notes on p. 27 ------------------------------------

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

1994 UT Date	Observer and Location	Universal Time	Number and Type* of Meteors Seen	Comments (+*N* = Limiting Magnitude)
JAN 04	Robert Lunsford , CA	12:00-13:30	2 QUA, 1 SPO	+5.4
06	David Holman, CA	03:08-05:00	8 SPO	+5.6
	George Zay, CA	04:24-13:50	31 SPO	+5.5
	John Gallagher, NJ	05:40-06:41	*None Seen*	+6.0
07	George Zay, CA	02:00-05:12	7 SPO	+5.7
09	John Gallagher, NJ	05:55-08:00	1 ACM, 6 SPO	+6.6
	Michael Morrow, HA	09:00-11:00	12 SPO	+5.5
10	John Gallagher, NJ	05:45-07:48	1 DCA, 2 SPO	+7.2
12	David Holman, CA	02:48-04:00	3 SPO	+5.4
13	David Holman, CA	02:40-04:00	4 SPO	+5.2
16	George Zay , CA	02:00-13:48	5 DCA, 43 SPO	+5.6
	John Gallagher, NJ	06:05-08:07	2 SPO	+7.1
	Mark Davis, SC	08:00-10:00	1 DCA, 12 SPO	+5.6
	David Holman, CA	11:49-14:00	6 COM,1 DCA, 21 SPO	+6.4
17	George Zay, CA	02:00-10:51	2 DCA , 27 SPO	+5.6
	David Holman, CA	08:00-11:00	3 COM, 3 DCA, 35 SPO	+6.4
18	David Holman, CA	05:05-08:42	2 DCA 25 SPO	+6.3
	Robert Lunsford, CA	09:00-12:00	2 ALE, 1 COM, 1 DCA, 7 SPO	+5.6
19	John Gallagher, NJ	05:50-07:24	1 ALE, 3 SPO	+7.0
	David Holman, CA	08:41-11:00	3 COM, 6 DCA, 20 SPO	+6.4
20	Mark Davis, SC	07:56-09:56	9 SPO	+5.5
	David Holman, CA	13:18-14:18	3 COM, 9 SPO	+5.6
21	Mark Davis, SC	08:20-09:20	11 SPO	+5.6
	David Holman, CA	09:17-13:00	5 COM, 2 DCA, 45 SPO	+6.4
22	Mark Davis, SC	08:37-09:37	6 SPO	+5.2
30	George Zay, CA	02:21-09:53	2 SPO	+5.4
FEB 02	John Gallagher, NJ	05:30-07:36	1 COM,1 PLE, 2 SPO	+7.0
05	John Gallagher, NJ	06:05-08:13	7 SPO	+7.1
10	George Zay, CA	02:26-13:35	2 DLE, 3 VIR, 40 SPO	+5.6
	Robert Lunsford , CA	09:00-13:00	2 BHY, 27 SPO	+6.6
12	George Zay, CA	02:26-10:50	1 DLE,10 SPO	+5.6
14	John Gallagher, NJ	05:10-06:37	1 ALE	+7.1
15	John Gallagher, NJ	05:35-07:39	1 AVA , 2 SPO	+6.9
	Robert Lunsford , CA	12:00-13:00	1 TCE, 3 SPO	+5.3
18	John Gallagher, NJ	05:45-07:49	6 SPO	+6.7
20	John Gallagher, NJ	05:25-07:30	2 PLE, 4 SPO	+7.2
23	George Zay, CA	02:30-04:31	*None Seen*	+4.8
MAR 05	George Zay, CA	03:00-13:16	4 DLE, 20 SPO	+5.5
06	John Gallagher, NJ	06:15-08:18	4 SPO	+6.7
10	Robert Lunsford , CA	10:15-13:15	3 DLE ,17 SPO	+6.7
12	John Gallagher, NJ	05:35-07:44	1 VIR, 7 SPO	+7.5
15	Robert Lunsford , CA	09:00-13:00	3 VIR, 6 AVA, 18 SPO	+6.5
16	John Gallagher, NJ	05:15-07:22	6 SPO	+7.3
	George Zay, CA	07:22-13:01	1 DLE, 1 VIR, 13 SPO	+5.5
	Robert Lunsford , CA	09:00-13:00	2 VIR, 2 AVA, 18 SPO	+6.4
20	Richard Taibi, MD	06:05-07:18	2 SPO	+5.8
21	John Gallagher, NJ	04:55-06:58	1 DDR, 3 SPO	+7.0
23	John Gallagher, NJ	05:15-07:18	1 VIR, 2 SPO	+6.7

------------------------------------- Table 1 continued on pp. 26-27 with notes on p. 27 --------------------------------

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

1994 UT Date	Observer and Location	Universal Time	Number and Type* of Meteors Seen	Comments (+*N* = Limiting Magnitude)
MAR 30	George Zay, CA	03:07-08:18	3 SPO	+5.3
31	John Gallagher, NJ	07:00-08:13	*None Seen*	+6.6; 30% cloudy
APR 02	John Gallagher, NJ	05:00-05:47	1 BLE, 1 DDR	+7.4
05	John Gallagher, NJ	04:30-06:36	1 FBO, 1 LYR	+7.5
08	John Gallagher, NJ	04:40-07:18	1 APV, 1 AVB, 1 APU, 1 EDR, 1 KSE, 1 SPO	+7.2
11	George Zay, CA	03:09-12:31	6 VIR, 3 ASC, 12 SPO	+5.6
	Robert Lunsford, CA	09:00-12:30	23 SPO	+6.6
12	George Zay, CA	03:10-12:30	1 VIR, 1 ASC, 9 SPO	+5.4
15	John Gallagher, NJ	05:05-07:08	1 ABV	+6.4
17	Mark Davis, SC	04:10-07:28	1 ABO, 2 ASC, 22 SPO	+5.2
	John Gallagher, NJ	05:40-07:44	1 SPO	+6.8; 15% cloudy
18	Mark Davis, SC	03:05-04:05	1 ABO, 4 SPO	+5.0
	Richard Taibi, MD	06:42-08:49	2 LYR, 2 VIR, 1 ABO, 6 SPO	+6.0
19	Robert Lunsford, CA	08:00-12:00	1 LYR, 17 SPO	+6.6
	David Holman, CA	09:00-11:48	1 LYR, 30 SPO	+6.2
20	Robert Lunsford, CA	09:15-12:15	5 LYR, 1 ABO, 15 SPO	+6.9
	David Holman, CA	11:06-12:22	2 LYR, 1 SPO	+6.2
21	Ron Rosenwald, TX	08:00-10:00	*None Seen*	----; 100% cloudy
	Robert Lunsford, CA	09:00-12:00	6 LYR, 27 SPO	+6.4
	David Holman, CA	09:04-12:13	5 LYR, 3 ABO, 1 ASC, 1 VIR, 35 SPO	+6.2
22	George Zay, CA	04:55-12:16	25 LYR, 22 SPO	+5.3
	John Gallagher, NJ	05:30-09:00	6 LYR, 1 WCA, 4 SPO	+7.1
	Peter Jenniskens, CA	05:58-12:14	32 LYR, 22 SPO	+6.7
	David Holman, CA	06:17-12:06	7 LYR, 1 ASC, 18 SPO	+6.0
	Felix Martinez, CUBA	07:30-08:30	6 LYR, 1 SPO	+5.5
	Ron Rosenwald, TX	07:50-09:05	4 LYR, 2 SPO	+4.0 ; 65% cloudy
	Robert Lunsford, CA	09:20-12:20	58 LYR ,1 ABO, 36 SPO	+6.3
	Glenn Piper, NY	09:30-10:00	1 LYR, 1 SPO	+5.0
23	George Zay, CA	03:30-12:15	16 LYR, 7 SPO	+5.3
	Frank Melillo, NY	06:45-07:45	1 LYR	+4.5
	Richard Taibi, MD	07:45-09:10	2 LYR, 2 SPO	+5.7
28	John Gallagher, NJ	04:05-05:54	2 DDR, 1 WCA, 1 GVR, 1 SPO	+6.4
MAY 03	George Zay, CA	03:30-12:07	13 ETA, 1 NOP, 3 ABO, 16 SPO	+5.4
	John Gallagher, NJ	04:50-06:57	1 URM, 1 BCA, 2 SPO	+6.9
	Robert Lunsford, CA	09:00-12:00	7 ETA, 1 MLB, 1 ASC, 15 SPO	+6.3
04	George Zay, CA	05:55-12:03	28 ETA ,1 SAG, 2 ABO, 24 SPO	+5.5
	Robert Lunsford, CA	09:10-12:10	45 ETA , 2 MVI, 1 ASC, 1 AVB, 16 SPO	+6.6
05	Richard Schmude, TX	06:20-07:00	*None Seen*	+5.5
	George Zay, CA	07:04-12:00	14 ETA, 1 SAG, 3 NOP, 16 SPO	+5.3
	Felix Martinez, CUBA	08:00-09:30	17 ETA ,10 SPO	+6.0
06	John Gallagher, NJ	04:35-05:55	1 ASC, 1 ABO, 2 SPO	+7.4
07	John Gallagher, NJ	05:25-09:00	1 ABO, 1 THE, 7 ETA ,1 WCA , 1 MLB, 4 SPO	+7.2
	Richard Taibi, MD	07:23-08:48	5 ETA, 9 SPO	+5.6
08	David Holman , CA	04:40-05:51	4 SPO	+5.1
	Tom Giguere, HA	07:35-08:36	7 SPO	+5.7
09	Richard Taibi, MD	06:40-08:42	5 ETA, 8 SPO	+5.8
10	John Gallagher, NJ	03:20-05:26	1 NOP	+6.8
11	John Gallagher, NJ	04:40-08:23	1 BCA ,1 MVI, 5 IAA, 8 SPO	+7.5
14	Frank Melillo, NY	05:45-05:50	1 URM	+4.5
16	David Holman, CA	08:00-11:39	1 ETA, 1 ASC,17 SPO	+5.6
	Robert Lunsford, CA	09:00-11:15	4 ETA, 1 NOP, 1 ASC, 5 SPO	+6.8
	George Zay, CA	10:00-11:38	2 ETA, 1 NOP, 1 SOP, 2 SPO	+5.7
21	John Gallagher, NJ	04:45-06:54	6 SPO	+7.3
27	George Zay, CA	10:00-12:38	3 SPO	+5.1

-- Table 1 continued on p. 27 with notes --

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

1994 UT Date	Observer and Location	Universal Time	Number and Type* of Meteors Seen	Comments (+*N* = Limiting Magnitude)
May 28	George Zay, CA	04:50-10:12	3 GSA, 1 KSC, 6 SPO	+5.4
29	George Zay, CA	04:50-08:00	5 SPO	+5.6
Jun 01	John Gallagher, NJ	04:35-06:07	2 SPO	+7.2
03	John Gallagher, NJ	03:35-06:45	3 THE, 1 ISC, 1 JLY, 2 SPO	+7.5
05	John Gallagher, NJ	03:40-06:19	4 THE, 1 JLY, 1 SPO	+7.3
08	John Gallagher, NJ	04:40-06:16	2 THE, 1 SPO	+7.1
	Robert Lunsford, CA	07:25-11:55	2 DAR, 48 SPO	+6.5
09	Robert Lunsford, CA	05:00-11:30	1 OSC, 3 TOP, 1 ISC, 44 SPO	+6.7
	John Gallagher, NJ	05:05-07:09	1 THE, 1 GSA , 1 SPO	+7.5
	George Zay, CA	05:54-12:21	1 OSC, 2 CSC, 1 GSA, 2 TOP, 3 LSA ,14 SPO	+5.7
10	David Holman, CA	05:09-07:29	2 LSA, 16 SPO	+6.5
	George Zay, CA	06:04-12:32	4 CSC, 2 GSA, 2 TOP, 20 SPO	+5.6
11	John Gallagher, NJ	03:45-06:26	1 JLY, 1 DCG, 3 SPO	+7.2
	David Holman, CA	08:07-11:05	32 SPO	+6.2
12	David Holman, CA	05:12-10:37	2 GSA, 1 TOP, 68 SPO	+6.4
	Tom Giguere, HA	08:00-10:00	3 JLY, 6 SPO	+6.0
	Michael Morrow, HA	08:00-10:05	6 SPO	+6.0
14	John Gallagher, NJ	04:10-05:42	1 DCG, 1 SPO	+7.1
	Robert Lunsford, CA	08:00-11:30	1 TOP, 40 SPO	+6.9
15	Robert Lunsford, CA	09:00-11:30	1 LSA, 1 TOP, 32 SPO	+6.8
16	Robert Lunsford, CA	09:00-11:30	1 JLY, 29 SPO	+6.8
18	John Gallagher, NJ	05:30-06:06	1 SPO	+6.5
21	John Gallagher, NJ	03:50-06:26	1 JLY, 2 BCG, 2 SPO	+5.6
	George Zay, CA	05:00-12:35	2 TOP, 9 SPO	+5.1
23	George Zay, CA	05:00-10:00	1 SPO	+5.0
	John Gallagher, NJ	05:00-06:43	*None Seen*	+5.7
26	John Gallagher, NJ	04:40-06:45	1 OPH, 4 SPO	+7.0
	" " "	07:05-08:07	2 SPO	+7.0
29	John Gallagher, NJ	03:45-05:07	1 BCG	+6.3

** Key to Abbreviations*

ABO	Alpha Boötids
ACM	Alpha Canis Majorids
ALE	Alpha Leonids
AMO	Alpha Monocerotids
AND	Annual Andromerids
APU	Alpha Puppids
APV	Alpha Puppid-Velids
ASC	Alpha Scorpiids
AVA	Alpha Virginids A
AVB	Alpha Virginids B
BCA	Beta Corona Australids
BCG	Beta Cygnids
BHY	Beta Hydrids
BIE	Bielids
BLE	Beta Leonids
CMI	Canis Minorids
COM	Coma Berenicids
CSC	Chi Scorpiids
DAR	Daylight Arietids
DAR	Delta Arietids
DAU	Delta Aurigids
DCA	Delta Cancrids
DCG	Delta Cygnids
DDR	Delta Draconids
DER	Delta Eridanids
DLE	Delta Leonids
EDR	Epsilon Draconids
EGE	Epsilon Geminids
ETA	Eta Aquarids
FBO	Phi Boötids
GEM	Geminids
GPI	Gamma Piscids
GSA	Gamma Sagittarids
GVR	Gamma Virginids
HYD	Sigma Hydrids
IAA	Iras-Araki-Alcockids
ISC	Iota Scorpiids
JLY	June Lyrids
KAQ	Kappa Aquarids
KSC	Kappa Scorpiids
KSE	Kappa Serpentids
LEO	Leonids
LSA	Lambda Sagittarids
LYR	Lyrids
MLB	May Librids
MON	Monocerotids (Dec.)
MVI	Mu Virginids
NCP	November Cepheids
NOP	Northern Ophiuchids
NPI	Northern Piscids
NTA	Northern Taurids
OAR	October Arietids
OCE	October Cetids
OCG	October Cygnids
OCM	Omega Canis Majorids
OPH	Ophiuchids
ORI	Orionids
ORN	Northern Chi Orionids
ORS	Southern Chi Orionids
OSC	Omega Scorpiids
PER	Perseids
PLE	Phi Leonids
QUA	Quadrantids
SAG	Sagittarids
SOP	Southern Ophiuchids
SOR	Sigma Orionids
SPI	Southern Piscids
SPO	Sporadic
SPP	Sigma Puppids
SPU	Sigma Puppids II
STA	Southern Taurids
TAU	Taurids
TCE	Theta Centaurids
THE	Tau HercuLids
TOP	Theta Ophiuchids
URM	May Ursids
URS	Ursids
VIR	Virginids
WCA	Omega Capricornids
ZPU	Zeta Puppids

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By: Michael Mattei

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● ●

COMET MACHHOLZ 2 (1994o)

On 1994 AUG 13 our Comets Recorder, Don Machholz, discovered his latest comet, designated Periodic Comet Machholz 2 (1994o), then at magnitude +10. Since then, this comet has had an interesting history. A second component ("D") was found by Michael Jager of Austria on 1994 AUG 28, and is now about 5 arc-minutes to the north-northeast of the main component ("A"). Three more fragments were found; and erroneous news stories predicted that the comet, or at least one of its pieces, would strike the Earth! There is really no danger of our being hit, but the comet passed close to Jupiter in the past, perhaps then being broken up, and will do so again in 2006.

Comet P/Machholz 2 reached about 7th magnitude in the northern skies. Although now receeding and fading, it is still visible in small telescopes. At latest report, the main component is 10th magnitude and the secondary component is about 11th.

The predicted Epoch 2000.0 coordinates for Comet P/Machholz 2 for October and November 1994 are as follows, given in the order: 0h UT date, right ascension/declination, solar elongation, and (very uncertain) visual magnitude

OCT	05	09:32.9/+14°26'	51° Morning	+10.3
	10	09:45.1/+11°34'	52° Morning	+10.6
	15	09:56.6/+08°55'	53° Morning	+10.9
	20	10:07.4/+06°28'	55° Morning	+11.3
	25	10:17.5/+04°11'	57° Morning	+11.6
	30	10:26.9/+02°03'	59° Morning	+11.9
NOV	04	10:35.5/+00°03'	61° Morning	+12.2
	09	10:43.3/ -01°49'	64° Morning	+12.4
	14	10:50.4/ -03°34'	67° Morning	+12.7
NOV	19	10:56.6/-05°12'	70° Morning	+12.9
	24	11:02.1/-06°43'	73° Morning	+13.2
	29	11:06.7/-08°09'	76° Morning	+13.4

These postions are plotted on the finding chart below. For those who wish to compute their own ephemerides, the perihelion date is 1994 SEP 17.8; perihelion distance, 0.7527188 AU, argument of perihelion 147°.54691, ascending node 247°.48372, inclination 13°.2657, eccentricity 0.7905423, and period 6.81 years.

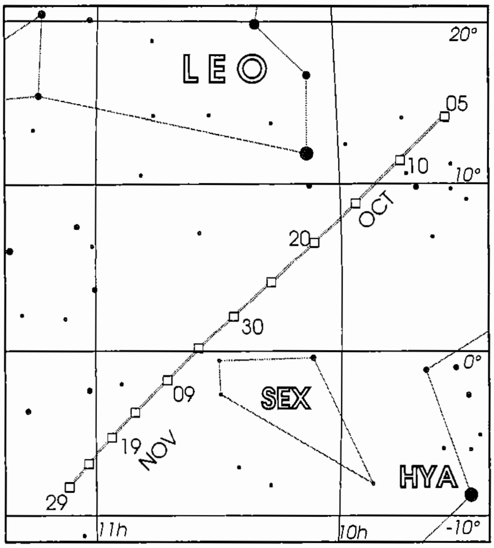

Figure 1. Path of Comet Machholz 2 in Leo and Sextans during October and November, 1994. The limiting magnitude is about +6. 2000.0 coordinates.

THE MELLISH QUESTION: A REBUTTAL

By: Rodger W. Gordon

In their letter published in *J.A.L.P.O.*, Volume 37, Number 3 (February, 1994, pp. 130-131), Richard McKim and William Sheehan attempted to discredit observations of Martian craters by John Mellish using rather dubious inferences and conjectures which can be disproved upon careful study.

We have no argument that Mellish was at best a mediocre draftsman. McKim and Sheehan claim, however, that Mellish's drawings were done in a "very Lowellian style." This is incorrect; Lowell shows narrow fine lines whereas Mellish's lines are broader. But let us indeed refer to Mellish's own words. Referring to a plate of Mars drawings sent to Walter Leight (the ones republished in my article in Patrick Moore's 1983 *Yearbook of Astronomy*), I quote from his January 18, 1935 letter to Leight, "The canals are not as straight as I drew them, but the best I could do because the fine detail was just at the limit of vision and waves wash across and destroy detail and then it comes at instants." Also, since when is poor draftsmanship evidence of poor observing skills? Mellish, Wilkins, and others may not have been good draftsmen but they were skilled observers. Mellish, for example, independently discovered a dark marking on Saturn in the summer of 1903 with only a 2-inch Bardou refractor, which discovery E.E. Barnard is given the professional credit for. Likewise, we have Mellish's record of his comet discoveries, for two of which he received medals.

McKim and Sheehan argue that, because seeing was usually bad at Yerkes that winter of 1915-1916, they now doubt that he could have made his observations on November 13, citing Barnard's log as evidence. This shows their unfamiliarity with how rapidly seeing conditions can change during one night. Seeing not only varies from hour to hour, but even from minute to minute. Mellish observed in the *early morning* until 1-2 hours after sunrise. The atmosphere has a remarkable tendency to stabilize in the early morning hours, which is the time when Mellish observed. I have seen this effect many times and I do considerable early morning observing. Indeed, solar observers frequently observe the Sun from sunrise to a few hours after; before the atmosphere and the ground have a chance to heat up. The best solar seeing in the course of a day is often the early period.

What Mellish himself says supports this argument. In an unpublished follow-up letter to Walter Leight dated February 1, 1935, referring to his crater observations, Mellish made this comment on the conditions at Yerkes in 1915-16, "I have never seen Mars as good since...mostly because I have not had a large telescope, but at times I have had a 16" reflector but Mars is not situated so well at all times; that fall of 1915 we had wonderful definition and it got worse as the winter progressed and when Mars was closest in March we had very little definition." Thus Mellish confirmed the poor conditions at Yerkes during the winter of 1915-1916. In any case, Barnard's evening observations are hardly comparable to Mellish's morning ones. Asaph Hall discovered the Martian moon Deimos on August 11, 1877, after the sky suddenly cleared at 2 A.M. However, one day earlier he had searched for Martian satellites but complained about the atmosphere, "..the image of the planet was very blazing and unsteady.." Conditions evidently improved enough to make the discovery one day later. Also, no serious observer of the Moon and planets could possibly be fooled into believing that predominately bad conditions cannot have good moments of seeing. McKim's and Sheehan's arguments on this matter do not hold water.

McKim and Sheehan then go on to state that E.M. Antoniadi never drew a canal on Mars after he started observing the planet with the 33-inch Meudon refractor. Again incorrect; examine the drawing of Mars done by Antoniadi, previously published in the June, 1954, issue of *Sky & Telescope* (p. 266) and shown in *Figure 1* (p. 34). Compare it to Lowell's drawing of the same portion of Mars made in 1894 and shown as Plate XVIII (facing p. 138) in his book *Mars*, shown here as *Figure 2* (p. 34). Despite the central meridian and axial tilt difference and the many years between the two drawings, Antoniadi's drawing almost totally confirms what Lowell saw. Note the linear aspect of Antoniadi's "canals." Indeed, Antoniadi, although opposing Lowell in the professional literature, was far more cordial to him in his personal correspondence; the two astronomers continued their contact until Lowell's death. After Antoniadi started using the 33-inch refractor, Lowell sent several of his own drawings to him. Antoniadi's reply, with his own italics, was, "There *are* many points of similitude in our drawings, proving that we have seen the same thing but our interpretations of such drawings are different." In a later letter to Lowell, Antoniadi stated (again with his italics), "A great many canals discovered by Schiaparelli and some discovered by yourself I have held steadily and they are *quite real*; probably the same holds good of many others, and there are interlacing canals—a sort of vague network—but all irregular and knotted or diffuse."

For comparison with both Lowell and Antoniadi, *Figure 3* (p. 34) shows what I believe are the only surviving Mars drawings by Mellish.

It is also an established fact that shortly before his death in 1944 Antoniadi admitted that he did see some Lowellian canals with the

Figure 1. Mars as drawn by E.M. Antoniadi during the 1909, or possibly the 1924, perihelic apparition. Note canals in the same regions as shown by Lowell (to right) and drawn in nearly the same fashion. Also see text. South at top.

Figure 2. Drawing of Mars by Percival Lowell in October, 1894. Note canals in the Sinus Sabaeus-Sinus Meridiani region. South at top.

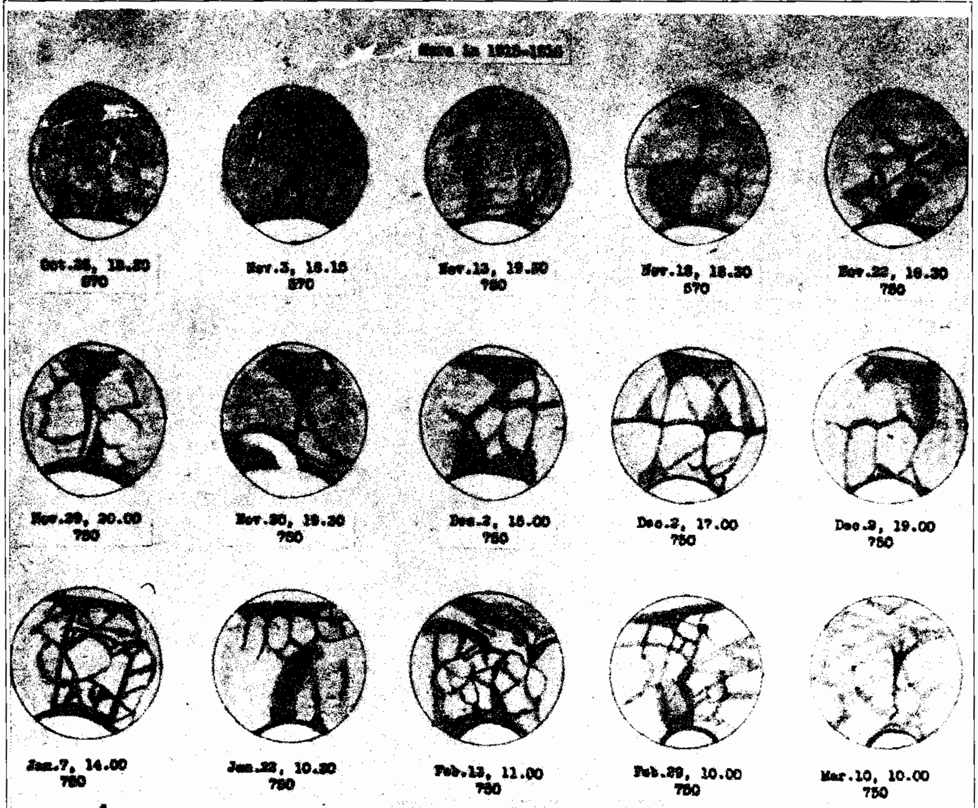

Figure 3. The only known surviving Mars drawings of John Mellish. Except for that of January 7, 1916, all were done with the 12-inch Yerkes refractor. Note that the canals are drawn broader than by Lowell and resemble some pre-Lowell drawings done by earlier observers. Note also how Mellish's drawing style shows improvement as the opposition approaches. The drawing of March 10, 1916, for example, compares very favorably with photographs made by Lowell during the same apparition. By then the Mellish canals had become broad, diffuse, and irregular streaks, as they were drawn by the majority of observers. The white area near the North Polar Cap on November 30, 1915 was likened by Mellish to a "snowstorm" but was probably a large cloud of water vapor or perhaps deposition on the ground—the North Cap is largely water while the South Cap is largely carbon dioxide. South at top.

33-inch, although he was reluctant in his admission and still maintained that they were natural features. Thus McKim's statements about Antoniadi, attempting to discredit Mellish's drawings, show incomplete research. I leave it to our readers to compare Antoniadi's and Lowell's drawings on page 34 and make their own decisions.

Sheehan and Stephen James O'Meara made an attempt to observe Martian craters using the 1-meter (39-inch) *Cassegrain* of the Pic du Midi Observatory. Their observations are described in the January, 1993, *Sky & Telescope*. This appears to be the only serious search by anyone in a direct attempt to duplicate Mellish's feat. Their search was negative, but was flawed for at least one major reason and possibly others. They stated that the conditions were similar to Mellish's and used comparable magnifications; Mellish used 750× and 1100×—this is enough to show that Mellish's conditions had to be very good. However, there was a fatal discrepancy; the Martian disk measured only 6.2 arc-seconds for Sheehan and O'Meara, whereas Mellish had 7.7 arc-seconds to work with, a full 24 percent larger in diameter and some 54 percent greater in area. Sheehan and O'Meara would have had to use a 50-inch telescope to obtain the extra theoretical resolution required to match the Mellish conditions.

However, the phase angle of both observations was similar. In the same article, Sheehan and O'Meara reported that as the Sun rose higher for them the contrast of the Martian markings got fainter and more washed out. However, skilled observers like Antoniadi, Schiaparelli, Lowell, See, Hall, and others, perhaps significantly using large *refractors* to study Venus and Mercury during the daytime, reported that faint markings on these planets were easier to see in daylight than in twilight or night observations. Seeing conditions play a part here as does glare, but I submit that the loss of contrast that the team of Sheehan and O'Meara experienced may have been due to skylight scattering in the Cassegrain system they used. For daytime use, Cassegrain telescopes require good baffling. To do this properly requires a central obstruction of at least 30 percent, or sometimes even 40 percent, unless the instrument is constructed along the lines used by Horace Dall in which auxiliary optics are used to obtain a much smaller central obstruction. However, this approach is seldom used with large Cassegrains. It is possible that the Pic du Midi Cassegrain may suffer from extraneous light because professionally built Cassegrains are seldom used for daylight observations. We must therefore ask if the instrument was properly baffled for daylight use and, if not, did Sheehan or O'Meara think to ask this question? Also, at the same time we must wonder why they did not think to employ a variable-density polarizing filter, which would have been highly useful under these conditions. The negative observations of Sheehan and O'Meara raise more questions than they answer. Even if they are accepted at face value, the best that can be said is "one swallow does not make a summer."

The McKim-Sheehan letter states that Mellish now has a crater on Mars named after him. This needs clarification. Only the Working Committee has approved this, and it must still be voted on at the International Astronomical Union Congress to be held in August, 1994. In a letter to Michael Anderer, who has also done research on Mellish, Bradford Smith, who chairs the nomenclature committee, stated that some opposition to Mellish will be forthcoming. Anderer has been asked to present a paper at the Congress, which he plans to do; and Anderer has in turn contacted me to provide him with resource material from my Mellish files, which I am in the process of doing. Thus Mellish's placement on Mars is not a sure thing.

Mellish at an early age developed a correspondence with Yerkes Director E.B. Frost. Frost was impressed with Mellish and in 1913 attempted to obtain a staff position for him. At that time no money was available.

However, in February, 1915, Mellish discovered another comet and reported it to Yerkes. Shortly thereafter, Frost contacted Mellish to come to Yerkes that Spring or Summer, but Mellish stated that he could not leave the farm. Frost nonetheless was able to secure a $300 grant from the National Academy of Sciences. This was enough to provide Mellish's room and board for a six-month stay and left enough for Mellish to hire a hand to do the farm chores. Mellish's stay was later extended to thirteen months. With the title of "Volunteer Research Assistant", he was hired to search for comets, but had use of the 12- and 40-inch refractors when they were not being used by other staff members.

After his sojourn was over, Mellish took over the directorship of Elmer Harrold's well-equipped private observatory at Leetonia, Ohio, but the poor conditions there caused by smoke from factories was a constant problem and in 1920 Harrold sold the observatory. It is recorded that Frost would have liked Mellish to return to Yerkes but no funds were available. Mellish had a growing family to support and turned to telescope making. He was evidently held in high esteem by the astronomical community. There is a story in the Mellish family that Dr. Anderson, who was in charge of the 200-inch project, invited Mellish to join the staff there to work on it. This story is evidently correct, but Mellish turned the offer down. He stated in a letter to Leight dated February 1, 1935, "Sometimes I feel like joining with Cal Tec [*sic*] but it would tie me down too much." He preferred being his own boss.

John Westfall has provided a Mars ephemeris for November 13, 1915, the date of Mellish's crater observations, which shows, according to Westfall, that at the time when Mellish observed both the Valles Marineris complex and the Nereidum Montes would have had a low sun angle. The former feature may well have been the "cracks" in the surface that Mellish reported seeing, and the latter the "mountain peaks" that he described.

Donald Parker's ephemeris supports Westfall's.

Sheehan admits that Mellish's descriptions of Barnard's drawings are correct. Also, Mellish's descriptions in his letters to Leight tally with the Martian markings that would have been visible on the morning of November 13, 1915.

I have performed experiments with low-power opera glasses and field glasses on the Moon. One can start to see lunar craters using a 2.3× opera glass, and a 4× field glass makes them obvious at any phase. Mellish's magnification of 1100× with the 40-inch refractor would be equivalent to seeing the Moon with about 4.5× in a field glass. Galileo's best telescopes, we are told in H.C. King's *History of the Telescope*, were capable of resolving 10-15 arc-seconds. With these very poor instruments, Galileo discovered the lunar craters; something a pair of modern opera glasses can reveal. However, Sheehan, McKim, and their associates, based on inference piled upon conjecture, would have us believe that Mellish could not see craters on Mars with what remains the world's most powerful refractor, denying Mellish's own words in the process.

It is always safe to attack someone's observations after they are deceased and not able to defend them. Sheehan and McKim ignore evidence in Mellish's favor and go on to present what can only be called incomplete research. Unless they are prepared to come out and call Mellish a liar about the observations, I suggest that his words be taken at face value; and at the same time I call upon those with adequate apertures to attempt to duplicate Mellish's feat in November, 1994, when the conditions for observing Mars will be similar. *[See below. Ed.]*

Also, Sheehan's book *Planets and Perception*, which he referred to in his letter, has met with only a lukewarm response by his peers; see for example its review by Andrew Young in the September, 1989, *Sky & Telescope*. The book is particularly deficient on the subject of optics, and its prospective readers should also refer to R.L. Gregory's *Eye and Brain, The Psychology of Seeing* (1966) and M. Luckiesha's *Visual Illusions* (1965).

Let me point out here that my criticisms in this article are not to be construed as a personal attack on either McKim or Sheehan; I have occasionally corresponded with the latter. We have a situation in which two schools of interpretation are open and, perhaps significantly, neither McKim nor Sheehan is in the possession of various relevant Mellish material that I have. I for one believe that Mellish's words in his correspondence can be taken at face value; people usually mean what they say, especially in personal correspondence. I also believe that my rejoinders effectively demonstrate that McKim, Sheehan, and their associates are "grasping at straws" in their attempts to discredit the Mellish observations. I leave it to the readership as to who has presented his case more effectively.

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Note by Editor.

This contribution by Mr. Gordon is controversial; but given its length, illustrations, and references, it deserves to be treated as a separate article rather than confined to our letters column.

Note that this article points out that this November we have an opportunity to confirm or disprove John Mellish's Mars observation of 1915 NOV 13 at Yerkes Observatory. Assuming that he observed at 8 A.M. local civil time (CST; 14h 00m UT, 1h 18m after sunrise), Mars' visibility parameters would have been:

Apparent Diameter = 7".6
Fraction Illuminated = 0.89
Solar Elongation = 092°W

Similar data for November, 1994 are:

1994 Date 0h UT	Apparent Diameter	Fraction Illuminated	Solar Elongation
Nov 01	7".0	0.89	084°W
05	7".1	0.89	086°W
09	7".3	0.89	088°W
13	7".5	0.89	090°W
17	7".7	0.89	093°W
21	7".9	0.90	095°W
25	8".2	0.90	098°W
29	8".4	0.90	100°W

The closest approach to Mellish's conditions comes on 1994 NOV 15 (apparent diameter 7".6, phase 0.89, and solar elongation 092°W), but conditions will be close throughout the month. (This illustrates the well known synchronism of 42 Mars years to 79 Earth years.)

COMING SOLAR-SYSTEM EVENTS: OCTOBER - DECEMBER, 1994

WHAT TO LOOK FOR

In this period, besides the bright planets, there is an opportunity to view a total solar eclipse, a penumbral lunar eclipse, occultations of Jupiter and Spica by the Moon, and several comets and minor planets predicted to be bright enough to spot in small telescopes.

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 1994 edition of the *A.L.P.O. Solar System Ephemeris*. (See p. 47 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 or PDT, 6 hours to CST or MDT, 5 hours to EST or CDT, and 4 hours to EDT. Note that this addition may well put you into the next UT day!

PLANETS

Mercury, because of its rapid motion, belongs to both the morning and evening sky. Two apparitions of Mercury occur in this period. The first is an evening one, favorable from the S Hemisphere, centered on SEP 26, the date of Greatest E Elongation (26°.1); the planet will be at least 15° from the Sun between AUG 30-OCT 13 with *dichotomy* (half-phase) *predicted* for OCT 01, 11h. Mercury's second apparition is a morning one that is favorable for N-Hemisphere observers. Greatest W Elongation is on NOV 06, with the planet then 18°.9 from the Sun, and at elongation 15° or greater from OCT 30-NOV 17. Dichotomy is forecast for NOV 04, 04h.

Venus is a morning object after its conjunction with the Sun on NOV 02. From then to the end of the year its elongation increases from 5° to 46°W of the Sun, it diameter decreases from 62" (" = arc-seconds) to 29", and its phase increases from 0.4 to 42 percent.

Mars is becoming brighter in the morning sky as it moves from Cancer to Leo, moving from 70°W of the Sun to 126°W, and brightening from magnitude +1.0 to -0.4. Its disk will grow from 5".9 to 11".0 during the same period, allowing detailed visual, photographic, and CCD observations to commence. (In mid-November, Mars will present an aspect very similar to that seen in 1916; see pp. 33-36.)

Jupiter is invisible for most of the period, being too near the Sun in our sky; it reaches conjunction on NOV 17. By late November, about the time the Giant Planet crosses from Libra to Scorpius, it will high enough in the predawn sky for observing to begin again to determine what will have transpired with the Comet Shoemaker-Levy 9 impact spots.

Saturn, in the evening sky, is certainly the most convenient planet to observe. During our period, the planet is visible in Aquarius after dusk, with its solar elongation decreasing from 149°E to 58°E. The Ringed Planet's magnitude dims from +0.6 to +1.0, while the disk's equatorial diameter drops from 19" to 16". Several equatorial white spots have recently been reported on the Globe, and should be followed, and their central-meridian transits timed, whenever possible. The tilt of the Rings to our line of sight will vary between 7°.0 and 8°.1, making them appear elongated in a ratio of 7-8 to 1.

The eclipses of the 10th-magnitude satellites **Tethys** and **Dione** continue, while those of 9th-magnitude **Rhea** commence. The times of disappearance and reappearance for eclipses of these three satellites are given in *Tables 1 -3* (below and p.38).

We thank Brian Loader for the predictions above. Their times are given in terms of *T̲errestrial D̲ynamic T̲ime*; subtract 1.0 minutes to obtain UT. The bright satellite, Titan, will follow suit as the Sun and the Earth approach Saturn's Ring plane, crossing it in 1995.

Table 1. Eclipses of Tethys by Saturn, 1994 OCT-DEC.

(Disappearance TDT followed by reappearance TDT; disappearances occur behind Saturn's limb; reappearances lie between 0.27-0.50 Saturnian equatorial radii to the celestial E of Saturn's limb.)

OCT 01	15 00.3-17 34.5
OCT 03	12 19.2-14 53.6
OCT 05	09 38.1-12 12.7
OCT 07	06 56.9-09 31.8
OCT 09	04 15.8-06 50.9
OCT 11	01 34.8-04 10.0
OCT 12-13	22 53.7-01 29.2
OCT 14	20 12.6-22 48.3
OCT 16	17 31.5-20 07.4
OCT 18	14 50.5-17 26.6
OCT 20	12 09.4-14 45.7
OCT 22	09 28.4-12 04.9
OCT 24	06 47.3-09 24.0
OCT 26	04 06.3-06 43.2
OCT 28	01 25.3-04 02.4
OCT 29-30	22 44.2-01 21.5
OCT 31	20 03.2-22 40.7
NOV 02	17 22.2-19 59.9
NOV 04	14 41.2-17 19.1
NOV 06	12 00.2-14 38.3
NOV 08	09 19.2-11 57.4
NOV 10	06 38.2-09 16.6
NOV 12	03 57.2-06 35.8
NOV 14	01 16.2-03 55.0
NOV 15-16	22 35.2-01 14.2
NOV 17	19 54.2-22 33.4
NOV 19	17 13.2-19 52.6
NOV 21	14 32.3-17 11.8
NOV 23	11 51.3-14 31.0
NOV 25	09 10.3-11 50.2
NOV 27	06 29.3-09 09.4
NOV 29	03 48.3-06 28.6
DEC 01	01 07.4-03 47.8
DEC 02-03	22 26.4-01 07.0
DEC 04	19 45.4-22 26.1
DEC 06	17 04.4-19 45.3
DEC 08	14 23.5-17 04.5
DEC 10	11 42.5-14 23.7
DEC 12	09 01.5-11 42.9
DEC 14	06 20.5-09 02.1
DEC 16	03 39.5-06 21.2
DEC 18	00 58.6-03 40.4
DEC 19-20	22 17.6-00 59.6
DEC 21	19 36.6-22 18.8
DEC 23	16 55.6-19 37.9
DEC 25	14 14.6-16 57.1
DEC 27	11 33.6-14 16.2
DEC 29	08 52.6-11 35.4
DEC 31	06 11.6-08 54.5

Uranus and **Neptune** both remain in Sagittarius. Uranus' magnitude is +5.7 - +5.9, while Neptune's is +7.9 - +8.0. By December both are too near the Sun to be observed.

Table 2. Eclipses of Dione by Saturn, 1994 OCT - DEC

(Disappearance TDT followed by reappearance TDT; disappearances occur behind Saturn's limb from NOV 24-DEC 30; reappearances lie between 0.32-0.63 Saturnian equatorial radii to the celestial E of Saturn's limb.)

OCT 01	04 39.9-06 53.0	NOV 16	17 31.2-20 00.5
OCT 03-04	22 21.5-00 35.7	NOV 19	11 13.2-13 43.3
OCT 06	16 03.3-18 18.5	NOV 22	04 55.2-07 26.2
OCT 09	09 45.0-12 01.3	NOV 24-25	22 37.2-01 09.0
OCT 12	03 26.8-05 44.0	NOV 27	16 19.2-18 51.8
OCT 14	21 08.5-23 26.8	NOV 30	10 01.2-12 34.6
OCT 17	14 50.4-17 09.6	DEC 03	03 43.2-06 17.4
OCT 20	08 32.2-10 52.4	DEC 05-06	21 25.2-00 00.2
OCT 23	02 14.0-04 35.2	DEC 08	15 07.2-17 43.0
OCT 25	19 55.9-22 18.0	DEC 11	08 49.2-11 25.7
OCT 28	13 37.7-16 00.8	DEC 14	02 31.2-05 08.5
OCT 31	07 19.6-09 43.6	DEC 16	20 13.2-22 51.3
NOV 03	01 01.5-03 26.4	DEC 19	13 55.2-16 34.0
NOV 05	18 43.4-21 09.3	DEC 22	07 37.2-10 16.7
NOV 08	12 25.4-14 52.1	DEC 25	01 19.2-03 59.5
NOV 11	06 07.3-08 34.9	DEC 27	19 01.2-21 42.2
NOV 13-14	23 49.3-02 17.7	DEC 30	12 43.2-15 24.9

Table 3. Eclipses of Rhea by Saturn, 1994 OCT-DEC.

(Disappearance TDT followed by reappearance TDT.)

OCT 15	04 05.8-04 30.0	NOV 24	19 37.8-21 24.4
OCT 19	16 24.5-17 07.3	NOV 29	08 03.4-09 55.2
OCT 24	04 46.2-05 41.7	DEC 03	20 29.1-22 25.8
OCT 28	17 09.3-18 14.9	DEC 08	08 55.0-10 56.3
NOV 02	05 33.1-06 47.3	DEC 12	21 21.0-23 26.7
NOV 06	17 57.4-19 19.3	DEC 17	09 47.1-11 57.0
NOV 11	06 22.1-07 50.9	DEC 21-22	22 13.2-00 27.2
NOV 15	18 47.1-20 22.3	DEC 26	10 39.4-12 57.3
NOV 20	07 12.3-08 53.4	DEC 30-31	23 05.7-01 27.2

Pluto, in Libra, is not observable, reaching conjunction with the Sun on NOV 20.

MINOR PLANETS

In late December, 1994 and early January, 1995 the minor planet **2062 Aten** passes near us, approaching to 0.127 AU on 1995 JAN 12 [1 AU is the mean distance of the Earth from the Sun; 149.597,870 km]. At its closest, the asteroid's apparent motion will be about 7" per *minute* of time, so its movement against the star background will be obvious through a telescope. An ephemeris of its 1994-95 passage is given in *Table 4* (p. 39)

No less than six of the brighter **minor planets** reach opposition in late 1994. Their 10-day ephemerides are given in the 1994 edition of the *A.L.P.O. Solar System Ephemeris*, their opposition data are given here:

	Opposition Data		
Minor Planet	1994 Date	Stellar Magnitude	Declination& Constellation
2 Pallas	NOV 19.7	+8.1	29°S For
40 Harmonia	NOV 23.9	+9.4	16°N Tau
8 Flora	DEC 05.8	+8.0	15°N Ori
5 Astraea	DEC 15.8	+9.4	15°N Ori
4 Vesta	DEC 25.0	+6.3	21°N Gem
15 Eunomia	DEC 28.7	+8.1	29°N Aur

Three other minor planets, **1 Ceres, 20 Massalia**, and **216 Kleopatria**, will fall in the 7th-10th magnitude range during this period.

THE MOON

For this period the schedule for the Moon's **phases** (1995 in italics) is:

New Moon	First Quarter	Full Moon	Last Quarter
OCT 05.2	OCT 11.8	OCT 19.5	OCT 27.7
NOV 03.6	NOV 10.3	**NOV 18.3**	NOV 26.3
DEC 03.0	DEC 09.9	DEC 18.1	DEC 25.8
JAN 01.5	*JAN 08.7*	*JAN 16.9*	*JAN 24.2*

The lunations listed are Numbers 888-891 in Brown's series. The dates in bold face indicate a total eclipse of the Sun and a penumbral lunar eclipse, both described below.

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 (with 1995 in italics):

North	West	South	East
OCT 01	OCT 01	OCT 14	OCT 14
OCT 29	OCT 29	NOV 10	NOV 10
NOV 25	NOV 26	DEC 07	DEC 09
DEC 22	DEC 24	*JAN 04*	*JAN 06*

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 latitude and longitude librations are well-synchronized with each other. The NW limb can be seen well on OCT 01-03, OCT 26-31, NOV 23-28, and DEC 20-26. The SE limb is well exposed on OCT 11-17, NOV 07-13, and DEC 05-11.

ECLIPSES

Total Solar Eclipse, 1994 NOV 03.—The track of totality crosses parts of the South American countries of Peru, Bolivia, Chile, Paraguay, Brazil, and Argentina as well as the South Atlantic Ocean. A partial solar eclipse will be visible throughout South and Central America, as well as S Mexico, the S Caribbean, and S Africa.

The maximum duration of totality, 4m 23s, occurs in the South Atlantic. In the vicinity of the eclipsed Sun, observers may see the planets Mercury (018°W, Mag. -0.3), Venus (005°W, -4.0), and Jupiter (011°E, -1.7).

Penumbral Lunar Eclipse, 1994 NOV 18.—At mid-eclipse, 90.8 percent of the Moon's diameter will lie within the Earth's penumbral shadow, producing obvious shading on the lunar N limb. Note that Lunar Transient Phenomena have been reported within the penumbral shadow for some eclipses. This will also be an opportunity, just before or after the eclipse, to observe the Moon at an unusually small phase angle. Because there will be minimal shadow interference from lunar features, this is a good time to study the actual albedo of the Moon's surface.

Table 4. Earth Approach of Minor Planet 2062 Aten.

Date	Coordinates (2000.0)			Distance from		Phase	Solar
00h UT	R.A.	Decl.	Mv	Sun	Earth	Angle	Elong.
1994	h m	° '	+	AU	AU	°	°
DEC 26	07 31.93	- 06 01.2	14.5	1.128	0.171	29.6	145.5
DEC 28	07 25.57	- 03 33.4	14.3	1.126	0.162	26.3	149.5
DEC 30	07 18.39	- 00 45.0	14.1	1.124	0.154	22.7	153.9
1995							
JAN 01	07 10.36	+ 02 25.0	13.8	1.121	0.147	18.8	158.4
JAN 03	07 01.43	+ 05 56.6	13.6	1.118	0.140	14.9	162.9
JAN 05	06 51.59	+ 09 48.5	13.4	1.115	0.135	11.5	166.9
JAN 07	06 40.83	+ 13 57.9	13.3	1.112	0.131	9.7	169.0
JAN 09	06 29.17	+ 18 19.9	13.3	1.109	0.128	11.0	167.6
JAN 11	06 16.64	+ 22 48.3	13.4	1.106	0.127	14.7	163.5
JAN 13	06 03.33	+ 27 15.9	13.5	1.102	0.127	19.5	158.0
JAN 15	05 49.35	+ 31 35.4	13.7	1.099	0.128	24.7	152.2
JAN 17	05 34.82	+ 35 40.5	13.9	1.095	0.131	30.0	146.2
JAN 19	05 19.91	+ 39 26.5	14.1	1.091	0.134	35.0	140.5
JAN 21	05 04.81	+ 42 50.6	14.3	1.087	0.139	39.8	135.0
JAN 23	04 49.72	+ 45 51.8	14.5	1.083	0.145	44.3	129.8
JAN 25	04 34.81	+ 48 30.5	14.7	1.078	0.151	48.3	125.1

This event will be visible in its entirety throughout North and Central America, as well as all but E South America. The remainder of South America, Europe, and N and W Africa can see the end of the eclipse; while Japan, NE Asia, and E Australasia can see the beginning. First Penumbral Contact is predicted for 04h 25.7m, Mid-Eclipse for 06h 43.9m, and Last Penumbral Contact for 09h 02.1m.

OCCULTATIONS

Just one minor planet is predicted to occult a star in this period. On OCT 23.97, **654 Zelinda**, at magnitude +12.7, will pass in front of a +7.81-magnitude star as seen from S Africa.

The Moon will occult **Jupiter** three times: Nov 04, 08h, as seen from central Africa, the Indian Ocean, and Australia except the E coast; DEC 02, 05h, from SW, S, and SE Asia and Indonesia; and on DEC 30, 01h, from Japan, Korea, N China, and E Siberia.

The bright star Spica (magnitude +1.0) will also be occulted three times by the Moon: NOV 02, 10h from central Africa; NOV 29, 21h, from E China and S Japan; DEC 27, 06h, from N and central Africa and S India.

COMETS

The column by Don E. Machholz, "Comet Corner," on pp. 19-20 and the *A.L.P.O. Solar System Ephemeris: 1994* list three known comets that are predicted to be 12th magnitude or brighter during at least part of this period. Of these, **Comet Borrelly (1994L)** may be as bright as 7th magnitude in October-November; it should be readily visible in small telescopes, or even in binoculars from dark sites.

We also have two new comet discoveries by Donald Machholz. The first, Periodic Comet Machholz 2 (1994r) is visible at 10th magnitude before dawn. The newest, found on OCT 08, is 12th magnitude, and currently in Ursa Major.

METEOR SHOWERS

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

A full Moon will spoil the best dates for watching the **Orionid** shower. As the Moon reaches its last quarter phase on October 27, remnants from the Orionids may still be observed.

The two **Taurid** radiants will gain in strength at the start of November, whose first two weeks are ideal this year to watch the Taurids. The southern radiant will be the chief producer of meteors in the first week of the month, while the northern radiant will reach maximum in the second week. Taurid meteors are visible all night but are best seen near midnight when Taurus is high in the sky. Taurid rates may be low, but both radiants produce many bright fireballs.

The **Leonids** are spoiled by a full Moon this year, but brighter shower members will be visible despite the moonlight. Watch for enhanced activity this year, particularly between 3 and 6 AM on the mornings of November 17th and 18th. Face eastward toward the "sickle" of Leo with the bright Moon at your back and out of your field of view.

The **Geminids** peak only four days before December's Full Moon. This would be no problem for most showers, which peak just before dawn. Unfortunately, as the best Geminid rates are between 1 and 2 AM, so average rates will be reduced about 25 percent due to moonlight. The rates on December 13th may equal or exceed those of the 14th because the Moon will set slightly earlier on the 13th. Geminids can appear anywhere in the sky, so keep the Moon out of your line of sight.

The **Ursids** peak on the morning of December 22, with a bright waning gibbous Moon in the sky. You can successfully observe under these conditions, but the hourly rate will be reduced 50 percent or more due to the moonlight. I suggest you observe the Ursids only on the morning of the 22nd; their rates are low, even in dark skies, away from the night of maximum.

Finally, conditions are ideal for observations of the 1995 **Quadrantids**. Most of their activity will occur on the morning of January 3rd. The slender crescent Moon will be in the evening sky and thus will not interfere because activity from this radiant is limited to the last few hours before dawn. You will not see Quadrantids before 2 AM. Also, the Eastern Hemisphere will be favored for this year's shower, although such predictions are not always accurate. At best, this shower can produce over 100 meteors per hour, including numerous fireballs.

MINUTES OF THE 1994 A.L.P.O. BOARD MEETING, GREENVILLE, SOUTH CAROLINA, JUNE 16, 1994

Minutes taken by: Elizabeth W. Westfall, A.L.P.O. Board Secretary

The Annual Board Meeting of the Association of Lunar and Planetary Observers for 1994 was called to order on June 16th at 4:05 PM EDT. Six of the seven Board members were present, establishing a quorum: Phillip Budine, Harry Jamieson, José Olivarez, Donald Parker, Elizabeth Westfall, and John Westfall.

OLD BUSINESS

1. Financial Report.—The total balance in the two A.L.P.O. bank accounts (Heber Springs and San Francisco) was $ 8570.11. The amount owed to the Executive Director (chiefly for postage and photocopying) was $105.86.

The Treasurer reported on Calendar Year 1993 income as follows: Membership Dues (Standard), $6098.00; Gifts (including Sponsorships and Sustaining Members), $667.90; Ephemeris Sales (through Treasurer only), $41.00; Membership Directory Sales, $151.00; Total $6957.90.

Some of the Heber Springs funds are in an interest-bearing account.

For section donations to be tax-deductible, the checks must go through the A.L.P.O. account, as these activities must be reported on our annual tax return.

2. Publications.—The *Journal* had 598 subscribers for the April, 1994, issue; 79 percent in the United States and 21 percent elsewhere. In the last year, we published four quarterly issues: Vol. 37, No. 1 (July, 1993) through Vol. 37, No. 4 (April, 1994). Each issue contained 48 pages, with the exception of 52 pages for Vol. 37, No.4.

The ***Solar System Ephemeris*** **(1994 edition)** had 100 copies distributed to date; with 28 complimentary; the rest were sold at $ 7.00 domestic or $ 9.50 foreign. The 1994 edition had 139 pages; 125 copies were printed at a cost of $704.99. Mark Davis is continuing generously to handle production and distribution and the Computing Section will now supply much of the contents.

3. Foreign Membership Fund.—Last year, at our Las Cruces meeting, $40.00 was contributed, bringing its balance to $60.00.

4. International Solar System Observers Fund (ISSOF).—The current balance is $25.77. The ISSOF is administered by Paul H. Bock, Jr. There has been no activity for 18 months with no donations of funds or materials. Four requests were received during this period, but not acted upon; two from India, one from Poland, and one from Romania. Five items remain on inventory; one 60-mm refractor tube assembly, one 60-mm refractor objective, two orthoscopic eyepieces (18mm & 25mm), and one binocular tripod adapter.

Equipment has been difficult to send overseas and to match to needs. We suggest that interested contributors sell excess equipment and donate the proceeds to this fund.

5. Membership Trends. —Recent A.L.P.O. Membership trends are as follows.

Issue	Date	U.S.A	Abroad	Total
36, 4	3/93	468	126	594
37, 1	7/93	475	125	600
37, 2	10/93	467	123	590
37, 3	2/94	474	125	599
37, 4	4/94	470	128	598
13-month Change		+2	+2	+4

A discussion on methods of increasing and holding members covered the following points: a. Place announcements or news items to promote visibility of A.L.P.O. Ken Poshedly is in Public Relations and offered to help. b. Develop contacts and "advertise" with local astronomy clubs. c. Promote A.L.P.O. at the large star parties. d. Develop an A.L.P.O. "prospectus" or membership brochure. Ken Poshedly also offered to help. e. Provide membership cards to all members to promote A.L.P.O. Jeff Beish thinks this would increase sense of membership. f. Phillip Budine is coordinating Jupiter impact book and reports; he has sent out many letters to answer questions, is giving talks to astronomy and public groups, and feels this has given A.L.P.O. good publicity. g. Harry Jamieson reported a study that showed that new members stay on average one year. We need to find ways to keep them. h. Ted Stryk said that A.L.P.O. is viewed as too advanced for beginners. i. The Journal should have more articles on how to use the kind of instrument you have, rather than so many "high-tech" articles. Add a column "observations." j. José Olivarez and Mike Mattei suggested a "circular" with news notes, and Solar System events from section heads.

A decision was made to publish a **Trial Newsletter**. After hearing all of the above comments, the Board voted to try a newsletter for one year, to be published every other month, and distributed as part of the membership fee to all domestic A.L.P.O. members. After one year, the cost of and interest in the newsletter will be evaluated and its continuation will be discussed. Jeff Beish volunteered to publish the newsletter, called *Through the Telescope*.

6. Reports from Section Recorders Attending Upon Section Activities for 1993-94 and Plans for 1994-95. These reports were not given due to lack of time.

NEW BUSINESS

1. Confirmation of Board of Directors. The current Board of Directors were approved for another year. It was then approved to increase the number of Directors from seven to eight. Julius Benton was nominated for Board membership. This was not approved. [A new procedure for nominations is described below.]

2. 1995 Meeting.—In our 1992 Meeting we decided to meet in Wichita, Kansas, for 1995. Because of the success of the past two A.L.P.O. meetings, the meeting will be extended from 3 to 4 days, and the dates will be sometime between July 21-August 12. [Now decided on as August 2-5.]

3. 1996 Meeting.—If we wish to meet with another group in 1996, such as the A.S.P. or A.L., we should decide now so as to inform them of our plans, so that they can decide at their 1995 meeting whether to include us at their 1996 meeting. [We subsequently have received an invitation for the A.L. to meet with them at Rockford, Illinois, in 1996, as well as an invitation to meet with them in the Philadelphia area for 1997, which will be the 50th Anniversary of the A.L. and the A.L.P.O.]

4. Section and Staff Confirmations.—The following Section and staffing actions were taken: The Computing section remains provisional and its Recorders, David D. Weier and Bob Manske, remain acting. The Lunar & Planetary Training Program and its Coordinators, Timothy J. Robertson and Matthew Will, become permanent. David O. Darling becomes permanent Recorder of the Lunar Transient Phenomena program. The Mercury/Venus Transit Section and its Recorder, John E. Westfall, become permanent. In the Mars Section, Carlos Hernandez is confirmed as a full Recorder and Harry Cralle is removed as a Recorder.

5. Listing Section Publications in *J.A.L.P.O.* —Suggested by Derald Nye. Approved by the Board, with the understanding that it is each Section's responsibility to send the information to the Journal editor.

6. Granting of Regular Non-Profit Status.—The A.L.P.O has received final approval as a nonprofit organization.

7. Announcement of Change in Executive Directorship.—John Westfall plans to resign the posts of A.L.P.O. Executive Director and Chair of the Board of Directors, effective at the end of our 1995 Meeting. He wishes to retain his Editorship, Board membership, and Section Recorderships, and to continue as the A.L.P.O. representative on the Hubble Space Telescope Amateur Working Group. He recommended that the Directorship rotate among the members of the Board, as they have the experience of the organization. The bylaws will need to be modified for this change.

This future item is placed on the agenda now to allow discussion of the duties of the Executive Director and of arrangements to select a new Executive Director.

The meeting was adjourned at 6 pm.

* * *

Members of the Board met again on June 17 to discuss the role, duties, and selection of the next Executive Director. The same Board members were present as on the previous day. They approved the following measures:

1. The Executive Directorship will rotate alphabetically by last name. Elizabeth Westfall will not take part in the rotation; she will retain her position as corporate Secretary and executive assistant, and Board membership.
2. The Executive Director shall also be Chair of the Board of Directors.
3. Staff actions must be made by and approved by the Board, not by the Executive Director alone.
4. A person is Associate Director for 2 years, and then Executive Director for 2 years (a 4-year commitment).
5. The next person "in rotation" has an option to pass with cause.
6. The change to the next Executive Director becomes effective at the conclusion of the Annual Board Meeting. [i.e, Phillip Budine becomes Executive Director from summer 1995 to summer 1997. Harry Jamieson becomes Associate Director from summer 1995 to summer 1997 and then moves to Executive Director from summer 1997 to summer 1999.]
7. Executive Director duties include: Management of staff; selection of Acting Recorders; management and oversight of A.L.P.O. programs; take short-term staff actions; represent the A.L.P.O.; arrange annual meetings; handle all correspondence (A.L.P.O. will reimburse the Executive Director for mail and correspondence expenses).
8. The A.L.P.O. will maintain the current mailbox address for continuity. Mail will be forwarded to the Executive Director.
9. The Executive Director will delegate or consult with the Associate Director to familiarize himself or herself with the issues. An important new role of the Associate Director is to develop a fund-raising program.
10. The Board approved the following method of selecting new Board members: a. Board vacancies will be announced in A.L.P.O. publications and interested persons are invited to apply. b. A candidate should submit two letters of reference from A.L.P.O. members. c. A candidate should submit a letter on why he or she wants to be on the Board. d. The Board will vote at the next annual meeting. The Board can approve enough to fill the vacancies, or it can chose none. The considerations are length of time in A.L.P.O., reasons for joining the Board, references, ability to attend annual meetings, and ability to manage an organization.

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 Mr. Westfall,

This letter is in response to Daniel Louderback's letter of November 9, 1993.

It seems curious to me that people still consider the canals of Mars to be any more than tricks of the eye. There is sufficient evidence indicating that they are mere products of our brain's attempts to connect things.

E.M. Antoniadi proved this in his 1916 experiment, in which he had his students draw a canal-free globe of Mars from different distances. Sure enough, canal-like features appeared in the drawings made by the students near the back of the class.

I read of this experiment with great interest, I decided I would repeat it using a class composed of High-School freshmen like myself, but who knew nothing of Mars. I purposely did not tell them what to look for, and indeed, some Lowellian lines showed up. Many of these linear features correspond to more or less circular features on the globe.

In light of this evidence alone, I find it appalling that people could believe Lowell's canal network has any basis for reality.

I am writing this [second letter] in response to the letter by Jeff Beish of March 16th.

I believe it is very possible that Chick Capen saw Neptune's Great Dark Spot, partially due to a recent experience of mine. On August 30, 1994, with Mars a mere 5 arc-seconds across, I was examining a region of Mars looking for features such as Chaos, Styx, Hyblaeus, Eunostos, and Cerberus, which form a circle around Elysium. Only Cerberus was visible, but there was a dark spot below it within the "ring" of the features listed above. Comparing my drawings to a map, I can only conclude that this feature was Elysium Mons, the most prominent Martian volcano outside Tharsis.

At the time, Mars showed a gibbous disk, with Elysium Mons close enough to the terminator to cast a shadow. It probably aided my sighting, and also probably explains why it seemed somewhat elongated.

When Mars comes to opposition this Winter, I see no reason why observers wouldn't have a chance at seeing Hecates and Albor Tholus, Elysium's other large volcanos.

I have reached the belief that observers who reject notions such as that Chick Capen saw Neptune's Great Dark Spot live in areas where they have never experienced a moment of truly good seeing.

Ted Stryk

300 Meadow Drive
Bristol, VA 24201

April 28, 1994 and September 1,1994
(two letters combined here)

Dear Editor, Strolling Astronomer,

I thought I would drop you a line concerning the "Our Readers Speak" column. I have been enjoying the ongoing dialog between Rodger Gordon and Daniel Louderback, and the few others who have throw in their opinions.

Such dialogs have been the meat of visual observing in the past and I for one am glad to find them alive today. Such things give readers all sorts of historical information and bring insights to the act of visual observing.

I hope readers will continue to contribute such letters. As in all scientific subjects, lively debates are a sign of health. I find it encouraging for visual observers and am inspired to find such material produced within the ranks of the A.L.P.O.

Michael E Sweetman

Sky Crest Observatory, 2951 W. Katapa Trail
Tucson, AZ 85741

May 25,1994

Dear John:

I am attempting with this letter to answer the two most vocal critics to my letter debating Rodger Gordon on the Martian "canals." The Editor has laid down new rules on the length of letters published in "Our Readers Speak" section [see *our February, 1994, issue, p. 133*], so I will have to try to shorten this and still get in all the important points I want to say!

First off, I will only touch on the Mars canal controversy this time because I think I said about everything there was to say in my last letter. However, I want to correct something I said in that last letter! I said when I was comparing the Mars "canals" with natural-occuring lines on Mercury, which has ray craters, or Jupiter's largest moon Ganymede, that has fault lines, I did not use the best example. The best example, I think, is Jupiter's moon Europa. Its strange pattern of cracks in its icy surface, that resembles a "wrapped ball of string," are probably the closest markings to Mars' canals of any body in the Solar System. However, if you take a Voyager image of Europa and stand back from it so it looks about the size of Mars seen through a moderate-size telescope (8 to 12-1/2 inches aperture), hardly any of the lines or cracks on this moon form geometric patterns like Mars' "canals" do. They just meander all over the place! So what does this experiment say about Karl Fabian's contrast/illusion theory then? Were his idea correct, you would expect to see this illusion on other Solar-System bodies that had similar markings.

I think that Mr. Fabian's comments at the start of his letter about the real mystery of the "canals," being about "who can see them and who can't," does not apply anymore. Both he and Robert Young completely ignored one point that I tried to bring out in my letter; that the real mystery is no longer who can see them and who can't, but rather why are they now also appearing on CCD images that amateur astronomers are now taking through their telescopes? It is easy to see how the old type of film that Lowell used may have shown defects, but now with the new CCD cameras there has to be some other explanation!

I enjoyed Mr. Young's description of how he thought he saw the entire canal system of Mars during the planet's closest approach to Earth in 1988. He did not say if he saw this "illusion," as he put it, during a moment of very fine seeing conditions or very poor conditions, but I assume that it would be the former, since we are dealing here with the observation of very fine detail through a telescope. Also, since he said he could not hold the detail very long, it must have been an extraordinary moment of fine seeing! Rodger Gordon, in one of his letters to me, informed me that he once had a similar experience, but Mars was not that close to Earth when he saw the network, and he was using only an 8-inch reflector.

Because I live in a location where seeing is almost always poor at best, If have only seen isolated "canals" and a few times double ones like the ones that sometimes form off the northern tip of Syrtis Major. So I unfortunately have not yet been blessed with that vision of the whole canal network, but would certainly like to see it sometime!

Now I would like to answer Mr. Young's criticism of my support for Hoagland and his "Face on Mars" theory. (I also received flak from the Editor on this.)

Mr. Young mentioned the *Skeptical Inquirer's* comments on the Mars face. This newsletter is put out by the Committee for Claims Against the Paranormal, and the name "Skeptical Inquirer" means just what it says; they are highly skeptical about nearly everything that is unnatural in their book.

Concerning the Mars face, I read both of Hoagland's books, *The Face on Mars* and *The Monuments of Mars.* In the latter book he told about all the professional computer experts and photographic experts that worked with him in interpreting the image, and which were very high-calibre people. Hoagland did say that the Mariner 9 and Viking Orbiter images of the face were at the very limit of resolution needed to resolve the issue. Here is where the higher resolution of the Mars Observer spacecraft's camera could have solved some things, were it not for that spacecraft's unfortunate, mysterious, and untimely demise!

Now about the pyramid structures seen on Mars in the Viking Orbiter images. The best examples of these were the three-sides pyramids imaged on the Elysium plain of Mars, and it is interesting to note that they stand out on this flat plain where there are no other hills or mountains! Carl Sagan, even though he is one of the top scientists working on NASA's new SETI program that is searching for evidence of extraterrestrial radio signals, is every skeptical about the possibilities of eventual discovering evidence for extraterrestrial intelligent life. When it comes to that, he demands absolute proof, whether it be extraterrestrial radio signals or UFO's! However, I quote what he said about the pyramids in the Elysium plain of Mars, imaged by the Viking Orbiters, when he was talking on his "Cosmos" television series: "When we get a robot rover on Mars we will make the final cautious approach to these old formations. We cannot yet say for sure whether these structures are artificial or not."

Now in closing I have a little question-and-anwer quiz; Could anyone please tell me the exact size of the parachutes that lowered the Viking landers safely to Mars? My second question is what materials were used for the parachutes and shroud lines on the Russian Venera landers that landed on Venus? It must have been something that can stand high temperatures!

Daniel Louderback

Box 702
South Bend, WA 98586

June 7, 1994

John Westfall, Director, A.L.P.O.:

Regarding Karl Fabian's letter in *J.A.L.P.O.*, Vol. 37, No. 4, p.187, the following should be noted:

1. San Brown's 8 arc-minutes figure used in *All About Telescopes* was designed for rank beginners, not skilled observers. I was at Edmund's from 1967-69 and Brown, who worked out of his home in Marion, Ohio, told me this in a telephone conversation. Alcor and Mizar are 8 arc-minutes apart and easily separated by anyone with normal vision. Numerous experiments show 3-4 arc-minutes resolution for the eye at night; the naked-eye doubles ε_1 and ε_2 Lyrae at 3-1/2 arc-minutes separation are a case in point. J. Thompson's experiments in *Making Your Own Telescope* give similar results. Mellish was observing in *daylight*, when the eye's resolution is even better; 1-2 arc-minutes. Using a more realistic figure of 4 arc-minutes, the supposed 1200X falls to 600X, well below what Mellish used.
2. The figure of "twice Dawes' Limit" to make out the smallest lunar craters regardless of aperture used is one of those hoary old statements no one seems to have checked out. Probably it comes from the table in Wilkins and Moore's *The Moon* (1952). Actually, craters considerably below this figure can be seen as true craters; i.e., with depth and shadow down to near Dawes' Limit. I have verified this on a number of occasions using 3-1/2 to 4-inch apertures and *The Times Atlas of the Moon,* which gives miles and kilometers scales on each pages. The famed 200-inch [telescope] photograph of Clavius (found in Wilkins and Moore, p. 305) has a ground resolution of one mile, according to the Rand Corporation. One arc-second subtends 1 mile at a distance of 206,265 miles. At an average lunar distance of 239,000 miles, 1 mile is about 1.2 arc-seconds. I have personally verified every detail on this photograph, including the smallest craterlets, with these apertures. Another example is the crater Linné, 2.4 km in diameter (about 1-1/2 mi), which can be seen with depth under the right illumination with these apertures. Statements like "twice Dawes' Limit" appear to be reprinted *ad infinitum* without anyone checking them out.
3. At aphelic opposition, the Martian atmosphere is much clearer than at perihelic ones, so scattering would be much less of a problem. The red color of Mars doesn't hurt observations either.

Many older refractors used a B-F correction instead of C-F, which shifts the color correction toward the yellow-orange. James G. Baker, in his article "Planetary Telescopes" (*Applied Optics*, Vol. 2, No. 2, 1963), mentions how this would favor Mars observations. Clark objectives were shifted toward the red more than the more common Fraunhofer type. Eugene Cross examined the 40-in Yerkes refractor in the late 1970's, finding the *visible* chromatic aberration to be no greater than with his 6-in f/7 refractor. Cross is an optical engineer and commented on the older workers being aware of the benefits of this type of optical correction.

4. The contrast of Mars versus that of the Moon is more complicated than Fabian realizes. The Moon's contrast averages 0.2 (about the same as a low-contrast National Bureau of Standards test chart), but varies greatly with the lunar phase. One or two days after New, it is 0.1, at the quarters it rises to 0.3, and by Full reaches 0.6. Mars comes in at 0.2 contrast.

Using 2.3X Russian opera glasses, I've seen lunar craters along the terminator, both waxing and waning.

5. In recent years, Dawes' Limit has come under criticism as being too conservative. Dobbins, Parker, and Capen use a value of 4.4/D (D in inches) in *Observing and Photographing the Solar System.* Dallmeyer, inventor of the telephoto lens, derived 4.33/D from his experiments. Kingslake uses 4.0/D in one of his books on optical design, and the Sparrow Limit is also below Dawes'. It's time to stop citing Dawes' as a "limit"; it's an approximation only.

Critics of Mellish appear to overlook his statement about diaphragming to 40-in to 24-in, causing the craters to disappear. A change in resolution from 0.11 arc-seconds to 0.19 arc-seconds (using Dawes' formula) was enough to change the craters' appearance drastically.

Recently, Mike Anderer spoke with Clyde Tombaugh about Mellish. Tombaugh remembered Mellish as a man of great talent and a skilled observer. Unfortunately, when they met on several occasions, they discussed optics and not planetary topography. Tombaugh was also glad to hear of a crater to be named after Mellish.

It is not possible to provide more than circumstantial and anecdotal evidence in Mellish's favor without the recovery of copies of drawings he sent to others many years ago. Mellish's critics primarily rely on O'Meara's and Sheehan's negative observation of a few years back. But this is only *one* negative observation, and made with a disk diameter of only 6.2 arc-seconds, 22 percent smaller than Mellish had. [Also see Mr. Gordon's article on pp. 33-36 of this issue.] Mellish's statements and descriptions counter his critics most effectively and I believe Mellish's observations will be duplicated using similar apertures before long. At that time, his critics will have the "egg on their face" they so richly deserve.

Rodger W. Gordon

637 Jacobsburg Road
Nazareth, PA 18064

June 8, 1994

Dear Dr. John Westfall:

I am quite surprised that there have been no letters to *J.A.L.P.O.* describing the "Fourth Major Type of Planetary Telescope," the Tilted-Component Telescope (TCT). TCT receive their name from the fact that their mirrors are tilted so no mirror blocks or obstructs the 'scopes' light path. Thus secondary obstruction is not a factor with a TCT. The most common type of TCT's are the Schiefspieglers. The two most widely used Schiefspiegler (Schief) types are the Anastigmatic Schiefspieglers (two mirrors) or the Trischiefspieglers (three mirrors). In trying to adhere to *J.A.L.P.O.* letter guidelines, I'm forced to forgo a complete description of the Schiefs. Perhaps a more detailed optical description can appear in a future article.

I have observed through a variety of Schiefs including a 4.25-in f/27 and 6-in f/30 Anastigmatic Schiefs, as well as a 6-in f/30 and 10-in f/20 Trischiefs. Our club, the Vermont Astronomical Society, has a 10-in f/20 Buchroeder Trischiefspiegler for a club planetary 'scope. Here's the advantages of observing with Schiefs:

1. Perfect achromatic images; no false colors due to objective lenses.
2. Long focal length makes it easy to obtain high-power with normal focal-length eyepieces (long eye relief).
3. Excellent planetary resolution and contrast due to the Schief's long focal length (F.L.) and unobstructed light path.
4. The 'scopes' narrow cone of light works well with simple three- or four-element eyepieces. Less elements in eyepieces means more contrast and more money in your pocketbook.
5. Schiefs' longer F.L. tends to show less light-pollution effects than more common f-ratio (f/4 - f/6).
6. Coma, field curvature, and astigmatism are suppressed well in a Schief.
7. Schiefs work well on small, high surface-brightness Deep-Sky objects like planetary nebulae and globular clusters.
8. Schiefs are excellent double-star 'scopes.
9. Schiefs long F.L.'s are a boon for planetary photography.

Here's the list of the Schief's disadvantages:

1. Lack of low-power, wide-angle field of view.
2. Schiefs work poorly on large, low surface-brightness Deep-Sky objects such as galaxies and nebulae.
3. Schiefs cost more than Newtonians.
4. Due to their high-power use and longer tube lengths, Schiefs are a bit harder to mount sturdily.
5. Schiefs have very shallow curved mirrors; these are harder to make (homemade) than standard Newtonians of' the f/6 - f/8 variety.
6. Only a few commercial manufacturers make Schief optics.
7. Schiefs work poorly for Deep-Sky astrophotography.

I highly recommend Schiefs for visual planetary observations. I have seen a homemade 6-in f/30 Schief beat an 8-in f/10 SCT [Schmidt-Cassegrain telescope] in contrast and resolution of planetary details.

Most of the Schief's mounting problems can easily be overcome. A 6-in f/30 Anastigmatic

Schief's tube is approximately the same length as a 6-in f/15 refractor tube.

I wish to make a few additional comments:

A. In my 25 years of planetary observing I have never seen a SCT beat a good refractor, planetary Newtonian, or Schief in an exact aperture-to-aperture comparison of planetary images. The two major problems with commercial SCT's are their large central obstruction and a wide range of variance in optical quality of mass-produced telescopes.

B. I also believe that *J.A.L.P.O.* needs to establish an independent, straightforward Product Review Column or "Test Section." The two major astronomical magazines have become biased or "slanted" in their reviews of astronomical products. The magazine reviews are often "cast in favor" of the larger purchasers of advertising space. Think about it. If you were a profit-making astronomical magazine, would your review "shoot down" a product of a company which buys one to three pages of advertising space each month? I don't think the paid staff of these magazines would "bite the hand that feeds them." Also, product tests are done for only a very short period. There are no "long-term field tests" to see how well a product holds up. (Come to Vermont in the Wintertime and I'll show you some real field testing .)

I hope my letter has shed some light on the "Fourth Major Type of Planetary Telescope." I also hope that I've opened some eyes as to the need for an independent product-testing review which is free from the advertisers' paid bias. Thank You for your time.

Gary T. Nowak

38 Thasha Lane #L-I
Essex Jct., Vermont 05452-4517

June 21, 1994

ANNOUNCEMENTS

A.L.P.O. AFFAIRS

A.L.P.O. Board Decisions

(also see pp. 40-41)

A.L.P.O. Newsletter.—As a one-year experiment, the A.L.P.O. is providing each member residing in the United States with a bimonthly newsletter, titled *Through the Telescope*, and edited by Jeff Beish. This is provided without extra charge and in addition to our *Journal.* The newsletter publishes news notes and up-to-date information on Solar-System events. After one year of publication, the A.L.P.O. Board will decide if this innovation should be made permanent and possibly extended to foreign members as well.

Joining the A.L.P.O. Board of Directors.—The A.L.P.O. Board of Directors currently has seven members, but can be expanded to eight. Any A.L.P.O. member can apply for Board Membership by providing the Board Chair (John Westfall; address on inside back cover) with: a. A letter describing why he or she wishes to be on the Board. b. Two letters of reference from A.L.P.O. members. The Board will then consider your application at their next meeting.

1995 A.L.P.O. Convention.—We confirmed our intention to hold our 1995 meeting in Wichita, Kansas. The convention dates will be August 2-5, inclusive. José Olivarez, an A.L.P.O. Board Member and Director of the Wichita Science Center, will be the local organizer. Besides four days of paper sessions and workshops, including reports on observations of the Comet Shoemaker-Levy 9 Jupiter impact results, we also plan a banquet, a showing at the Science Center's Omnisphere, and at least one short field trip to Lake Afton Public Observatory.

Section and Staff Changes.—Several changes in the status of Sections and staff were approved:

- The Lunar and Planetary Training Program is now permanent, as are its two Coordinators, Timothy J. Robertson and Matthew Will.
- David O. Darling is now permanent Recorder of the Lunar Transient Phenomena Program.
- The Mercury/Venus Transit Section and its recorder, John E. Westfall, are now permanent.
- In the Mars Section, Carlos E. Hernandez is now a full Recorder and Harry Cralle is no longer on its staff.

Other A.L.P.O. News

A.L.P.O. Lunar and Planetary Training Program.—Our Lunar and Planetary Training Program is now "open for business" to all A.L.P.O. members, both beginning and experienced. There are two training levels; the "Basic Level" includes working through the *Novice Observers Handbook.* The next level is the "Novice Level," where one works under a specialized tutor. Upon completion of the Novice Level, a person is certified to "Observer Status" for that speciality.

Enrollment in the Basic Level, which includes a copy of the *Novice Observers Handbook*, costs $6. To enroll, or just to obtain further information, contact either of the Training Coordinators, whose addresses are on the inside back cover.

A.L.P.O. Members Honored.—This summer two A.L.P.O. members received recognition for their longtime contributions to amateur astronomy. A.L.P.O. Comets Recorder Don E. Machholz was given the A.L.P.O. Walter H. Haas Award on June 16 at our Banquet at our Greenville Convention for his many years of comet observations (he soon thereafter discovered two more comets!). Then A.L.P.O. Founder Walter H. Haas received the Astronomical Society of the Pacific's prestigious Amateur Achievement Award at their Annual Awards Banquet, held on June 29 in Flagstaff, Arizona. The award specifically recognized Walter Haas' role in founding the A.L.P.O.

Extra-Generous Members.—A significant number of our members help finance our organization by contributing more than the standard membership dues. Below are listed such persons as of our last mailing.

Sponsors, contributing at least $50 for their annual dues, consist of: Julius L. Benton, Jr., Paul M. Bock, Jr., Darryl J. Davis, Phillip R. Glaser, Alan W. MacFarlane, Michael Mattei, Arthur K. Parizek, Donald C. Parker, Thomas C. Peterson, James Phillips, David J. Raden, Takeshi Sato, Berton and Janet Stevens, Richard J. Wessling, Matthew Will, and Thomas R. Williams.

Sustaining Members, who contributed $25-49 for their annual dues, are: Henry Q. Adams, George D. Bailey, Claus Benninghoven, Klaus R. Brasch, James R. Brunkella, Phillip W. Budine, Clark R. Chapman, Donald L. Clement, Robert D. Davis, Stephen L. Davis, Jack Eastman, Norman G. Foster, Alan French, John W. Griesé III, Robert H. Hays, Carlos E. Hernandez, John M. Hill, Mike Hood, John T. Hopf, David A. Houlihan, Joe and Joann Kamichitis, H.W. Kelsey, Joseph R. Kraus, Mark Lancaster, Robert D. Lunsford, Ashley T. Mc Dermott, David D. Meisel, Woodie F. Morris, Donald E. Neiman, Brenton R. Ogle, William P. Pala, Richard H. Pembroke, the Richmond Astronomical Society, Bob Riddle, Timothy J. Robertson, James V. Roth, Jr., John Sanford, Donald W. Spain, Michael E. Sweetman, Richard A. Sweetsir, Ken Thomson, Brad Timerson, Daniel M. Troiani, William A. Vance, Wynn K. Wacker, and Samuel R. Whitby.

We express our sincere thanks to all the contributing members listed above.

ELSEWHERE IN THE SOLAR SYSTEM

American Geophysical Union Fall Meeting.—Held in San Francisco, California, on December 6-10, 1994, including a special session on the S-L 9 impacts. Contact: AGU Meeting Department, 2000 Florida Avenue NW, Washington, DC 20009 (telephone 202-939-3203; Fax 202-328-0566).

MEPCO '95.—The second Meeting of European (and elsewhere) Planetary and Cometary Observers will be held in Violau, Bavaria (Germany) on March 24-27, 1995. The official language will be English. Highlights will include discussions, papers, workshops, and a field trip to the Nördlinger Ries crater led by Eugene Shoemaker. The conference fee, which includes the *Proceedings*, is DM 270. For further information, contact: Wolfgang Meyer, Martinstr. 1, D-12167 Berlin, Germany. Copies of the *Proceedings* of the previous meeting, MEPCO '92, are available for DM 10 (plus postage) from: Daniel Fischer, Im Kottsiefen, 53639 Koenigswinter, Germany.

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
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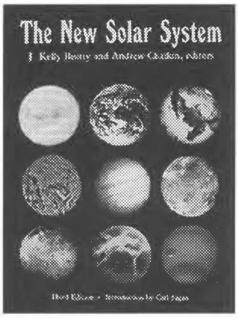

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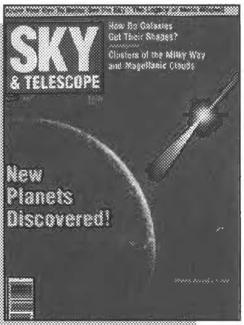

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