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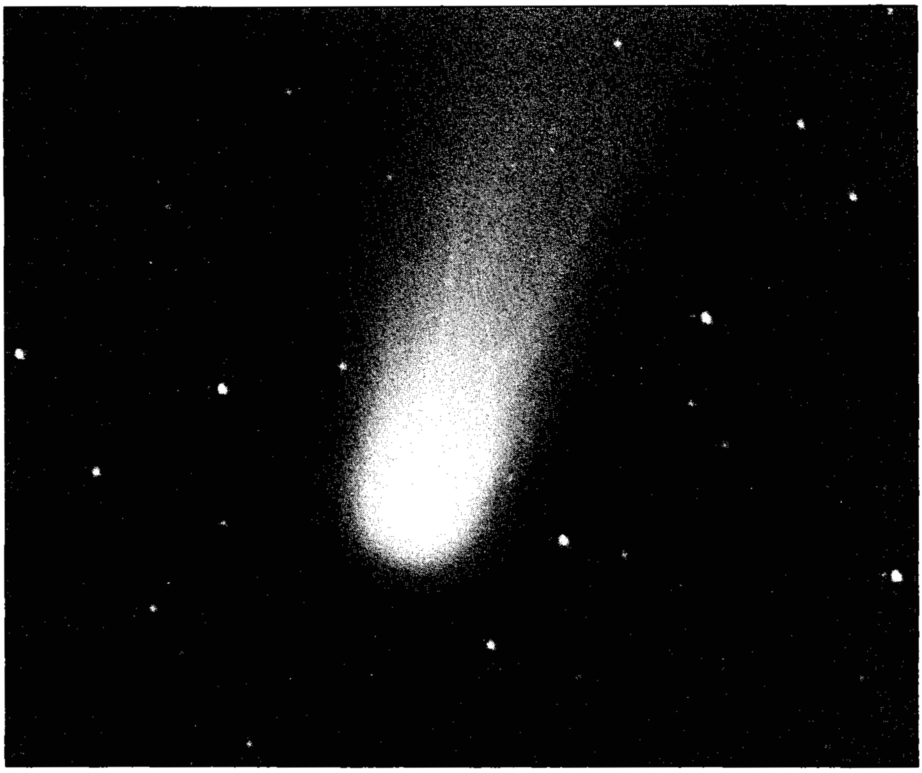

Photograph of Comet Hyakutake, C/1996 B2, by John McAnally and Jeff Bradburn. Taken 1996 Apr 16, 02h45m UT with an 8-inch (20-cm) Schmidt-Cassegrain telescope at f/10. This was a 10-minute guided exposure on Kodak Royal Gold color film (speed ISO 1000). Celestial north is to the upper right.

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In This Issue

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COMET HYAKUTAKE, C/1996 B2

By: Don Machholz, Previous A.L.P.O. Comets Coordinator

ABSTRACT

This report studies the discovery, orbit and appearance of Comet Hyakutake, C/1996 B2. This comet passed 9 million miles from the Earth on 1996 MAR 25 with a tail spanning the sky. It was the brightest comet in the past 20 years.

DISCOVERY

As reported in *International Astronomical Union Circular 6299*, dated January 31, 1996, Yuri Hyakutake, an amateur astronomer from Kagoshima, Japan, discovered a comet on 1996 JAN 29.664 UT, using 25×150 binoculars. The comet was than at magnitude +10.0 and located at RA 14^h 31^m, declination -24°.9 [*IAU Circular 6299*].

Hyakutake had found his first comet only five weeks earlier. On the morning of January 29 he went back to his observing site, ten miles from his home, to photograph his first comet, then in the eastern sky. But clouds covered that part of the sky so he swung southward and began sweeping near where his first comet was found. In a short time he discovered his second comet.

The comet was designated Comet 1996 B2 (Hyakutake). The "1996" identifies the year it was found, the "B" means it was found in the second half of January, and the "2" means it was the second comet found in that half-month.

ORBIT

Five days after discovery, a preliminary orbit was calculated by Dr. Brian Marsden of the Smithsonian Astrophysical Observatory. It showed that the comet would pass near the earth in late March, 1996, reaching perihelion a month later [*IAU Circular 6303-4*]. Shortly thereafter a prediscovery position was determined from a photograph taken by K. Takamizawa on 1996 JAN 01 [*IAU Circular 6311*]. This further refined the orbit. A few weeks later new elements were published which showed that the comet was not new to the inner Solar System–it had been here 10,000 to 20,000 years ago [*IAU Circular 6329*]. It also showed that the comet would be closest to the Earth at 0.102 AU on 1996 MAR 25.3 UT. [One AU, or *astronomical unit*, is the mean distance of the Earth from the Sun; 149,597,870 km.]

The latest orbit is from *MPC 27287*, based on 703 observations from 1996 JAN 31-MAY 23:

Epoch:	1999 JAN 22.0
Time of Perihelion:	1996 MAY 01.15174025
Perihelion Distance:	0.232088 AU
Argument of Perihelion:	130°.1937 (2000)
Ascending Node:	187°.9683 (2000)
Inclination of Orbit:	124°.9497 (2000)
Eccentricity of Orbit:	0.999854

Figure 1 (p. 98) shows the changing distance of the comet from the Sun and the Earth during the period of observation.

PATH ACROSS THE SKY

Once the orbit was known, the comet's path across the sky could be predicted. As shown in *Figure 2* (p. 98), the comet was found in the southern sky and did not appear to move much as we were approaching it.

As we got closer to Comet Hyakutake, it sped up as it passed over the top of the Earth, getting to within a few degrees of the North Star (*Figure 3*, p. 99). During this time the comet was above the horizon for nearly the whole night as seen from the Northern Hemisphere.

After the comet passed the earth, we left it behind as it sped toward the sun (*Figure 4*, p. 100). The comet was expected to fade slightly during this time.

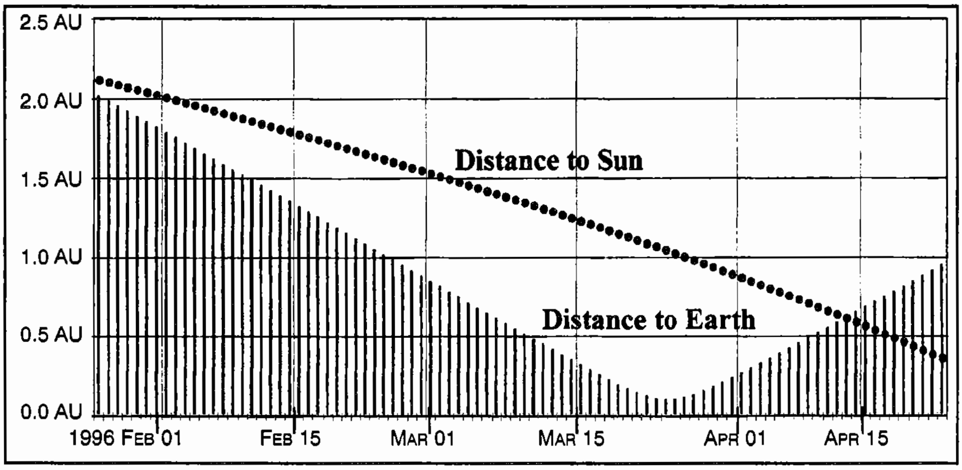

Figure 1. The distance of Comet Hyakutake from the Sun and the Earth in astronomical units.

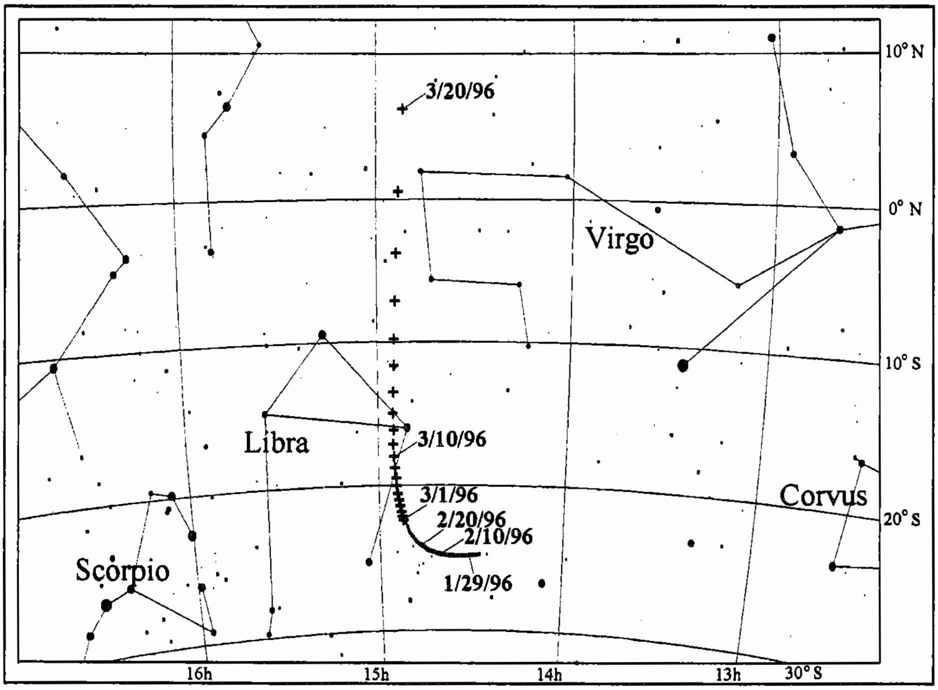

Figure 2. The path of Comet Hyakutake across the sky from its discovery until 1996 Mar 20, showing how quickly it picked up speed as it neared the Earth.

The Predictions

The discovery of Comet Hyakutake followed the discovery of Comet Hale-Bopp by about six months. It was Comet Hale-Bopp that was predicted to be the brightest and most spectacular comet since Comet West in 1976. Yet while Comet Hale-Bopp was still out past Jupiter and slowly warming up, in came Comet Hyakutake, rushing past the Earth, poised to produce an upset.

There were several reasons why Comet Hyakutake could be expected to become bright and put on a good show:

- It was going to pass near the Earth. Even faint comets passing near the earth cause a lot of excitement and are well-observed.
- It would be getting close to the Sun. Comets that do this tend to get hot and very bright, and possibly outburst.
- This is not a comet new to the Solar System. It has been here before so most of the volatile gases that attribute to high brightness farther out (and exhaust themselves as the comet gets closer to the Sun) have already been expelled.

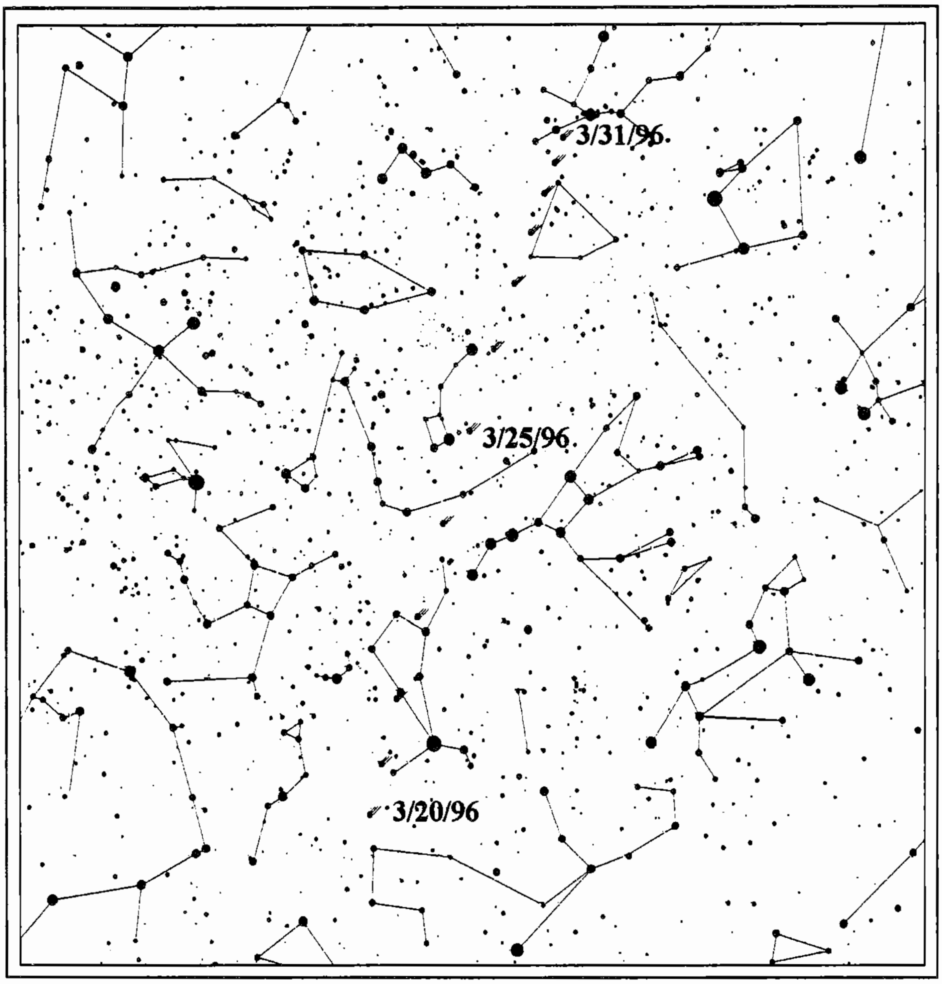

Figure 3. The approximate straight-line path of Comet Hyakutake as it passed the North Star and into the evening sky.

- It would be observable in the dark sky, well away from the Sun (as seen from Earth), and would be up for nearly the whole night. The Northern Hemisphere had all-night views for more than a week!

How bright was the comet expected to get? When a new comet is found, astronomers assign to it a brightness model which is used to predict future brightness. As the comet deviates from this standard formula, the model is adjusted to fit the comet. The standard formula is:

$$m = H_0 - 5 \log \Delta - 2.5\, n \log r,$$

where: m = apparent magnitude of the comet, H_0 = absolute magnitude of the comet [i.e., its magnitude were it 1 AU from both the Earth and the Sun. *Ed.*], Δ = comet-Earth distance in astronomical units (AU), r = comet-Sun distance in AU, n = a constant representing the rate of brightening of the comet-Sun distance changes. This is assumed to be +4.0 for new comets. That is, as the comet's distance to the Sun is halved, the comet becomes 16 times brighter.

For Comet Hyakutake, if "n" equaled +4.0, then the absolute magnitude, at discovery, would be +5.5. This is about 1.5 magnitudes brighter then the average comet. The formula also predicted that the comet would brighten to about magnitude +1 by 1996 Mar 25. Then, as it pulled away from us and continued toward the Sun, it would dim slightly, until reaching magnitude +1 again as it neared perihelion and became lost in the twilight (see *Figure 5*, p 101).

There were a few "unknowns" about this new comet.:

- If it was in outburst at discovery, then as it faded back to normal the absolute magnitude would dim, meaning

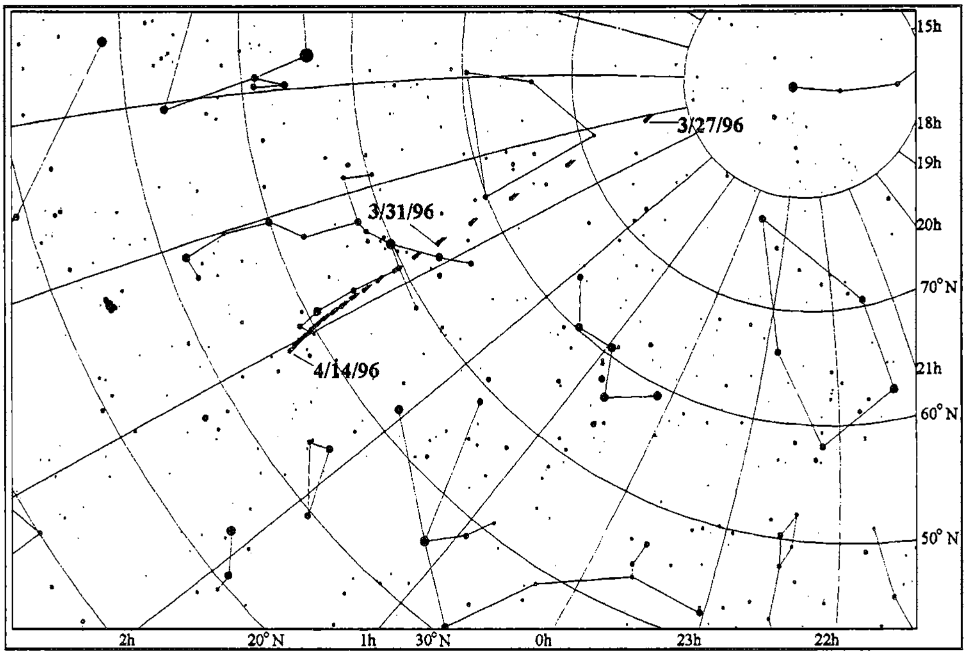

Figure 4. The continuation of the path of Comet Hyakutake toward the Sun in our northwestern sky.

the comet would not put on as good a performance as expected.

- But even if it wasn't in outburst, some comets fall apart as they rush toward the Sun.
- Finally, as the comet passes near Earth, it grows in size and the surface brightness decreases. If the comet is feeble to begin with, it may turn out to be difficult to see from urban areas as its surface brightness is barely brighter than the background sky.

Despite the "promise" of a bright comet, news of Comet Hyakutake remained confined chiefly to the astronomical community for the first six weeks following discovery. By mid-March, local clubs had time to schedule comet observation parties for the public, the comet community had monitored the comet well enough to see that its brightness predictions were right on schedule, and the media were ready to tell the public about this amazing bright comet. The media had only one question that they could never seem to answer: how do you pronounce the name of this comet?

Comet Hyakutake's Actual Performance

The comet was visible to the naked eye to experienced Southern-Hemisphere observers during the first week of March. The Moon was full on March 5, putting an end to serious observation of the comet until after Third-Quarter Moon on March 12. Thereafter the comet became a naked-eye object as it started moving rapidly northward. The tail was then pointing more or less away from us, producing short apparent tail lengths. With the comet performing well and living up to expectations, both the news media and astronomers were becoming more vocal with their publicity about this comet.

New Moon happened on March 19. The comet was then just crossing the equator going north. This allowed nearly the whole world an all-night view of the comet in a dark sky. What did they see? Our observers report the magnitude than as about +3.0 (Figure 5), a coma 1° across (*Figure 6*, p. 101), and an apparent tail length of 5° (*Figure 7*, p. 101).

Over the next five days, the Earth-comet distance halved, the coma doubled in apparent size, the tail lengthened to 35°, and the comet became brighter then first magnitude. The comet had a very well-condensed coma, making it easily visible to city dwellers. The tail was also seen from the cities, making this a memorable event for millions.

The comet continued putting on a good show as it pulled away from the Earth and headed closer to the Sun. In

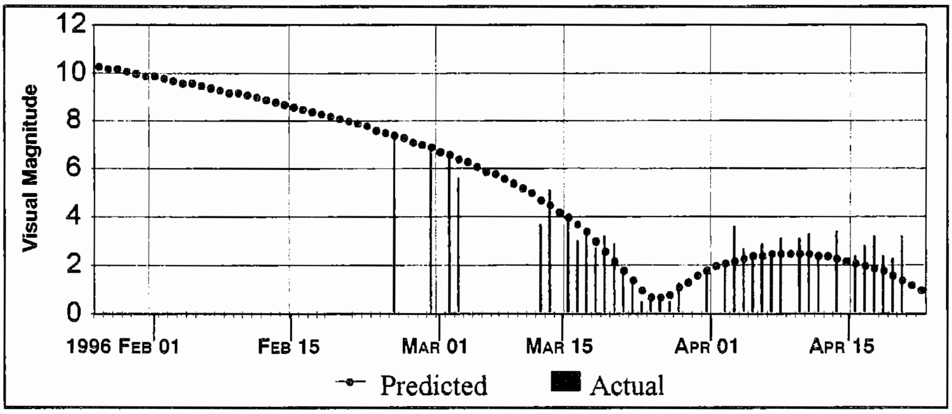

Figure 5. The predicted visual magnitude of Comet Hyakutake (dots), plotted against actual magnitude estimates made by A.L.P.O. observers (vertical bars).

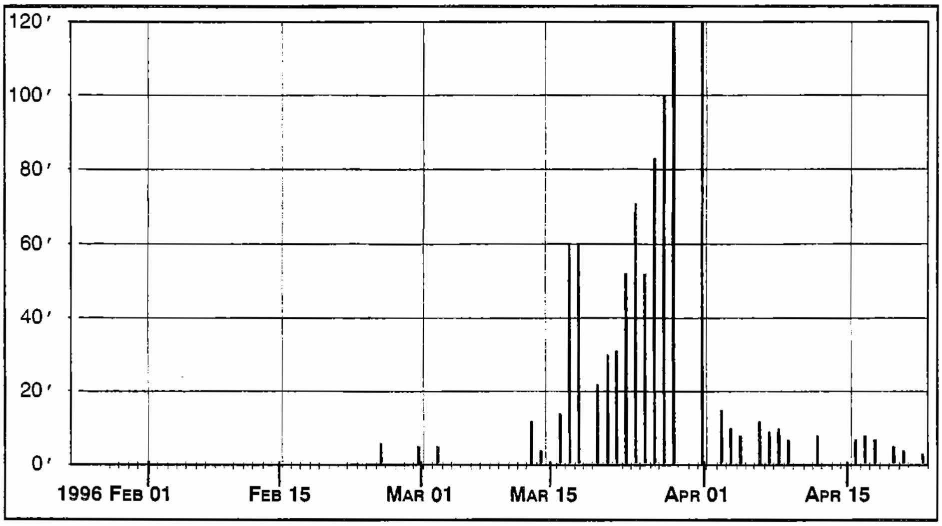

Figure 6. The estimated apparent coma diameter (in arc-minutes) of Comet Hyakutake.

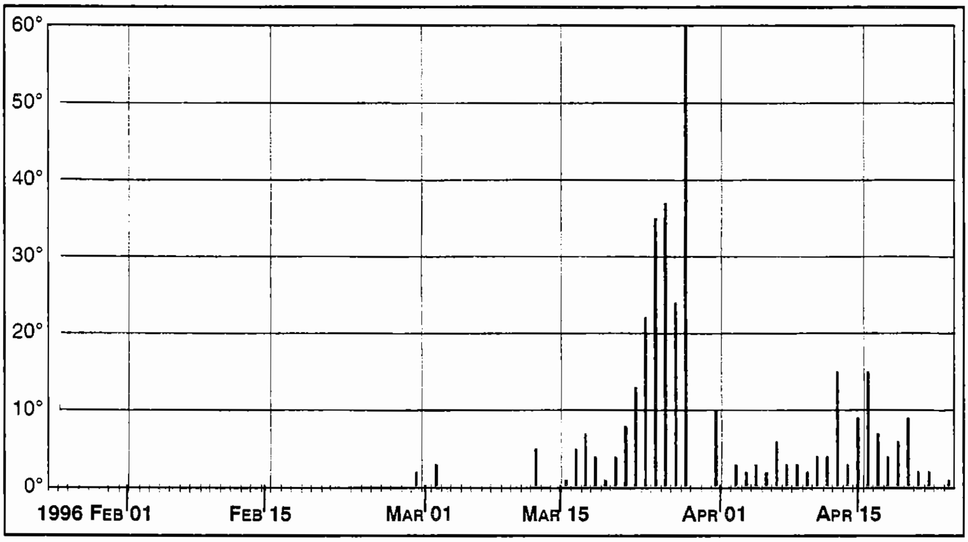

Figure 7. The estimated apparent tail length (in degrees) of Comet Hyakutake.

early April it was in the northern evening sky, at naked-eye visibility, with a strong tail.

Selected Observations

The following observations are listed in approximate chronological order; some include several dates. Several drawings, photographs and CCD images by A.L.P.O. observers are reproduced on pages 103-105 (*Figures 8-19*).

Observing from Essex Jct., Vermont, Gary Nowak reported the tail being "long, but very, very faint" on March 13, 17 and 18. On March 26 and 27 he noted "spine on nucleus was yellow in color, some blue near edge of coma." He used 11×80 binoculars for these observations. By March 31, "all colors are gone."

On 1996 Mar 21.9, Zhou Xin-ming saw the comet from Xinjiang, China. Using a 15-cm refractor at 25×, he writes "there was a jet clearly, 5′ long at P.A. (position angle) 40 degrees in the center of comet head." [P.A. is measured counterclockwise from celestial north. *Ed.*] This was in the opposite direction to the main tail.

I recall stepping out on my back deck in the predawn hours of Saturday, March 23. I live in a dark area, but the sky was fogy. I looked up and through the thick fog I saw only three objects. One was the star Vega. One was the star Arcturus. The third object was the nuclear region of Comet Hyakutake. Later that night we were showing it to thousands of people from downtown Sacramento, California.

Richard Didrick of Taunton, Massachusetts reported seeing "fine detail near the nucleus." On 1996 Mar 23.11 he saw a short (2′) arc-like spike inside and parallel to the main tail. He reported later seeing a fan of material near the nuclear region, this may have been a layer which broke off the nucleus about March 20 and caused an increase in brightness.

From Istanbul, Turkey, Haldun and Gamze Menali watched the comet on 1996 Mar 25.7 through a 20-cm telescope. They reported a tail disconnection event, and that the nuclear region was "peanut-shaped-elongated in the northeast-southwest direction."

Matthew Will of Springfield, Illinois saw "several envelopes around a star-like nucleus" on 1996 Mar 25.8. He was using a 15-cm refractor at 30×.

In Göttingen, Germany, Detlev Niechoy noted how the coma appeared flattened in front of the nuclear region on 1996 Mar 27.9, but appeared more "irregular" the next night. He also noted a "dark area in the coma." (See *Figure 13*, page 104.)

Richard Hill of Tucson, Arizona saw the nucleus region elongated with a possible forward-pointing jet. Using a 25-cm f/12 Cassegrain telescope he saw "forward pointing horns (two) from coma."

From England, David Graham was clouded out for much of March but managed to see the comet toward the end of the month. From Brompton-on-Swale, North Yorkshire, on 1996 Mar 28.9 he saw "a brilliant, almost stellar condensation within the coma." The next day "the condensation remained sharply defined with a magnification of 222× showing diffraction rings." Graham was using a 15-cm, f/13 refractor. On 1996 Mar 31.8 he wrote "The coma was brightest ahead of the brilliant, star-like condensation. A well-defined boundary gave the effect of a dark void immediately to the rear of the condensation. A distinct but slender tail could be made out with at least one fainter streak within the coma." (See *Figures 15* and *16*, pages 104 and 105.)

This was truly a comet for everyone. Those south of the Equator and those north of the Equator saw it well. It offered fine views to those in the city and those in the country. Seldom will we see a comet so big and so bright.

Acknowledgments

This report would not have been possible without the observations contributed by our many A.L.P.O. comet observers. I wish to thank those mentioned above for their observations and remarks about Comet Hyakutake. Also submitting observations were Karl and Wanda Simmons, Jim Pryal, Jens Rummler, Richard Schmude, Robert Warren, Gus Johnson, Daniel Louderback, John Westfall, Mark Schmidt, Randy Tatum, John McAnally, and Brian Cudnik.

References

IAU Circular 6299, Daniel W. Green, January 31, 1996.

IAU Circular 6303-4, Brian Marsden, February 3, 1996.

IAU Circular 6311, Daniel W. Green, February 10, 1996.

IAU Circular 6329, Brian Marsden, February 29, 1996.

Minor Planet Circular 27287, Brian Marsden.

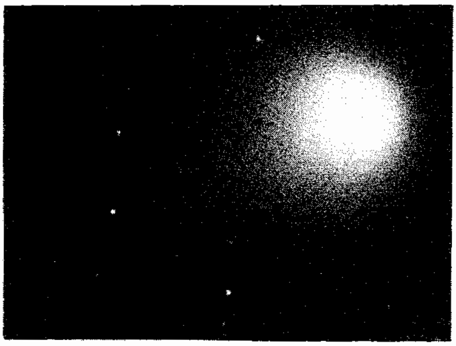

Figure 8. CCD Image of Comet Hyakutake by Mark L. Schmidt of Racine, Wisconsin. 1996 MAR 16, 07^h48^m UT. 10.4-cm (4.1-in) Astro-Physics refractor, f/5.8, 30-s exposure. Seeing = 6.5, Transparency = +4.5. The tail is pointing to the celestial west (lower left).

NOTE: Figures 8-19 are presented as oriented by each observer. The Editor has exaggerated contrasts. With drawings, he has, where indicated, converted negative versions to positives, and deleted notes, arrows, etc., placed on the drawings. Seeing is given in the A.L.P.O. System (0 = worst to 10 = best), while transparency is the limiting naked-eye stellar magnitude in the vicinity of the comet.

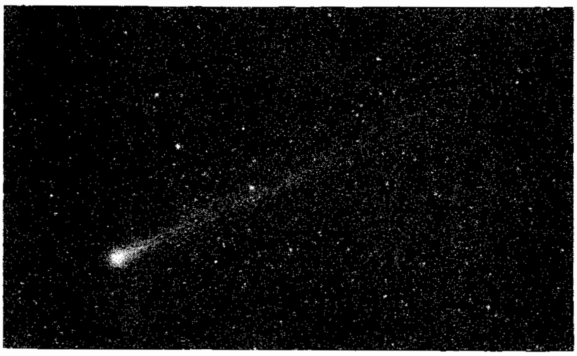

Figure 9. Photograph of Comet Hyakutake by Randy Tatum of Richmond, Virginia. 1996 MAR 25, *ca.* 6^h UT. 35-mm focal length, ISO 400 color film, 10-m exposure. Mr. Tatum visually estimated the tail length as 40°, noting a bend that was a gas-tail disconnection. The "handle" of the Big Dipper asterism is above the comet, whose tail extends SW. The field of view is approximately 45° × 27°.

Figure 10. Photograph of Comet Hyakutake by Jim Pryal of Federal Way, Washington. 1996 MAR 25, 09^h12^m UT. 180-mm focal length, f/2.8, hypered Fuji 400 print film, 10-m exposure. Transparency ~ +6.0. Comet in constellation Draco, tail pointing SW. Field of view approximately 5° × 7°.

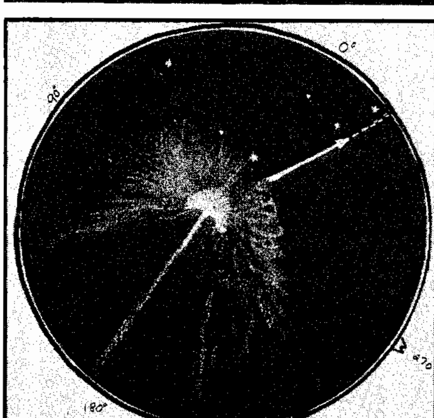

Figure 11. Drawing of Comet Hyakutake by Detlev Niechoy of Göttingen, Germany. 1996 MAR 26, 00^h00^m-00^h30^m UT. 25-cm (10-in) reflector, f/4.5, 49× with a 70 arc-minute field. Position angles are indicated (where 0° is celestial north) and the comet's direction of motion is shown with an arrow. His negative drawing has been converted to a positive, with notes upon or near the drawing removed. Mr. Niechoy commented: "Very bright disk-type nuclear region with a small fan at the northern edge slowly tapering outward, then faning back southward, the ion-tail ... having a nuclear shadow along the east and west edge dividing the ion-tail from where the coma fans back." Comet Hyakutake was in Ursa Minor at this time.

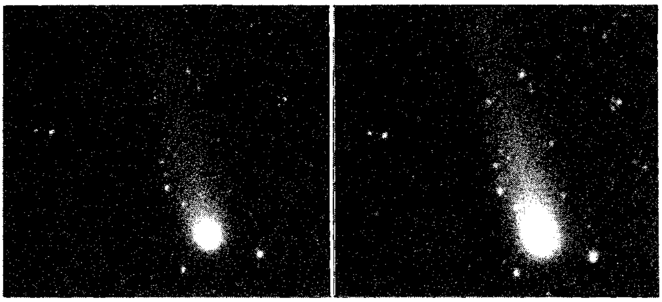

Figure 12. CCD images of Comet Hyakutake by John Westfall from San Francisco, California. 1996 MAR 26. 24-mm f/2.5 lens, giving a field 6°.3 E-W × 5°.7 N-S (north at bottom). The star in the lower right is 4 UMi.

Left view: 16-s exposure at 07^h 32^m UT.

Right view: Two 32-s exposures at 07^h35^m and 07^h36^m UT combined, with the darker of each pixel chosen to reduce random noise.

Figure 13. Drawing of Comet Hyakutake by Detlev Niechoy. 1996 MAR 27, 00^h55^h-$01h03^m$ UT. 25-cm (10-in) reflector, f/4.5, 49× with a 70 arc-minute field. Position angles are indicated (where 0° is celestial north). His negative drawing has been converted to a positive. Mr. Niechoy commented: "1′ nuclear region, disk-shaped and very bright, from the northern edge of the disk there seemed to be a small fan of material apparently being ejected at a 0° vector. As the 0° vector fan extended and became diffuse to a distance of 15′ the material was noticed to blow back southward creating a fan shape extending from pa. 125° - 245°. From the south at p.a. 180° the ion-tail extended beyond the 70′ field of view." Comet Hyakutake was in Ursa Minor at this time, at declination 86°40' North.

Figure 14. Photograph of Comet Hyakutake by Gus Johnson of Swanton, Maryland. 1996 MAR 27, 07^h37^m UT. Unguided camera, 50-mm f/1.9 lens. 2.5-m exposure on ISO 400 color film. Field 35° × 23°. Polaris is slightly to the upper right of the comet's coma with the "Little Dipper" asterism in the right-hand portion of the frame; note the short arcs made by the stars as the rotate about the Celestial Pole. Mr. Johnson noted that the tail extended about 50° when this photograph was joined to an adjoining frame.

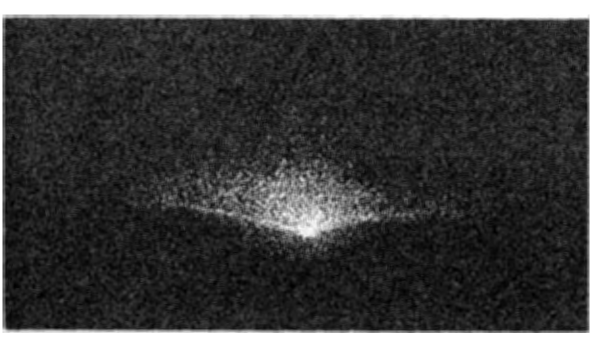

Figure 15. Drawing of Comet Hyakutake by David L. Graham of Brompton-on-Swale, North Yorkshire, England. 1996 MAR 29, 21^h UT. 15-cm refractor, 111×. At this time the comet was in Ursa Minor with its tail pointing northeast (bottom). Mr. Graham noted: "Brilliant star like condensation in coma remained sharply defined at ×222 ... Stellar condensation within coma. Broad fan shape to coma. Brightest "ahead" [to top] of comet with sharp, defined boundary." His negative drawing is here converted to a positive.

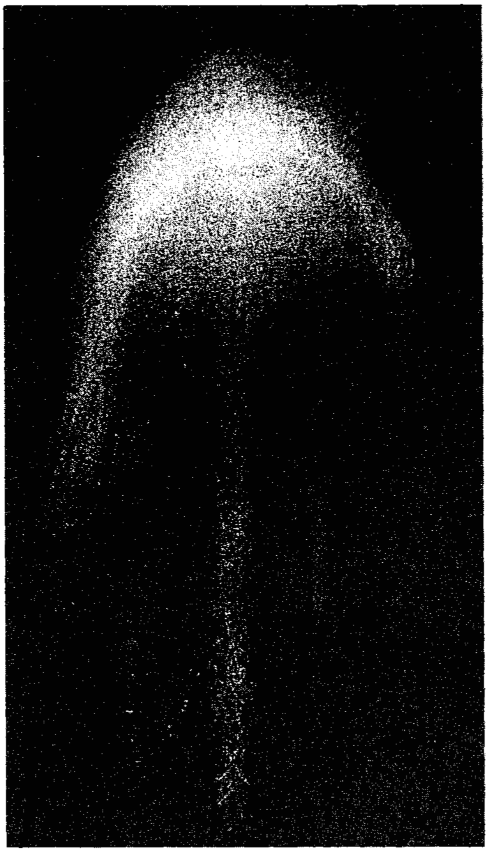

Figure 16 (to left). Drawing of Comet Hyakutake by David L. Graham. 1996 MAR 31, 21^h UT. 15-cm refractor, 50X. Celestial northeast is to the bottom. Mr. Graham noted that the "p" lobe (left) was brighter than the "f" lobe (right), that there was a "strong suggestion of another tail" to the left and a "faint streak" to the right of the mail tail (center). He commented "Intense sharp condensation in coma with sharply defined edge. ie. coma brightest "in front" of [above] the condensation. Estimated visual coma diameter would be 1/2°." His negative drawing has been converted to a positive, with notes upon or near the drawing removed.

Figure 18 (below). Photograph of Comet Hyakutake by Brian M. Cudnik of Houston, Texas. 1996 APR 16 UT. 135-mm f/2.8 lens, 7-m exposure on Kodak 1000 Gold Film (color). Field of view 30° × 38°. The comet is in the constellation Perseus, with α Per the brightest star shown. The tail of the comet is extending NE and the bright line with bright points on it is an airplane trail.

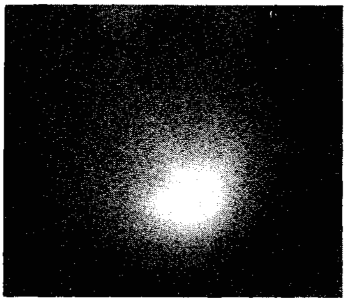

Figure 17 (to left). CCD images of Comet Hyakutake by John Westfall. 1996 APR 13. 28-cm Schmidt-Cassegrain, f/10; field of view 206″ × 175″ (0″.74/pixel). North at top.

Left view: 8-s exposure at $03^h 56^m$ UT.

Right view: Two 16-s exposures at 03^h57^m and 03^h58^m UT combined, with the darker of each pixel chosen to reduce random noise.

Figure 19 (to left). Photograph of Comet Hyakutake by Jim Pryal from the Ahi Ahi Kin'au Natural Area on Maui, Hawaii. 1996 APR 18, $06^h00^m45^s$ - $06^h03^m15^s$ UT. 190-mm f/2.8 lens, 2.5-m exposure on Kodak Royal Gold 1000 Film (color). Transparency = +5. Field of view 6°.7 × 4°.9. The comet is in Perseus with a tail extending about 8° at position angle 038° (NE). North at top.

OBSERVATIONS OF SATURN DURING THE 1997-98 APPARITION

By: Julius L. Benton, Jr., Coordinator, A.L.P.O. Saturn Section

ABSTRACT

A.L.P.O. Saturn observers in the United States, France, Germany, and Japan contributed an interesting and useful sequence of visual, photographic, and CCD observations during the 1997-98 Apparition, covering the period from 1997 JUL 11 through 1998 MAR 20. Telescopes that were used in making these observations ranged in aperture from 15.2 cm (6.0 in) up to 50.8 cm (20.0 in). Observers witnessed vague, recurring festoons and other dusky disturbances among the belts and zones of Saturn's Southern Hemisphere during the apparition, and a few transient, diffuse white ovals were suspected in the southern Equatorial Zone (EZs) from 1997 Nov 17 through 1998 JAN 21. Unfortunately, none of these atmospheric features persisted long enough for meaningful central meridian (CM) transit timings, which could be utilized to try to derive rotation rates for different Saturnian latitudes. During the 1997-98 Apparition, the inclination of the Ring System to our line of sight, B, reached a maximum value of -11°.88 on 1998 MAR 20. With the Rings progressively opening up since the edge-wise ring presentations of 1995-96, increasingly advantageous views of the Southern Hemisphere of Saturn's Globe and the South face of the Rings are now possible. Accompanying this report are references, drawings, photographs, graphs, and tables.

INTRODUCTION

A useful collection of visual, photographic, and CCD observations of the planet and its accompanying Ring System for the 1997-98 Apparition were submitted by members of the A.L.P.O. Saturn Section. This analytical summary, which is augmented by drawings, photographs, and CCD images, is derived from data received for the observing season (apparition) ranging from 1997 JUL 11 through 1998 MAR 20. All times and dates mentioned in this report are in Universal Time (UT).

Table 1 (lower right) provides geocentric data in Universal Time (UT) for the 1997-98 Apparition of Saturn. During the observing season the numerical value of **B**, the Saturnicentric latitude of the Earth referred to the ring plane (negative when south), ranged between the extremes of -8°.73 (1997 DEC 10) and -11°.88 (1998 MAR 20). The value of **B'**, the saturnicentric latitude of the Sun, ranged from -8°.95 (1997 JUL 11) and -12°.58 (1998 MAR 20).

Table 2 (p. 107) lists the 16 individuals who submitted a total of 127 observations to the A.L.P.O. Saturn Section for the 1997-98 Apparition, along with their observing sites, number of dates of observations, and descriptions of their telescopes.

Figure 1 (p. 107) is a histogram giving the distribution of observations by month, illustrating that the bulk of the data were received for the months of 1997 September through 1998 February (82.7 percent), with a slight decline in the number of observations on either side of this period of peak activity. Of the submitted observations, 18.9 percent were made before opposition (1997 OCT 10), none actually on that date, and 81.1 percent were made following opposition. Although close scrutiny of Saturn during

Table 1. Geocentric Phenomena for Saturn During the 1997-98 Apparition

Conjunction	1997 MAR 30 22h UT
Opposition	1997 OCT 10 04
Conjunction	1998 APR 13 12
Opposition Data:	
Visual Magnitude	+0.2 (in Pisces)
Declination	+4°.08
B	-10°.02
B'	-10°.29
Globe	
Equatorial Diameter	19″.71
Polar Diameter	17″.66
Rings	
Major Axis	44″.94
Minor Axis	7″.85

Table 2. Contributing Observers, 1997-98 Apparition of Saturn.

Observer & Location	No. of Obser.	Telescope Data*
Benton, Julius L. Wilmington I., GA	25	15.2-cm (6.0-in) REF
Boisclair, Norman J. Boynton Beach, FL	1	50.8-cm (20.0-in) NEW
Brasch, Klaus San Bernardino, CA	1	35.6-cm (14.0-in) SC
Crandall, Ed Winston-Salem, NC	11	25.4-cm (10.0-in) NEW
Haas, Walter H. Las Cruces, NM	7 21	20.3-cm (8.0-in) NEW 31.8-cm (12.5-in) NEW
Jamison, Eric Pepperell, MA	1	18.0-cm (7.1-in) REF
McAnally, John W. Waco, TX	13	20.3-cm (8.0-in) SC
Melillo, Frank J. Holtsville, NY	5	20.3-cm (8.0-in) SC
Miyazaki, Isao Okinawa, Japan	1	40.6-cm (16.0-in) NEW
Niechoy, Detlev Göttingen, Germany	22	20.3-cm (8.0-in) SC
Plante, Phil Poland, OH	6	20.3-cm (8.0-in) SC
Post, Cecil Las Cruces, NM	1	20.3-cm (8.0-in) NEW
Schmude, Richard W.	1	25.4-cm (10.0-in) NEW
Teichert, Gérard Hattstatt, France	2	28.0-cm (11.0-in) SC
Whitby, Samuel R. Hopewell, VA	3	15.2-cm (6.0-in) REF
Will, Matthew Springfield, IL	5	20.3 cm (8.0-in) NEW

Total Observations: 127
Total Observers: 16

* NEW = Newtonian, REF = Refractor, SC = Schmidt-Cassegrain.

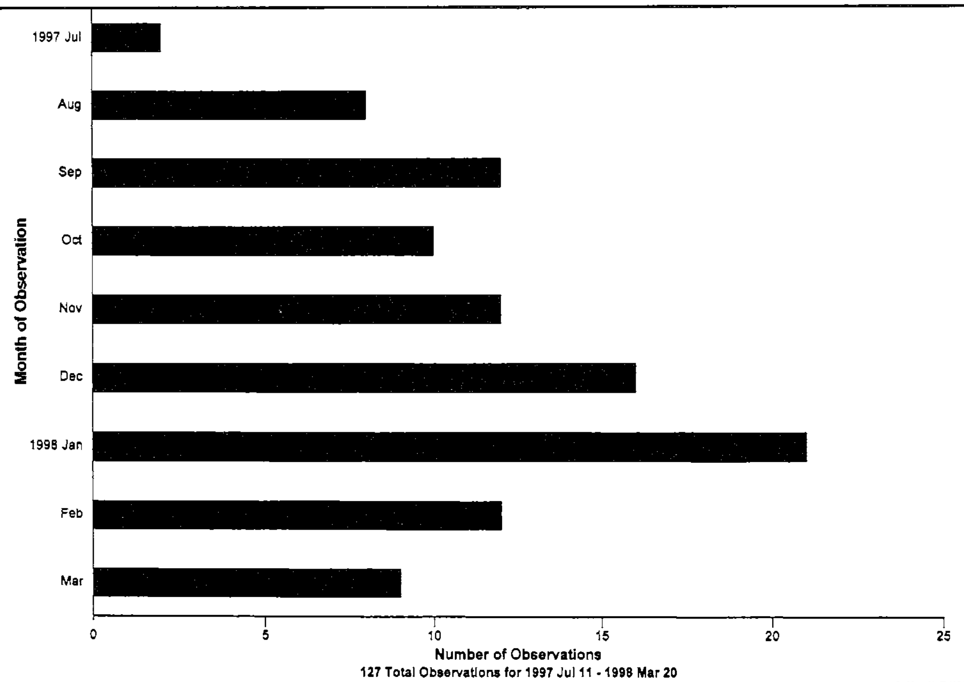

Figure 1. Distribution of observations by month, 1997-98 Apparition of Saturn.

the months inclusive of and surrounding opposition is always important, uninterrupted coverage of the planet from the time it first appears in the eastern sky before dawn until it approaches conjunction with the Sun is equally worthwhile.

Figure 2 (p. 108) shows the A.L.P.O. Saturn Section observer base (a total of 16) for 1997-98, plus the international distribution of the 127 observations that were contributed. During the apparition, the United States accounted for 80.3 percent of the submitted observations and a similar proportion of the participating observers (81.3 percent). International cooperation in our programs continued throughout 1997-98, with observers in Japan, France and Germany submitting reports.

Figure 3 (p. 108) graphs the number of observations by instrument type, and it can be seen that telescopes of classical design, refractors and Newtonians, were utilized in making slightly less than

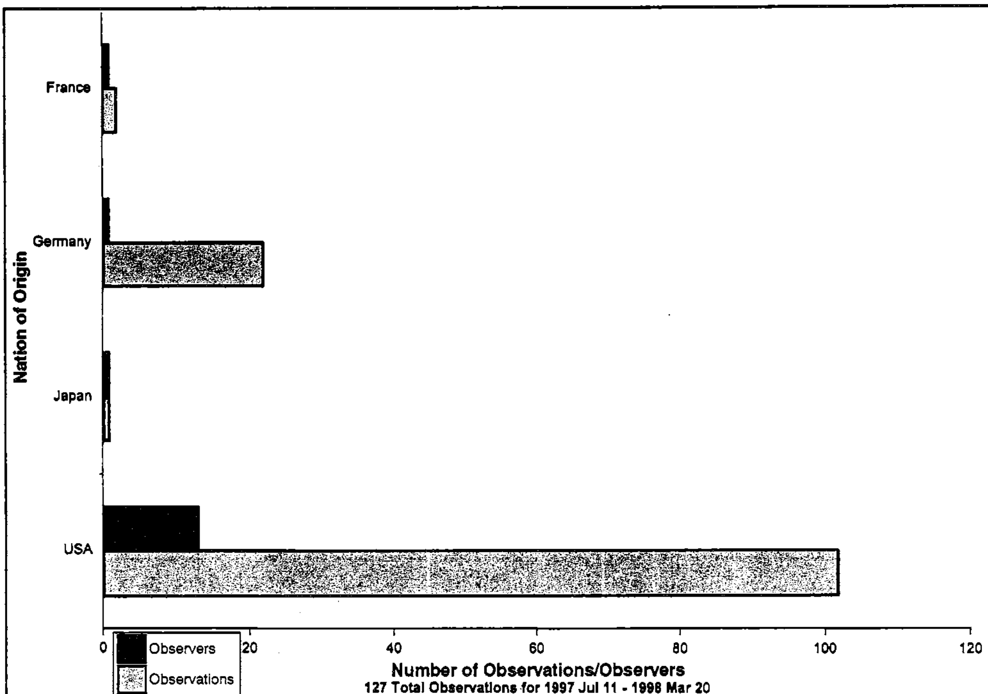

Figure 2. Distribution of observations and observers by nation of origin, 1997-98 Apparition of Saturn.

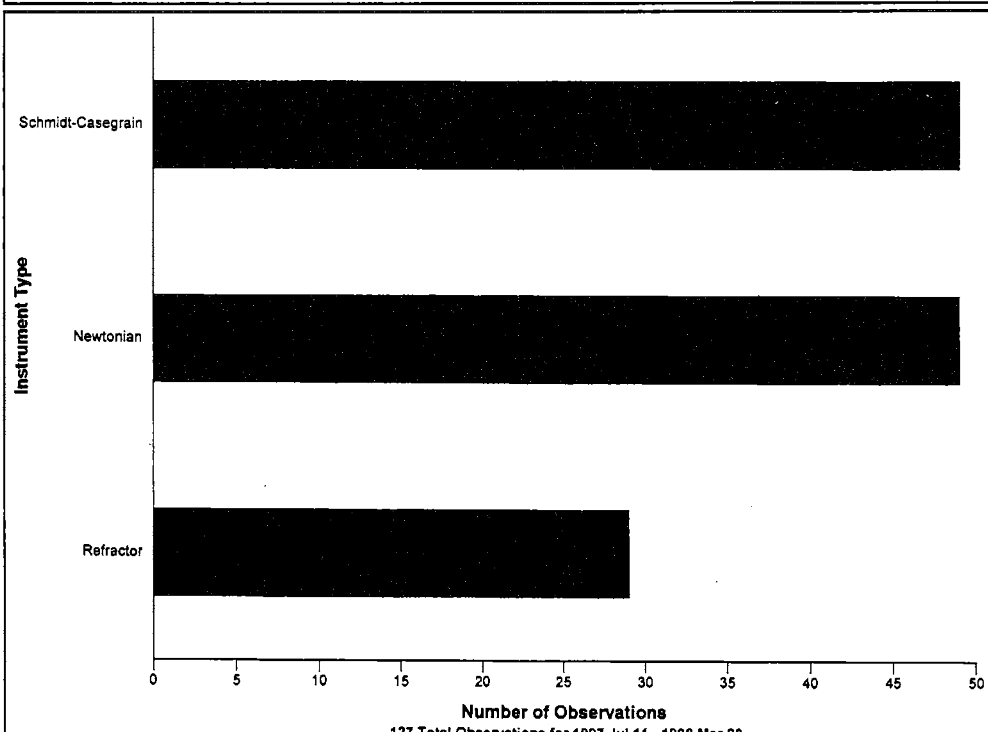

Figure 3. Distribution of observations by instrument type, 1997-98 Apparition of Saturn.

two-thirds (61.4 percent) of the 127 total observations in 1997-98. Such instruments are well-known for their unsurpassed resolution and image contrast, which often means they are the telescopes of choice for individuals seeking a telescope strictly for lunar and planetary studies. All of the observations contributed during 1997-98 were made with instruments equal to or greater than 15.2 cm (6.0 in) in aperture. There has been an ever-increasing percentage, in recent apparitions, of observers using larger apertures for A.L.P.O. investigations of

Saturn. Based on feedback from more experienced Saturn observers, there appears to be a greater emphasis on aperture these days when selecting a telescope than there is on any specific design, and optical quality should never be compromised. Observers are also reminded that smaller apertures, in the range of 10.2 cm (4.0 in) to 12.7 cm (5.0 in), can still be successfully employed in useful work on Saturn.

The writer wishes to thank all of the dedicated observers mentioned in Table 2 who contributed their reports to the A.L.P.O. Saturn Section in 1997-98. Observers throughout the United States and elsewhere interested in detailed studies of the planet Saturn are urged join us in future apparitions as we strive to maintain an international, comprehensive surveillance of the planet. Novice observers are also cordially welcome to contribute, and the A.L.P.O. Training Program and the Saturn Section will always be delighted to provide assistance in getting started.

The Globe of Saturn

This apparition report is based on an analysis of 127 observational reports that were sent to the A.L.P.O. Saturn Section by the 16 observers in Table 2 during 1997-98. To conserve space and maintain brevity, names of observers are omitted from the text unless the identity of an individual is relevant to the discussion. Drawings, photographs, CCD images, tables, and graphs accompany this observational synopsis, and it is recommended that readers refer to them as they study the material presented. Note that features on the Globe of Saturn are described in south-to-north order and can be identified by looking at the nomenclature diagram shown in *Figure 4* (below).

An enduring policy of the A.L.P.O. Saturn Section is to prepare apparition reports by comparing and contrasting data for global atmospheric features between successive apparitions. This practice helps maintain continuity and aids the reader in understanding the very subtle, but nonetheless discernible, variations that may be taking place seasonally on Saturn. Observational results suggest that the constantly changing inclination of Saturn's axis of rotation relative to the Sun and Earth contributes to any perceived variations in belt and zone intensities, which are listed in *Table 3* (p. 110). Photoelectric photometry of Saturn in recent years has revealed slight oscillations of about ±0.10 visual magnitudes with time, and these data have prompted some investigators to postulate that transient and long-enduring atmospheric features in Saturn's belts and zones may conspire to induce such brightness fluctuations. Regular photoelectric photometry of Saturn, in conjunction with visual intensity estimates, is obviously a valuable project for suitably-equipped observers to initiate and maintain.

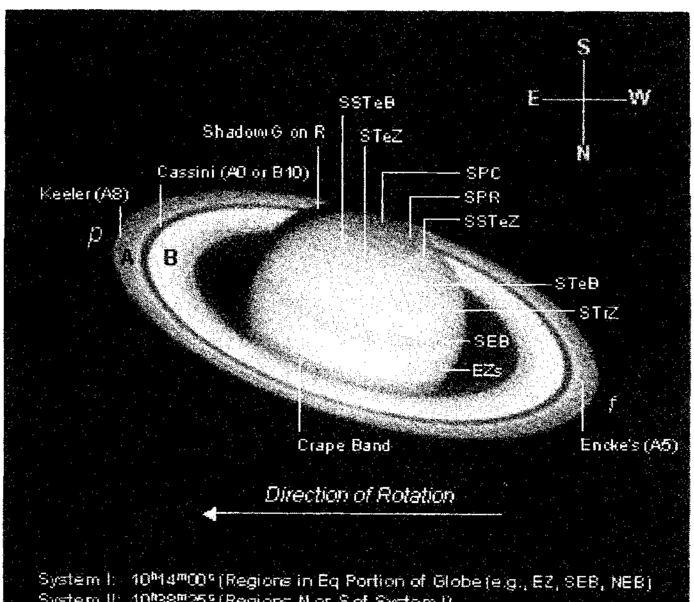

Figure 4. Nomenclature diagram for Saturn's Globe and Rings. Abbreviations used are: B = Belt; C = Cap; E = Equatorial; G = Globe; N, n = North; R = Rings, Region; S, s = South; Te = Temperate; Tr = Tropical; Z = Zone. A, B, C = Ring components; A5 = 0.5 of distance from inner edge to outer edge of A Ring (Encke's Division); A8 = 0.8 of distance from inner edge to outer edge of A Ring (Keeler's Division); A0 or B10 = between outer edge of B Ring and inner edge of A Ring (Cassini's Division); the Crape Band is the projection of Ring C on the Globe. f = following and p = preceding.

Table 3. Visual Numerical Relative Intensity Estimates and Colors for the 1997-98 Apparition of Saturn.

Globe/Ring Feature	Number of Estimates	1997-98 Relative Intensities: Mean & Standard Error	1997-98 Relative Intensities: Change Since 1996-97	"Mean" Derived Color in 1997-98
ZONES, HEMISPHERES, REGIONS AND CAPS:				
SPC	11	3.85 ±0.27	-0.15	Grey
SPR	30	5.18 ±0.14	+0.46	Yellowish-Grey
SSTeZ	8	5.88 ±0.12	-0.09	Dull Yellowish-White
STeZ	11	6.09 ±0.26	+0.21	Yellowish-White
STrZ	20	6.12 ±0.20	+0.60	Yellowish-White
SEBZ	8	5.46 ±0.30	-1.04	Dull Yellowish-White
EZs	58	7.11 ±0.13	-0.22	Bright Yellowish-White
Globe S of Rings	21	4.69 ±0.02	-1.27	Dull Yellowish-Grey
Globe N of Rings	31	4.86 ±0.10	+0.27	Dull Yellowish-Grey
EZn	16	5.28 ±0.04	-1.38	Yellowish-Grey
NTrZ	5	5.40 ±0.22	-0.64	Dull Yellowish-White
NTeZ	2	6.00 ±0.00	+0.08	Yellowish-White
NPR	8	5.25 ±0.22	+0.83	Yellowish-Grey
BELTS:				
SPB	13	2.38 ±0.15	—	Very Dark Grey
STeB	4	5.33 ±0.76	+0.51	Greyish
SEB (entire)	26	3.81 ±0.20	+0.51	Greyish-Brown
SEBs	36	3.55 ±0.20	+0.55	Dark Grey
SEBn	35	3.35 ±0.24	-0.35	Dark Grey
EB	9	4.24 0.04	+1.24	Dark Grey
NEB (entire)	22	3.82 ±0.09	-0.07	Greyish-Brown
NTeB	1	5.50 ----	+0.50	Light Grey
RINGS:				
A (entire)	52	6.90 ±0.08	+0.07	Yellowish-White
A5	1	4.60 ----	—	Light Grey
A0 or B10 (Cassini's Division)	35	1.96 ±0.15	+0.31	Greyish-Black
B (outer 1/3)	*STANDARD*	8.00 ±0.00	—	White
B (inner 2/3)	38	7.11 ±0.08	+0.78	Yellowish-White
C (ansae)	30	1.31 ±0.22	-3.19	Very Dark Grey
Crape Band	23	1.56 ±0.06	-1.08	Very Dark Grey
Sh G on R	37	0.18 ±0.06	-0.15	Dark Greyish-Black
Sh R on G	34	0.69 ±0.11	+0.43	Dark Greyish-Black
TWS	21	7.80 ±0.03	-0.70	White

Notes: For nomenclature see text and Figure 4. A letter with a digit (e.g., A0 or B10) refers to a location in the Ring specified in terms of units of tenths of the distance from the inner edge to the outer edge. Visual numerical relative intensity estimates (visual surface photometry) are based upon the A.L.P.O. Intensity Scale, where 0.0 denotes complete black (shadow) and 10.0 refers to the most brilliant condition (very brightest Solar System objects). The adopted scale for Saturn uses a reference standard of 8.0 for the outer third of Ring B, which appears to remain stable in intensity for most Ring inclinations. All other features on the Globe or in the Rings are compared systematically using this scale, described in the *Saturn Handbook*, which is issued by the A.L.P.O. Saturn Section. The "Change Since 1996-97" is in the sense of the 1996-97 value subtracted from the 1997-98 value, "+" denoting an increase in brightness and "-" indicating a decrease (darkening). When the apparent change is less than about 3 times the standard error, it is probably not statistically significant.

The intensity scale employed in this report is the A.L.P.O. Standard Numerical Relative Intensity Scale, where 0.0 is total black and 10.0 is the brightest possible condition. This scale is normalized by setting the outer third of Ring B at a standard brightness of 8.0. The arithmetic sign of an intensity change is found by subtracting a feature's 1996-97 intensity from its 1997-98 intensity. Variations of only ±0.1 mean intensity points are not considered to be of any real significance. Likewise, a perceived intensity fluctuation is not considered really important unless it exceeds roughly three times its standard error.

For estimating Saturnian global latitudes in 1997-98, observers utilized the visual method pioneered by Haas during the 1960s. Using his method, estimates are made of the fraction of the polar semidiameter of the planet's disk that is subtended on the central meridian (CM) between the limb and the feature whose latitude is desired. Haas' procedure is easy to use and produces results that compare favorably with latitude values measured with a bifilar micrometer. After mathematical reduction, latitudes of Saturn's global features during 1997-98 appear in *Table 4* (p. 111), but one must be cautious not to place too much confidence in data generated by only one or two observers. Haas and others have been employing the technique for many years with excellent and reliable results, and observers are encouraged to use this very simple procedure whenever possi-

Table 4. Saturnian Belt Latitudes in the 1997-98 Apparition

Saturnian Belt	Form of Latitude (all values are in degrees) Planetocentric		Eccentric		Planetographic	
S edge SEB	-26.8 ±1.8	(-5.6)	-29.4 ±1.9	(-5.9)	-32.3 ±2.0	(-6.3)
N edge SEB	-19.6 ±1.4	(-3.9)	-21.8 ±1.5	(-4.3)	-24.1 ±1.6	(-4.6)
Center EB	-7.4 ±0.4	(---)	+8.2 ±0.4	(---)	-9.3 ±0.5	(---)
Center NEB	+22.4 ±3.1	(---)	+24.7 ±3.4	(---)	+27.3 ±3.6	(---)

Notes: For nomenclature see Figure 4. Latitudes are calculated using the appropriate geocentric tilt, B, for each date of observation. Planetocentric latitude is the angle between the equator and the feature as seen from the center of the planet. Planetographic latitude is the angle between the surface normal and the equatorial plane. Eccentric, or "Mean," latitude is the arctangent of the geometric mean of the tangents of the other two latitudes. The change shown in parentheses is the result of subtracting the 1996-97 latitude value from the 1997-98 latitude value.

ble, even if a bi-filar micrometer is available. Haas recently suggested that a control on the accuracy of his method would be for participating observers to include in their estimates the positions on the CM of the projected Ring edges and the shadow of the Rings. The actual latitudes can then be computed from the known values of B and B′ and the dimensions of the Rings. It is true that this suggested test cannot be applied readily when B and B′ are near their maximum attained numerical values.

Comparing latitude data gathered by both methods is always useful. A full discussion of Haas' visual technique can be found in *The Saturn Handbook.* In discussing each feature on Saturn's Globe, notes regarding latitude data are incorporated into the text where appropriate.

Southern Regions of the Globe

Increasingly better views of the Southern Hemisphere of Saturn occurred during 1997-98 as these regions became tilted farther into our line of sight since 1996-97. Much less, of course, of the Northern Hemisphere of the planet was now visible, but a few belts and zones at corresponding latitudes in both hemispheres could still be compared with one another in 1997-98. Observers suspected that the Southern Hemisphere of Saturn appeared very slightly dimmer than the planet's Northern Hemisphere in 1997-98 (by -0.17 mean intensity points), an impression somewhat in contrast with the immediately preceding apparition. Infrequent sightings of transient dark features and some wispy festoons occurred among the belts and zones of the Southern Hemisphere of Saturn in 1997-98, but perhaps the most prominent, yet still very subtle, activity of the observing season was a series of diffuse, ill-defined whitish splotches in the Equatorial Zone (EZs). These features were first noticed on 1997 Nov 17 and were seen off-and-on until the third week of 1998 January. More will be discussed about these features in the upcoming section dealing with Saturn's Equatorial Zone.

South Polar Region (SPR).—The SPR displayed a uniform yellowish-grey hue during 1997-98, with no activity reported. The SPR had a mean intensity that differed by a factor of +0.46 from that of 1996-97, a variance that is considered to be negligible. There were several sightings in 1997-98 of a greyish South Polar Cap (SPC), and it was described as being slightly darker than its surroundings and at essentially the same mean intensity as in 1996-97. The South Polar Belt (SPB) was reported intermittently in 1997-98 as a very dark greyish linear feature encircling the SPR.

South South Temperate Zone (SSTeZ).—The SSTeZ was sighted on a few occasions during 1997-98, as opposed to the total absence of reports of its counterpart (the NNTeZ) in Saturn's Northern Hemisphere. The SSTeZ was described as a yellowish-white feature of consistently uniform intensity and displaying no change in brightness since 1996-97.

South South Temperate Belt (SSTeB).—The SSTeB was not reported during the 1997-98 Apparition.

South Temperate Zone (STeZ).—The yellowish-white STeZ was similar in overall intensity to the SSTeZ farther south, and the STeZ showed virtually no change in its mean intensity from 1996-97 to 1997-98. Comparing the STeZ with its complement in the Northern Hemisphere (the NTeZ), both zones were basically the same average intensity throughout the observing season. The STeZ showed uniform intensity during 1997-98 and no clearly-defined activity.

South Temperate Belt (STeB).—The STeB was greyish in color during

1997-98, extending without interruption across the Globe from limb to limb, displaying no activity. There was a mean intensity difference of +0.51 when comparing data for 1996-97 with 1997-98, but this mean numerical variance was trivial. The STeZ was reported to be roughly equal in intensity to its Northern Hemisphere equivalent, the NTeB.

South Tropical Zone (STrZ).—A mean intensity difference of +0.60 from 1996-97 to 1997-98 was derived for the dull yellowish-white STrZ, but this was not considered representative of an real brightness increase. Although the STrZ was thought by some to be lighter than the NTrZ in the North, a mean intensity difference of +0.72 is not significant. The STrZ remained stable in brightness and devoid of activity throughout the observing season.

South Equatorial Belt (SEB).— The SEB was characterized during 1997-98 as a greyish-brown feature, and unlike the immediately preceding apparition, it was often seen differentiated into SEBn and SEBs components (where **n** refers to the North Component and **s** to the South Component). Observers sometimes noticed that the SEB exhibited an intervening dull yellowish-white South Equatorial Belt Zone (SEBZ), with mean intensity data showing a difference of -1.04 (1997-98 vs. 1996-97). With the exception of the South Polar Belt (SPB), the SEB was the darkest and most obvious belt in the Southern Hemisphere of Saturn in 1997-98 with a negligible mean intensity difference since the last apparition of +0.51. Observational data revealed that the SEB and NEB had basically the same mean relative intensity during 1997-98. From the standpoint of the two dark greyish SEB constituents, the SEBn was always perceived to be slightly darker than the adjacent SEBs, and from 1996-97 to 1997-98, the SEBn was -0.35 mean intensity points darker than in the last previous apparition.

Random reports were received in 1997-98 of darkish spots and dusky projections that emanated from the northern border of the SEB, extending into the EZs. These vague dark features did not remain visible for a sufficient length of time to permit repetitive CM transit timings.

Equatorial Zone (EZ).—With Saturn's Rings inclined more favorably into our line of sight in 1997-98, the bright yellowish-white EZs was the region of the EZ seen to greatest advantage, although the EZn could still be viewed to the North. The intensity of the EZs was virtually unchanged since 1996-97, and it was consistently the most brilliant zone on Saturn during the 1997-98 Apparition, brighter than Ring A, usually equal to the inner two-thirds of Ring B in intensity, and on rare occasions observers believed that it even approached the brilliance of the outer third of Ring B. The enduring prominence of the EZs this apparition may partially be attributable to the aftermath of diffuse white spots reported in 1996-97, but more likely, it was due to the changing tilt of Saturn to the Sun and Earth. From 1997 Nov 17 through 1998 Jan 21 observers thought they could see diffuse whitish spots in the EZs, not quite as obvious as those sighted in 1996-97, and nowhere near as striking as the spots witnessed in the EZ during the great outbursts of 1960 and 1990. The 1997-98 spots were suspected in instruments ranging from 20.3 cm (8.0 in) to 25.4 cm (10.0 in) in mediocre seeing, and observers remarked that a light blue (W80A) filter improved the view. Attempts to recovery the whitish features in the EZs at subsequent rotations of Saturn were unsuccessful, prohibiting reduction of CM transits to rotation rates at that latitude.

The EZn was described in 1997-98 as yellowish-grey and quite dull when compared with 1996-97 (with derived mean intensity difference between apparitions of -1.38). Comparing the brightness of the southern and northern halves of the EZ, the data reveal a mean intensity difference of +1.83 (EZs vs. EZn). Perhaps the shadow of the Rings on the Globe contributed to a diminished intensity of the EZn; in addition, the Rings blocked most of the EZn from view.

Several observers called attention to the Equatorial Band (EB) in 1997-98, describing it as a dark greyish, ill-defined linear feature across Saturn's Globe. Intensity data hint that the EB may have had a marginally lighter tone in 1997-98 than in 1996-97 (by +1.24 mean intensity points).

Northern Portions of the Globe

In 1997-98 the Northern Hemisphere of Saturn did not fluctuate in mean intensity since 1996-97 (a difference of +0.27 mean intensity points is of no consequence), nor did regions north of the Rings display activity of any significance throughout the apparition.

North Equatorial Belt (NEB).—In 1997-98 the greyish-brown NEB was invariably undifferentiated into NEBn and NEBs components, and no discrete phenomena were reported in the NEB during the observing season. On the basis of intensity estimates in 1997-98, the NEB was essentially unchanged in mean intensity since 1996-97. Other than the aforementioned exception of the SPB, the NEB ranked second only to the SEB in being the darkest belt on Saturn in 1997-98.

North Tropical Zone (NTrZ).—The dull yellowish-white NTrZ was roughly the same intensity as the SEBZ during 1997-98 and uniform in intensity across the Globe from limb to limb. Visual photometric data showed a mean intensity decrease of only -0.64 for the NTrZ from 1996-97 to 1997-98.

North Temperate Belt (NTeB).—The NTeB was reported only once during the observing season, described as a poorly-defined light-greyish feature.

North Temperate Zone (NTeZ).—In 1997-98 the yellowish-white NTeZ was sighted only twice, with virtually no change in intensity since 1996-97. The NTeZ and STeZ exhibited about the same mean intensity during the 1997-98 observing season.

North North Temperate Belt (NNTeB).—Observers did not report this feature during the 1997-98 Apparition.

North North Temperate Zone (NNTeZ).—Observers did not report the NNTeZ during the 1997-98 Apparition.

North Polar Region (NPR).—The brightness of the yellowish-grey NPR appeared constant throughout 1997-98, with an apparent brightening of +0.83 from 1996-97 to 1997-98. The North Polar Cap (NPC) nor the North Polar Belt (NPB) were reported during the 1997-98 Apparition. The NPR and SPR were very similar in mean intensity during 1997-98.

Globe and Ring Shadows

Shadow of the Globe on the Rings (Sh G on R).—The Sh G on R was seen by observers as a dark greyish-black feature on either side of opposition during 1997-98, with regular form. Any perceived departure from a true black (0.0) intensity was a result of poor seeing conditions or scattered light.

Shadow of the Rings on the Globe (Sh R on G).—Observers in 1997-98 described this shadow as a dark greyish-black feature south of the Rings where they crossed the Globe. Reported variations from an intrinsic black (0.0) condition were due to the same causes given in the preceding paragraph.

Saturn's Ring System

This section of the 1997-98 Apparition report deals with investigations of Saturn's Ring System, including an continuing comparative investigation of mean intensity data that has been a practice in previous observing seasons. Views of the southern face of the Rings were progressively more favorable during 1997-98 as the value of B increased.

Ring A.—Considered as a whole, Ring A was yellowish-white throughout 1997-98 with no real change in mean intensity since 1996-97. An isolated observation of a light grey Encke's Division (A5) at the ring ansae was received during the apparition, and individuals apparently did not detect any other intensity minima in Ring A in 1997-98. Observers did not consistently distinguish obvious outer and inner halves of Ring A in terms of intensity.

Ring B.—The outer third of Ring B is the standard of reference for the A.L.P.O. Saturn Visual Numerical Relative Intensity Scale, with an assigned value of 8.0. For the entire 1997-98 Apparition, this region of Ring B was white, was always stable in intensity, and was undoubtedly the brightest feature on Saturn's Globe and Ring System, with the possible exception of a few suspected EZs white spots (of mean intensity 8.0) in 1997 November through 1998 January.

The inner two-thirds of Ring B, which was yellowish-white in color and uniform in intensity, had an apparent +0.78 brightening in mean intensity from 1996-97 to 1997-98, which represents virtually no change in brightness. During 1997-98, Ring A was only slightly dimmer than the inner two-thirds of Ring B, as witnessed by most observers, but this difference was far from being statistically significant (the mean intensity difference between Ring A and inner two-third of Ring B was +0.21).

Cassini's Division (A0 or B10).—Most observers concurred that sighting Cassini's division anywhere other than the ansae in 1997-98 was very difficult even in good seeing and with larger apertures. Of course, with fairly small Ring inclinations during 1997-98 (values of B averaged about -10°.0), views of Cassini's Division were nowhere near their optimum. Cassini's division was seen at both ansae throughout the apparition as a greyish-black gap, having about the same mean intensity as in 1996-97. Any divergence from a totally black intensity for this feature is almost certainly due to the scattering of light, poor seeing, inadequate aperture, and so forth.

Ring C.—The very dark grey Ring C (Crape Ring) was frequently seen at the ansae during 1997-98, and it appeared -3.19 mean intensity points darker in 1997-98 than it was reported to be in 1996-97. The Crape Band (Ring C across the Globe) was described as uniform in intensity and extremely dark grey in color. It is fairly easy to recognize that when B and B′ are both negative, and B > B′, the Shadow of the Rings on the Globe will be cast to their north (which occurred prior to 1997 OCT 07). The Crape Band is then also to the south of the projected Rings A and B. If B < B′, the shadow will be north of the projected Rings (the situation following 1997 OCT 07). When the shadows of Ring A and Ring B and the projection of Ring C are superimposed, they are not going to be easily distinguished from each other in ordinary apertures and seeing conditions. The shadow of Ring C is probably a further complication.

Terby White Spot (TWS).—The TWS is an occasionally-seen brightening of the Rings immediately adjacent to the Sh G on R. On several occasions observers referred to a bright TWS (mean intensity 7.8) during 1997-98, but it is of no real importance, because the TWS is almost surely a spurious contrast effect and not an intrinsic Saturnian feature. Even so, it is still useful to attempt to ascertain if any correlation exists between the visual numerical relative intensity of the TWS and the changing tilt of the Ring System, including its brightness and visibility in color filters and variable-density polarizers.

Bicolored Aspect of the Rings.—The bicolored aspect is a reported variation in color between the East and West ansae (IAU system) when systematically compared with W47 (Wratten 47), W38, or W80A (all blue) and W25 or W23A (red) Filters. Will and Haas were the only observers during 1997-98 who detected a bicolored aspect of the ring ansae, and *Table 5* (p. 115) lists the circumstances of their observations. Readers should note that the directions in Table 5 refer to Saturnian or IAU directions, where West is to the right in a normally-inverted telescope image (for observers located in the Northern Hemisphere of the Earth) which has South at the top.

To attempt to fully understand the bicolored aspect of the Rings, the A.L.P.O. Saturn Section strongly encourages observers to participate in organized simultaneous observing programs based on a schedule developed to insure that individuals in various locations are viewing Saturn on the same date and at the same time. The greater the number of people taking part in this effort, making independent, systematic visual estimates with color filters and doing CCD work and photography in the corresponding wavelengths, all at the same time, the greater will be the chances of shedding some new light on this intriguing and poorly-understood phenomenon.

SATURN'S SATELLITES

Unfortunately, as in the past few apparitions, observers in 1997-98 did not contribute systematic visual estimates of Saturn's satellites employing recommended methods discussed in *The Saturn Handbook*. Photoelectric photometry and systematic visual magnitude estimates of Saturn's satellites are strongly encouraged for future apparitions.

Table 5. Observations of the Bicolored Aspect of Saturn's Rings During the 1997-98 Apparition

Observer	UT Date and Time (entire observing period)	Telescope Type and Aperture	X	S	Tr	Filter Bl	IL	Rd
Will	1997 Sep 01 05:46-06:05	NEW 20.3 cm (8.0 in)	270	7.0	4.0	W	=	W
Will	1997 Sep 27 03:30-03:50	NEW 20.3 cm (8.0 in)	230	6.0	4.0	E	E	E
Will	1997 Oct 17 03:00-03:20	NEW 20.3 cm (8.0 in)	230	6.5	3.5	=	W	=
Will	1997 Oct 19 04:10-04:40	NEW 20.3 cm (8.0 in)	270	8.0	2.5	E	W	W
Haas	1997 Nov 11 02:10-03:26	NEW 20.3 cm (8.0 in)	231	4.5	3.0	E	=	W
Haas	1997 Nov 25 03:35-03:58	NEW 31.8 cm (12.5 in)	366	4.0	4.0	E	=	=
Haas	1997 Nov 30 03:26-04:05	NEW 31.8 cm (12.5 in)	366	3.5	4.5	E	=	=
Haas	1997 Dec 05 03:45-04:18	NEW 31.8 cm (12.5 in)	366	4.0	3.5	E	=	=
Haas	1997 Dec 13 02:45-03:27	NEW 31.8 cm (12.5 in)	366	2.5	5.0	E	=	=
Will	1997 Dec 14 01:40-02:00	NEW 20.3 cm (8.0 in)	270	3.5	2.5	E	E	E
Haas	1997 Dec 17 02:40-03:25	NEW 31.8 cm (12.5 in)	321	3.0	2.5	E	=	=
Haas	1997 Dec 18 03:20-03:48	NEW 31.8 cm (12.5 in)	321	4.0	3.5	W	=	=
Haas	1997 Dec 28 02:56-03:26	NEW 31.8 cm (12.5 in)	321	2.5	4.0	E	=	=
Haas	1997 Dec 30 03:08-03:45	NEW 31.8 cm (12.5 in)	366	4.0	2.5	E	=	E
Haas	1998 Jan 01 02:10-03:01	NEW 31.8 cm (12.5 in)	366	3.5	4.5	E	=	=
Haas	1998 Jan 07 02:34-03:03	NEW 31.8 cm (12.5 in)	366	3.0	3.5	E	=	=
Haas	1998 Jan 25 01:20-02:22	NEW 31.8 cm (12.5 in)	366	3.5	3.5	E	=	=
Haas	1998 Jan 26 01:59-02:24	NEW 31.8 cm (12.5 in)	366	3.5	4.0	E	=	=
Haas	1998 Jan 29 01:24-01:54	NEW 31.8 cm (12.5 in)	388	3.0	4.0	E	=	=
Haas	1998 Feb 03 01:29-02:04	NEW 31.8 cm (12.5 in)	321	3.0	4.5	E	=	=
Haas	1998 Feb 13 01:23-01:54	NEW 31.8 cm (12.5 in)	366	3.5	4.0	E	=	=
Haas	1998 Mar 01 01:38-02:00	NEW 20.3 cm (8.0 in)	231	3.5	4.0	E	=	=
Haas	1998 Mar 02 01:40-02:09	NEW 20.3 cm (8.0 in)	231	3.5	4.0	E	=	=
Haas	1998 Mar 04 01:34-02:03	NEW 20.3 cm (8.0 in)	231	3.5	3.5	E	=	=
Haas	1998 Mar 20 02:05-02:10	NEW 20.3 cm (8.0 in)	231	1.0	2.5	E	W	E

Notes: Telescope types are as in Table 2. Seeing is the 0-10 A.L.P.O. Scale (0 = worst to 10 = perfect), and Transparency is the limiting visual stellar magnitude in the vicinity of Saturn. Under "Filter," Bl refers to the blue W47 or W80A filters, IL to integrated light (no filter), and Rd to the red W25 or W23A filters. E means the East ansa was brighter than the W, W that the West ansa was the brighter, and = means that the two ansae were equally bright. East and West directions are as noted in the text.

Simultaneous Observations

Simultaneous observations, defined as studies of Saturn by individuals working independently of one another but at the same time and on the same date, provide much-needed verification of ill-defined phenomena on Saturn's Globe and in the Ring System. Such efforts significantly reinforce the level of confidence we have in data submitted for each apparition. A few simultaneous, or near-simultaneous, observations of Saturn were submitted during 1997-98, but as in the 1996-97 Apparition, the occurrence of such observations was fortuitous. The A.L.P.O. Saturn Section has organized simultaneous observing team so that several individuals in reasonable proximity of one another will be viewing Saturn at the same time using similar equipment and methods. Although it is important that at least our more experienced observers take part in this effort, newcomers to observing Saturn are welcome to contribute. Readers are urged to inquire about how to join the simultaneous observing team for future observing seasons.

Conclusions

From the preceding report, it should be obvious that Saturn appeared relatively quiescent in terms of atmospheric activity during 1997-98 when compared with the past two apparitions. One possible highlight of the 1997-98 Apparition was the sighting of diffuse white spots in the EZs during the late Fall of 1997 and early winter of 1998, although these features were far too transient for observers to successfully track their recurrent passage across Saturn's CM. Saturn's Southern Hemisphere also displayed a few festoons and dark projections along the SEB, but these phenomena were even more short-lived than the white ovals in the EZs.

Sample observations of Saturn in the 1997-98 Apparition, in the form of drawings, photographs and CCD images, are shown in *Figures 5-11* (pp. 116-117).

The author is extremely grateful to all individuals mentioned in this report who submitted drawings, photographs, CCD images, and descriptive reports to the A.L.P.O. Saturn Section for the 1997-

98 observing season. Without such dedicated efforts, our programs and endeavors to gain further understanding of the planet Saturn would have little success.

Interested prospective observers in the United States and other countries are encouraged to join our team and submit observational reports to the A.L.P.O. Saturn Section, which is always pleased to provide guidance for novice and advanced observers alike. Also, budding young astronomers, who may be exposed to lunar and planetary subjects for the first time in their school years, are heartily welcomed to join us. One very meaningful resource for learning just how to observe and record data on the Moon and planets is the A.L.P.O. Training Program, and one of our responsibilities is to always encourage development of special talents a particular observer might bring to our programs.

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Caption Information for Figures 5-11 (below and p. 117).

Unless otherwise stated for these illustrations: All dates and times are in Universal Time (UT). Telescope types are as given in Table 2; **Seeing** (S) is given on the 0-10 A.L.P.O. Scale, where 0 is the worst possible and 10 is perfect; **Transparency** (Tr) is the limiting naked-eye visual magnitude in the vicinity of Saturn; **CM(I)** is the central-meridian longitude in rotational system I (844°.3/day, applying to the NEBs, EZ, and SEBn); **CM(II)** is the same in rotational system II (812°.0/day, applying to the remainder of the Globe); **B** is the saturnicentric latitude of the Earth; **B'** is the saturnicentric latitude of the Sun; **Globe** is the apparent diameter of the Globe in arc-seconds (equatorial and polar); and **Rings** is the apparent major and minor axes of the Rings in arc-seconds. The source of ephemerides was *The A.L.P.O. Solar System Ephemeris* (1997 edition) and *The Astronomical Almanac for the Year 1998*. Saturnicentric south is at the top, with celestial east (following) to the right, unless otherwise stated. The sky background has been made black for all illustrations when it was not already so, and contrasts have been exaggerated.

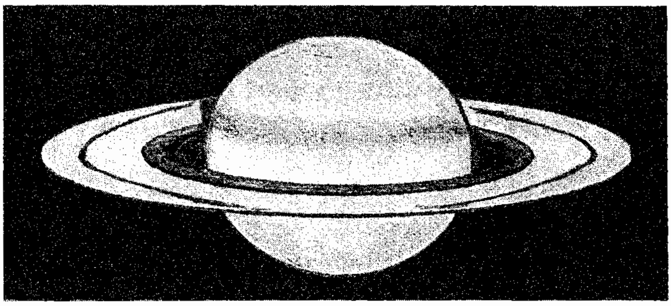

Figure 5. Drawing of Saturn by P. Plante, 1997 Aug 30, 03^h50^m-04^h15^m UT. 20.3-cm (8.0-in) SC, 250X, Wratten 38A (blue) and 23A (light red) Filters. S = 7-8, Tr = +3.5. CM(I) = 237°.2-251°.9, CM(II) = 352°.2-006°.2. B = -11°.2, B' = -9°.7. Globe = 19".2 X 17".2, Rings = 43".7 X 8".5.

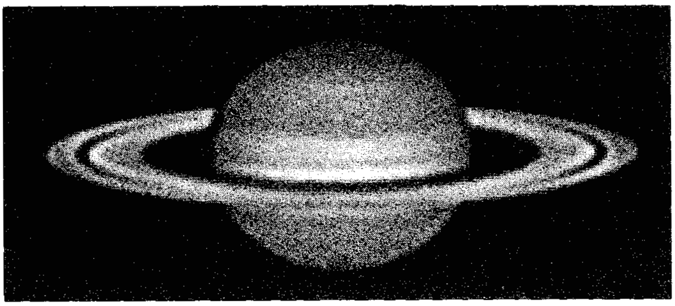

Figure 6. CCD image of Saturn by I. Miyazaki, 1997 Oct 03, $14^h52^m25^s$ UT. 40.6-cm (16.0-in) NEW, Lynxx PC CCD camera, integrated light, NR400 Filter, 1.4-s exposure. S = 7.0. CM(I) = 174°.7, CM(II) = 256°.6. B = -10°.2, B′ = -10°.2. Globe = 19″.7 × 17″.6, Rings = 44″.9 × 8″.0. The bright spot on the north (bottom) limb is the satellite Tethys.

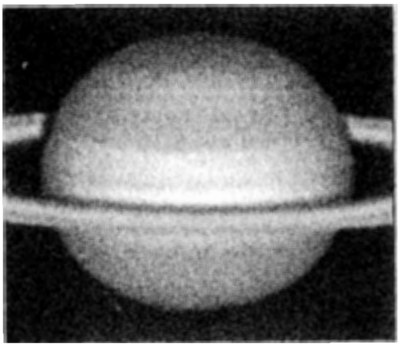

Figure 7. CCD image of Saturn by I. Miyazaki, 1997 Oct 03, $15^h02^m29^s$ UT. 40.6-cm (16.0-in) NEW, Lynxx PC CCD camera, integrated light, 1.8-s exposure. S = 7.0. CM(I) = 191°.2, CM(II) = 272°.4 B = -10°.2, B′ = -10°.2. Globe = 19″.7 × 17″.6, Rings = 44″.9 × 8″.0. Satellite Tethys to lower left of Globe.

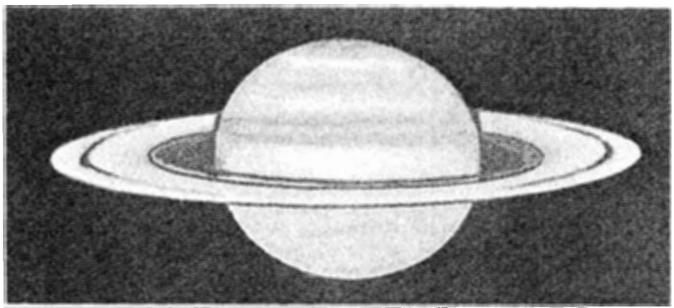

Figure 8. Drawing by P. Plante. 1997 Nov 21, 01^h35^m-01^h58^m UT. 20.3-cm (8.0-in) SC, 250×-380×, integrated light. S = 6-7, Tr = +3.0. CM(I) = 244°.9 -258°.4, CM(II) = 284°.1-297°.1. B = -9°.8, B′ = -10°.4. Globe = 19″.7 × 17″.6, Rings = 44″.9 × 7″.7.

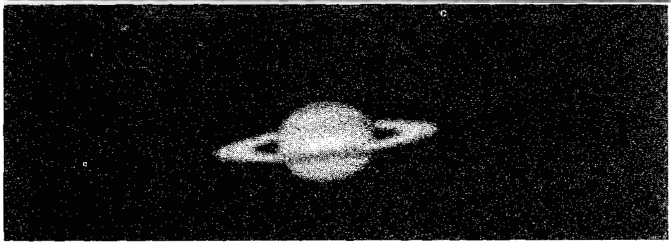

Figure 9. CCD image of Saturn by F.J. Melillo, 1997 Nov 21, $01^h37^m56^s$ UT. 20.3-cm (8.0-in) SC, Starlite Xpress MX5 CCD camera, integrated light, 2.0-s exposure at f/20. S = 8.0. CM(I) = 006°.2, CM(II) = 324°.5. B = -8°.9, B′ = -10°.9. Globe = 19″.7 × 17″.6, Rings = 44″.9 × 8″.0. Satellite Titan in upper left.

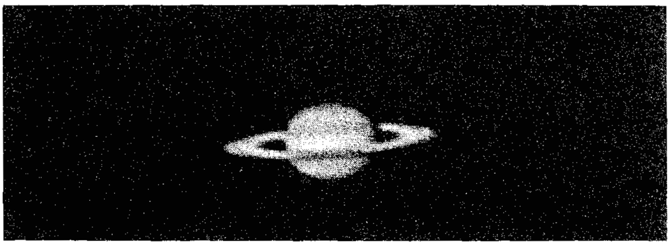

Figure 10. CCD image of Saturn by F.J. Melillo, 1997 Dec 29, $02^h06^m46^s$ UT. 20.3-cm (8.0-in) SC, Starlite Xpress MX5 CCD camera, integrated light, 2.0-s exposure at f/20. S = 7.0. CM(I) = 099°.4, CM(II) = 008°.5. B = -8°.8, B′ = -11°.4. Globe = 18″.0 × 16″.1, Rings = 41″.0 × 6″.3. Satellites Rhea (upper right) and Tethys (below and to the left of Rhea) shown.

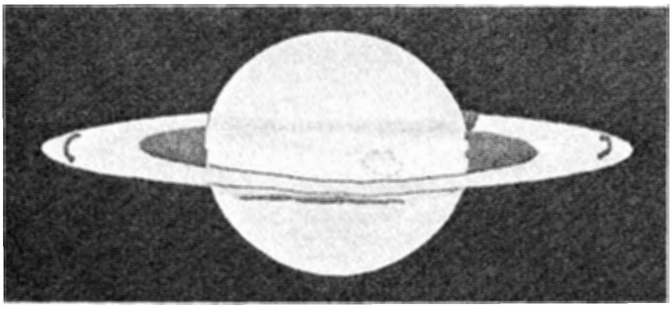

Figure 11. Drawing by E. Crandall. 1998 Jan 21, 00^h02^m-00^h29^m UT. 25.4-cm (10.0-in) NEW, 150×-220×, Wratten 82A (blue) Filter. S = 3-5, Tr = +3.8. CM(I) = 013°.5-019°.3, CM(II) = 151°.9-167°.2. B = -9°.37, B′ = -11°.76. Globe = 17″.2 × 15″.4, Rings = 39″.3 × 6″.4.

The Enigmatic Light of Venus: An Overview

By: Richard Baum

The greyish gleam alleged to illuminate the dark side of Venus and known as the Ashen Light, is one of the oldest unsolved mysteries in the observational history of the Solar System, having first been remarked in 1643 by the Jesuit priest and professor of astronomy at Bologna, Giambattista Riccioli. [1] At least that was the opinion of C. V. Zenger who first drew attention to the observation in 1883. [2] It is of course possible the whole disk was seen because Riccioli gives a drawing here reproduced as *Figure 1* (below). But the phenomenon he describes is of such an extraordinary character that Camille Flammarion was constrained to say; "We know of few observations as amazing as this," and he categorized it as a historical curiosity. [3]

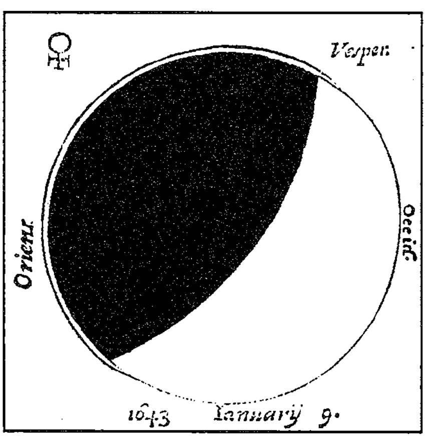

Figure 1. Drawing of Venus by Giambattista Riccioli, 1643 January 9. North at top. From *Almagestum Novum* (1651), Vol. 1, p. 484.

Without wishing to denigrate the observation still further, it is as well to note that the first incontestable report of the visibility of the dark side is that by the English cleric William Derham, Canon of Windsor, mentioned by Francois Arago in his greatly admired two-volume *Astronomie Populaire* (1855). The original account is to be found in Derham's *Astro-Theology*, a work forgotten today, but which once had great renown. It is there in Book V, Ch. 1 of the first edition (1715), while discussing the shape of the celestial bodies that Derham casually remarks; "this sphaericity, or rotundity is manifest in our Moon, yea and in Venus too; in whose greatest falcations the dark part of their Globes may be perceived, exhibiting themselves under the appearance of a dull, and rusty colour." [4]

Here then is the classic description of how the phenomenon of which astronomical historian Agnes Clerke said; "it may serve on a night-enwrapt hemisphere to dissipate some of the thick darkness otherwise encroached upon only by the pale light of stars", is universally perceived. [5] The implied analogy with earthshine needless to say, has no significance beyond coincidence; earthshine is verifiable fact, the Ashen Light is not, and what is known of it is ambiguous, circumstantial, and contradictory.

For instance on seven mornings in the period 1871, October 15 to November 12, H.C. Vogel and O. Lohse with the refractor at Bothkamp, saw the dark hemisphere partially lit by secondary light. Yet on five other mornings they failed to discern either the light or the dark side. [6] In 1935 D. Barbier of the Marseilles Observatory organised a programme of concerted observation. Twenty-one observers took part, and between August 15 and October 1 examined Venus on each day but three; as many as eight reports were available for certain days. Three observers reported positive sightings of the entire disk, each on a different day; but each checked negative against reports from two to six other observers. Not surprisingly Barbier pronounced "la lumiere cendree de Venus est une legende." [7]

Curiously, the effect most often remarked by the observers was an indefinite darkening within, and sometimes beyond, the horns of the crescent. This was visible in daylight and bright twilight, and gave the impression that the unlit hemisphere was actually darker than the surrounding sky. The effect is well known. Arago called it *negative visibility*, and de Heen and others were disposed to ascribe it to projection on the solar corona or the zodiacal light. This involves difficulties, not the least of which is scattering in the Earth's atmosphere. So, perhaps, the simplest explanation is contrast. Careful study of earthshine may provide useful insights about this vexing problem; for instance, it has been the writer's experience that in bright twilight the region embraced by the horns of the crescent moon is somewhat darker than the adjoining sky.

Half a century or so ago C.B. Stephenson, graduate student in the Yerkes Observatory and Recorder of the Mercury Section of the A.L.P.O., set the wires of the astronomical exchange vibrating with extraordinary intelligence when he disclosed in a letter to Walter H Haas that A.B. Meinel had actually succeeded in obtaining a photograph showing the interior of the crescent of Venus darker than the background sky. The photograph was taken near inferior conjunction in June 1940, with a 15-cm reflecting telescope, to the optical system of which a lens had been added in order to increase the focal length. It is a matter of some regret that so far as is known the image was never published, and is now presumed lost. Haas cites the story in his "La Visibilidad del Hemisferio Oscuro de Venus" (1950). [8]

Haas himself was "unable to distinguish the least difference in colour or brightness between the obscure face and the sky adjoining the planet" when he observed at inferior conjunction in 1942. Yet, he says, "it was a curious fact that I continued to receive reports from correspondents confirming the visibility of the dark face, including one from Mr. Robert Barker in England. My first personal positive verification of the phenomenon was made on June 6th, 1948, at 2hr. 35min. UT. Sunset occurred at 2hr. 17 min. and the Sun-Venus-Earth angle was 143°." His notes of that time comprehensively summarize what most reliable observers have seen. "I have seen the ashen light, the curious illumination of the dark side, for the first time! It is not surprising, I would have seen it without seeking to do so; in all, I think that there is little chance of it being an illusion. It is very like the ashen light of the Moon, in particular the edge of the dark face is brighter than the central part (contrast effect?) and the circle of the illuminated crescent appears larger than that of the dark face (irradiation) ... I cannot see any colour (in the dark side) except possibly a grey-reddish hue." [9]

Haas adds that "the obscure face was repeatedly seen by members of ALPO" prior to inferior conjunction 1950 JAN 31. "So often in fact that it no longer seems possible to doubt the objective reality of this phenomenon... At least sixteen people saw the obscure face during December [1949] and January [1950], seemingly a much greater number than during any similar period previously." Observations on December 15 "between lhr 10min and 3hrs 25min., UT," by D.L. Bellot, F.E. Brinckman, Jr., and T.R. Cave, Jr., at Long Beach, California, were of particular interest. With telescopes of from 15- to 20-cm aperture they each independently affirmed, "that the dark face glowed over an area in the form of a biconvex lens, with one surface along the terminator and the other some way within the dark limb. This lens, ... occupied about one third of the projected area of the whole disc, considered as circular." Haas judged the observation "of major importance and ... preferable as evidence to many individual and unconfirmed reports."

In the same period, on December 29 and 30, L.E. Armfield, Elyria, Ohio, found the dark side "completely visible as if it were faintly luminous. Its aspect was identical with that presented by the ashen light of the moon seen through a small glass at low magnification when the moon is two days old, not so bright of course, but all the same clearly visible." [10]

The leading British planetary observer M.B.B. Heath, from 1951 to 1963 Director of the Saturn Section of the British Astronomical Association, also saw the dark side faintly glowing on several occasions in January, 1950, as well as obscurity between the horns. [11] Hestin in France had the same experience on the 23rd and 26th of the month. He described the dark side as bluish. [12] Likewise, the present author noted illumination on the dark side of the Planet on 1951 SEP 11; his drawing is shown in *Figure 2* (p. 120).

Of course all this contrasts sharply with earlier presumptions. Alexander von Humboldt knew of only three observations of the dark side. Francois Arago listed five, Johann Maedler but two, while Friedrich A.T. Winnecke thought his daylight observations of 1871 were the first since 1759. Early editions of Webb's *Celestial Objects* were no more informative. [13] But A. Schafarik of Prague was

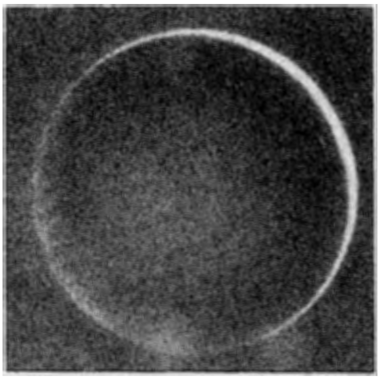

Figure 2. Drawing of the dark side of Venus by Richard Baum on 1951 Sep 11, 05h45m UT. 7.62-cm refractor, 100X. Made under excellent conditions of seeing and transparency. South at top.

aware of "more observations ... than is ordinarily supposed," and following a personal sighting in July, 1868, undertook to collect all known observations of the secondary light. His paper, which lists twenty-two instances starting with Derham, was first printed in the notices of the Bohemian Academy of Sciences, July 18, 1873, [14] and given in abstract by Winnecke. [15] The paper was also published in the annual proceedings of the British Association for the Advancement of Science, 1873. [16] C.V. Zenger's paper of 1883 is notable for drawing attention to Riccioli's curious observation. [17] The subject aroused great interest in 1895 as may be deduced from the many communications found in the sixth volume of the *Journal of the British Astronomical Association.* In 1950, Walter H Haas published his invaluable summary. [18] In 1936 D. Barbier announced the results of his investigation. [19] Twenty-one years later, the writer produced a descriptive list of forty-four of the more interesting sightings from 1643 to 1900. [20] Research has since uncovered the existence of numerous unreported observations.

In 1988 C.T. Russell, University of California, and John Phillips, Los Alamos National Laboratory, repeated Barbier's experiment, targeting Venus as it passed through inferior conjunction on June 13. The investigation involved 70 observers in six countries, and provided over 2000 separate observations. Telescopes varied in type and design, and ranged from 5.08- to 91.5-cm in aperture. An initial step in analysis was to limit the observations to night and twilight, discounting those made during daylight. Another step was to consolidate each sequence of multiple observations by a single astronomer at a single sitting into a single report. The resulting data set contains 700 observations spanning 120 days before and after inferior conjunction. [21]

Significantly 190 positive sightings were registered. Of these the most credible were from Robert W. Middleton (England), Massimo Giuntoli, (Italy), Gerald North and Alan Carey. North and Carey observed together at the Royal Greenwich Observatory, using 17.8-, 76.2- and 91.5-cm telescopes. [22] Their observation is well known.

Less familiar is what Mr. Middleton saw through his 12.7-cm refractor on May 12. Cloud thwarted active response to his telephone alert that evening. The next day he reported to the writer; "I commenced observing Venus 1930 UT. 12/5/88. I use Wratten filters 25 (red), 58 (green), 15 (yellow) and 44a (blue). When I used the Blue I was astonished to see the dark side very faintly lit, I went through the filters again, it was not seen with the Yellow, Green or Red. I checked a couple more times then I rang yourself. I don't know if it was ashen light, I have seen nothing like it before. I estimated the phase as 0.22." [23] There things might have remained, but for the fact that as Mr Middleton logged his observation, the German astronomer Bernd Flach-Wilken imaged Venus in ultraviolet. His photograph shows a faint gleam on the dark side, not unlike that seen visually by Middleton. [24]

Coincidence or confirmation? Whatever the answer, the observational data tell us here is something in need of close investigation. Something that has properties one expects of a phenomenon intrinsic to the planet; a fact Phillips and Russell recognised when they urged astronomers "to continue efforts to solve this centuries-old riddle." [25] Against this background a review of recent observations of more than ordinary interest, is not without relevance.

In 1996 inferior conjunction occurred on June 10. Two weeks earlier, on May 2, using the 0.20-m Thorrowgood refractor at Cambridge University, England, Jonathan Shanklin had a; "Strong impression of ashen light, but probably psychological .... impression of faint continuous ring of light [twilight arc outlining the dark limb]". With the 0.30-m Northumberland refractor at Cambridge on the 30th he had an; "Impression of ashen light which disappeared when the bright limb was out of the field." His sighting with the Thorrowgood, of June 4, phase 0.02, is more positive; "Razor thin crescent. Cusps elongated to 200 - 240 deg. A[shen] L[ight] suspected even when bright crescent occulted." [26]

Popular texts allege it is only when the crescent of Venus is very thin that the Ashen Light makes its appearance; this makes sense since the dark side is then almost entirely turned in our direction. Yet the math is otherwise. From a study of 125 visual sightings made between 1954 and 1962, J.L. Levine found that only 12 percent of all the observations were made at this time; 25 percent of the total were actually made at a reference angle of 21° to 30° (here inferior conjunction corresponds to 0°, superior conjunction to 180°). [27]

Laurence H. Field, University of Canterbury, Christchurch, New Zealand, found the dark side brightly illuminated before sunrise 1998 Apr 17, some three months after inferior conjunction. Dr. Field was sited at an elevation of 1000 feet at Port Hills, the remains of a volcanic caldera above a large natural harbour, south of Christchurch, some 5 km from the edge of the city suburbs. Venus was at an altitude of 25° above the Southern Ocean and half full. "The sky was still dark before sunrise," he writes. "I looked at Venus with the Questar [3.5-in Maksutov, 160×, Konig eyepiece plus Barlow], and noticed ... it clearly looked like the Moon with ... earthglow." The appearance was quite distinct, and defined the disk of the planet. Seeing conditions were superb. The moon was gibbous, its limb sharp and still, with no trace of undulation due to turbulence.

Another observation followed prior to inferior conjunction 1999 Aug 20. On this occasion Dr. Field observed at 18^h30^m on July 6 from Christchurch, at an elevation of 200 feet, with a 17.8- cm Maksutov, 12-mm Brandon eyepiece (212× and 424× with Barlow). He says; "Venus was above the neighbor's house, about 30 deg. altitude in the northwest evening sky. Weather had been clear all day (warm nor'wester, high pressure zone). I set up the Questar for a quick look at Venus, which was about 1/4 crescent phase. Although the seeing was poor, every so often I could see light extensions of the two cusps into a partially circular outline [twilight arc, which did not completely encircle the disk]. Along with this phenomenon, I could occasionally make out the very pale shadow side enclosed by the cusp extensions." Kevin Barker from South Island, New Zealand, independently confirmed the observation with a Zeiss APQ 10.0-cm f/10 fluorite refractor. C.E.R. Brook, Plymouth, England reported a similar appearance some three weeks or so earlier, at 20^h33^m on June 18. [28]

Although Barker, Brook and Field each describe the phenomenon in terms of uniformity, *viz.*, an undifferentiated illumination at once subtle and illusive; others speak of structure, of patchiness, irregular contrasts, even of a filmy granular look, such as was evident to the writer in 1953. [29]

David Graham of the British Astronomical Association (BAA) suspected structure when he used a 152-mm, f/13 refractor to inspect the planet on 1988 May 16. In a bright sky at 18^h35^m UT, the dark side looked normal in integrated light. Fifteen minutes later with a W15 (yellow) Filter irregularity was suspected, and at 19^h00^m he noted with a W25 (red) Filter; "something funny with unilluminated portion of disk," but had a strong impression that"very illusive mottling remains." At 19^h15^m, with a W44A (blue) Filter, no trace of the anomaly could be found. By 19^h30^m, using a W58 (green) Filter, it was again faintly visible, but less so than in the red.

Structure was visible at 21^h15^m with the W25 (red), W44A (blue), and W58 (green) Filters, but vanished once the bright crescent was occulted. No trace was visible in integrated light, or with the W15 (yellow) Filter at 18^h35^m. At $21^h 50^m$, using the W25 Filter, and 166× and 222×, Graham thought the whole of the unilluminated side brighter than the sky. A feeble trace showed in integrated light. [30]

What confronted David Gray at Kirk Merrington, England, on the morning of 1999 Oct 03 was even more striking.

"Whilst scrutinising the image with a W22 [deep orange] filter," he

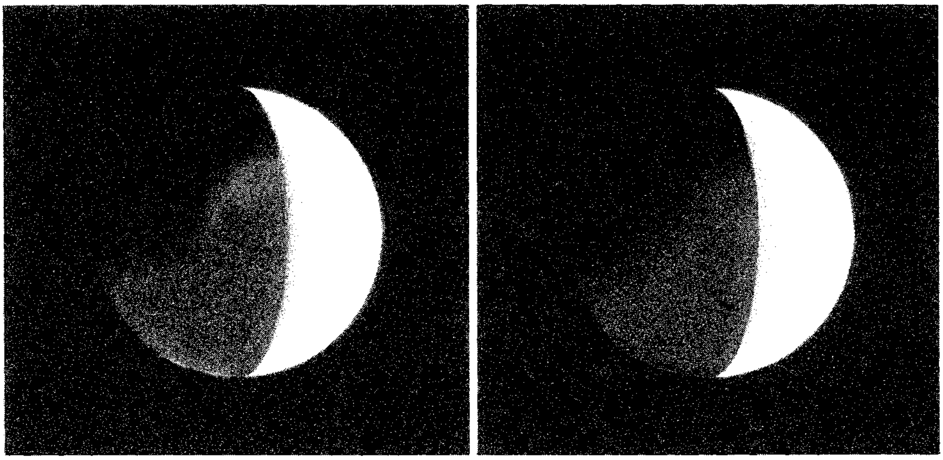

Figure 3. Drawings of the Ashen Light of Venus made on 1999 OCT 03 by David Gray of Kirk Merrington, England, with a 41.5-cm Dall-Kirkham reflector, 348X. (Left) 05^h50^m UT, Seeing II/III, Transparency very good, W38A (light blue) and W47B (dark blue) Filters. (Right) 05h30m UT, Seeing II/II-III, Transparency excellent, W15 (yellow) and W58 (green) Filters. Seeing is in the Antoniadi Scale, where **II** = "Slight undulations, with moments of calm seeing lasting several seconds" and **III** = "Moderate seeing, with large air tremors." South at top.

says, "and although highly suspicious of it most of the time, I started to believe that the dark hemisphere was lighter than the sky. Changing to integrated light seemed to indicate the area to be of a tawny-grey hue. Suspecting some effect from the apodiser [apodising screen constructed of fine mesh] this was removed but the impression remained—possibly more so! Returning to W22 it was all made the more convincing in that it stood out more clearly during the better moments with some discrete structure(s) glimpsed. Also at these times it was apparent that not the whole of the disk was outlined. The main illumination being more toward the north and rather tapering off toward the mid-south terminator side. Here being an irregular lighter patch; but most definite of all were two, or more, light 'extensions' running from the north cusp, apparently along the limb. The effect was weaker and featureless tho' pear-shaped with W23A [light red] and doubtful with W25. W15 showed it, very doubtfully, and the blue filters not at all—even W80A [light blue]. Though the latter investigations were done in an ever brightening sky—even then, a last look with W22 still rather suggested something there!"

Could the W22 Filter be flawed? "As far as I know," Gray writes, "it performs as well as other filters in the collection. I have often used [it] on the moon to good effect; had I noticed any 'overspill' of light into, for instance, craters with shadowed floors, this would soon have offended, as I enjoy good clean crisp views! I can say that I checked the Venus phenomenon by using the filter both in front of and behind the eyepiece; and also tipped and rotated the filter to be satisfied that there was no defect."

He further notes: "Secondary spiders have been blamed for causing the Ashen Light effect." But the Dall-Kirkham has the secondary affixed to the optical window, so as Gray remarks "no vanes." Of course the optical window itself might come under suspicion, and Gray admits there "is a slight ghost from this, but displaced a few arc minutes from the source." He continues, "I think this is due to it being not exactly square on but have left it that way so as not to interfere with faint objects near bright planets!" (31) Mr. Gray's two drawings made that morning are shown in *Figure 3* (above).

Like many others before, Larry Field drew a comparison with earthshine. Ostensibly the Ashen Light of Venus is analogous to earthshine. But Rheinauer in 1861 calculated that if earthlight were indeed the cause, the ashy light should equal a star of magnitude 14. "That this explanation is insufficient," remarked Schafarik, "is so clear as to need no further proof." [32] Nor can we invoke light reflected from a satellite; Venus is moonless. The *Kunstliche Feuer* of Gruithuisen is sheer fantasy. J. Lamp proposed the feeble gleam visible to him at Bothkamp 1887 Oct 21 and 26, might result from electrical activity in the planet's atmosphere. [33] Certainly airglow and other processes connected with the planet's meteorology are possibilities, though attempts to correlate Pioneer Venus Orbiter data with the many corroborated sightings obtained during the 1988 global campaign produced no evidence of interaction with solar emissions. [34] Vulcanism as a cause has also been suggested, while lightning in the clouds of Venus—which may explain electromagnetic signals picked up by all 4 Venera landers—was proposed by Meinel and Hoxie (1962), [35] and Russell (1991) [36] and others. Another possibility emerged in 1983 when David A. Allen and John W. Crawford imaged the planet in infrared and found cloud patterns on its night side. These clouds have a retrograde rotation period of 5.4±0.1 days and are thought to be at a lower level than the UV features, and may be sufficiently lit by radiation scattered from the dayside to occasionally become visible in integrated light. [37]

Of course, speculation of this nature presupposes a phenomenon of predictable characteristics. This is certainly not the case. So with what are we faced? A fabulous fiction, or hard reality? History dictates caution when dealing with phenomena at or near the limits of visibility. We need only remind ourselves of the story of Mars and its canals, of Neptune and its phantom ring and so on, to realise how skilled and experienced observers can be easily deluded. But even if the evidence is circumstantial, there is about it a quality that leaves us with intimations of something as yet to be recognized; the sense of a riddle wrapped up in an enigma.

It is acknowledged that the amateur fraternity is the main source of observational information about the Ashen Light. Dedicated and enthusiastic, often with limited means, its members produce results which are scientifically useful. We only have to cite Ch. Boyer's observations that led to the discovery of the 4-day rotation of the upper atmosphere of Venus to appreciate the fact. Even so amateur observers are circumscribed by domestic pressures, *viz.*, the need to earn a living, and the responsibilities of family life and so on. Hence their observations are invariably seen as snapshots, not continuous records. This is not to say they lack substance, rather that if the problem is to be resolved collaboration between amateur and professional is vital. However it is not the purpose of this note to assign observational procedures, or to delineate a specific strategy, but to put some of the more interesting observations into historical context, and so perhaps establish a departure point for a future study.

In the meantime observers should adopt a more consistent observational strategy. There is no doubt about the great difficulty of detecting the phenomenon. In some respects its visibility in the telescope can be compared with the appearance of earthshine to the naked eye or with slight optical aid, though there is a significant difference; we are conscious of the nature of earthshine. Still it is not easy to recognize earthshine in daytime or in a bright twilight sky. Indeed, as mentioned earlier, it is hard to decide whether the unlit parts of the Moon are brighter or darker than the sky. Also, earthshine is difficult to detect when the Moon is more than three or four days old. This suggests that any true brightening of the unilluminated hemisphere of Venus is likely to be detected by the visual telescopic observer only when the planet is a narrow crescent, and is viewed in a comparatively dark sky. The two requirements are somewhat exclusive. When Venus is observed in a dark sky it is bound to be near the horizon, with the inevitable cocktail of bad seeing, poor transparency and atmospheric dispersion. Obviously an occulting bar is an essential tool. It is also necessary to be vigilant for contrast-induced illusions close to the planet.

Experimentation with a range of techniques, including the use of a CCD recorder of appropriate sensitivity and dynamic range, is also suggested. We also need further studies of the emission spectrum of the night side of Venus. Professionals are not readily able to make this observation due to scarce telescope time, and the difficulty of accessing the planet against a dark sky because of zenithal-angle limitations. A direct-vision spectrograph on a low-power eyepiece is perhaps the best tool. If the Ashen Light is an airglow phenomenon, there is a reasonable possibility that much of the radiation would be a single line. A continuum source would probably be smeared and diffused below the threshold of sensitivity.

What then are we to make of the phenomenon? This *lumiere cendree*? How do we explain the ambiguity of filter observations? Are filters a hindrance or an asset? Why is it visible to one observer, but not to another, yet simultaneously seen by independent observers many kilometres apart? It is reported then lost; reappears only to vanish again. It is a haunted, and haunting phenomenon; as elusive and illusive as *Gran Quivira*, the legendary place where Francisco Vazquez Coronado sought the fabulous Seven Cities of Cibola. Still his quest ended in a sort of truth, the dwellings of the Zuni; so perhaps our search for the truth of the Ashen Light may likewise end in similar fashion. A study conducted with care and persistence over a period of time by dedicated, and well-equipped observers, may finally unravel the mystery.

Notes & References

1. Riccioli, G. (1651). *Almagestum Novum.* Vol. 1. pp. 484-485. Riccioli says: "Iam veto & Nos saepissime observavimus Venerem falcatam; nec semel bifidam, aut gibbam, semper tamen flammivomam: Anno praesertim 1643. Ianuarij 9. tubo Fontana rnihi commodato, eo situ ac figura, quam eernere eft in praesenti diagrammate. Erat vero Solem versus rubicunda, in medio flavescens, & in parte a Sole aversa cauleoviridis: sed illa varietas a vitro tubi probabiliter fuit. Semiannulus autem lucidus, quo a tergo coronabatur, erat forte a Iove ac Saturno illam illustrantibus, utpote orientalioribus." Literally translated: "Now I personally have very often observed Venus in the shape of a sickle, and repeatedly when half or gibbous, and always vomitting flames. Particularly in the year 1643, on January 9th, when Fontana's telescope was made available to me, it was of the appearance shown in the diagram above. In the part towards the Sun it was bluish-green, but that colour probably arose from a fault in the telescope tube. However, the bright half-ring of light with which it was ringed at the back, was perhaps caused because Jupiter and Saturn were lighting it, as it were, from a more easterly direction." The instruments at this time were not achromatic, therefore images were red on one side and blue on the other. A luminous ring outlining the dark limb is not seen except close to inferior conjunction, and is due to the passage of sunlight through the upper layers of the Venus atmosphere, not to the action of Jupiter and Saturn as Riccioli surmised. Little wonder Flammarion regarded the observation with a measure of scepticism.

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9. *ibid.* 10. *ibid.*

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SOMETHING DOES HAPPEN ON THE MOON!

THE NATURE OF THE HOOK-LIKE SHADOW OBSERVED BY WILKINS AND MOORE ON PLATO'S FLOOR IN 1952

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INTRODUCTION

During the 1998 A.L.P.O. meeting held in Atlanta, Harry Jamieson read a paper by Bill O'Connell entitled "Plato's Hook: Clementine and CCD Images Shed Light on the Shadowy Mystery of a 45 year old Drawing." (O'Connell, 1998) The author commented about the drawing of Plato made by H. P. Wilkins during the night of April 3-4 1952, observing the Moon with the 83-cm refractor of Meudon Observatory. O'Connell pointed out a curved shadow on the drawing, the so-called "Plato's Hook," projected on the south-east portion of the floor of the lunar crater Plato under eastern (morning) illumination [IAU directions here and later]. The drawing is reproduced on page 234 of the second edition of *The Moon* by Wilkins and Moore (1961).

O'Connell discarded the hypothesis that the configuration of Plato's floor could be responsible for the odd shadow, on the basis of Wilkins and Moore's opinion that the floor is remarkably smooth and level. In his personal CCD archives O'Connell found one image which, after a simple contrast-stretching, revealed a shadow with a curved tip. He concluded that Wilkins' feature is real, but it doesn't appear at each lunation on Plato.

After examining Lunar Orbiter and Clementine images, O'Connell discarded also the possibility that a lobate lava flow front may be responsible of the curved shadow. As Wilkins' drawing and O'Connell's CCD image differ both in libration and in solar altitude, but in his opinion the "hook" appears on both, O'Connell concluded that the event was proven but its visibility rules were not yet understood.

WILKINS AND MOORE'S DRAWINGS

The drawing by Wilkins is remarkable in reporting the "hook" shadow, but it is not unique. A similar drawing, traced at about the same time by P. Moore, who observed with the same instrument, appeared on page 70 in the book *Our Moon* by H. P. Wilkins (1958). Comparing the two drawings shows similarities and differences. Similar are: the elliptical shape of the walled plain (1.32:1 major-to-minor axis ratio); the general profile of the shadows, in particular of the hook-like one under examination; the position of four craterlets on Plato's floor; the absence of a fifth craterlet, which was searched for, by the observers, but was not seen; and the position of about twenty white spots on Plato's floor. The two drawings show differences outside the crater rim ranging from subtle to obvious. One can conclude, according to Wilkins' words (*The Moon*, p. 235) that on 1952 APR 03 the two observers were concerned with Plato's floor, and completed the rest of their drawings from memory later.

The features depicted similarly by the two expert observers on Plato's floor show small differences, typical of visual observations. For instance, the craterlet near the center is placed by Wilkins at 0.45 units of the major axis starting from east, while Moore placed it at 0.47 units. The difference of about 5 percent can be taken as a typical limit to the accuracy of Plato's major axis and of the shadow. The shadow should be projected by a sort of shelf, a peak protruding horizontally toward the south from a point on the north-east wall. Therefore we have not only one, but two peculiar features, the hook-shadow and the shelf.

[Comment by Editor. Unfortunately we have not been able to obtain permission to reproduce the two drawings referred to above. I note a problem in attributing the drawings as the one reproduced in The Moon is credited in its caption to H.P. Wilkins, while that in Our Moon is initialed "H.P.W.", rather than credited to Patrick Moore. Nonetheless, the two drawings do differ in detail, including the outline of Plato's east wall shadow.

Figure 1 (upper right) shows a tracing of the shadow of the edge of the east wall shadow from the Wilkins sketch in The Moon superimposed upon a photograph of Plato taken by the Lunar Orbiter 4 spacecraft]

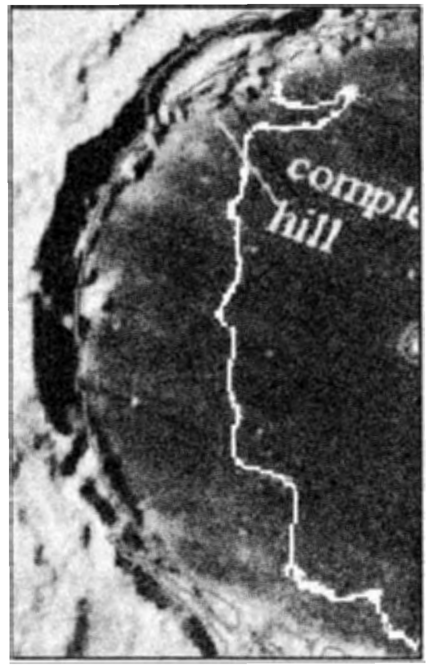


Figure 1. Outline of Plato east wall shadow from Wilkins drawing in *The Moon* (white line), superimposed on Lunar Orbiter 4 frame H-127 (shown also on Figure 8, p. 131).

THE O'CONNELL CCD IMAGE

Figure 2 (lower right) shows a heavily stretched CCD image by O'Connell. The east wall shadow profile is dissimilar from it as sketched by Wilkins and Moore because of different solar elevation, 5° as calculated for the 1952 drawings against 3° for the CCD image. The lunar librations are also different, Plato being less elliptical in the CCD image, with an apparent 1.24:1 axis ratio. O'Connell proposed the identification of the 1952 hook-shaped shadow with his longer southern shadow, slightly bent on the south, even if he recognized that the position of this feature is definitely west and north of that shown by Wilkins and Moore. For these same reasons we were doubtful of O'Connell's identification and extended the analysis of the problem with our CCD image archives.

Fig. 2. CCD image by Bill O'Connell showing the shadows on Plato's floor, giving a contour considerably different from that in Figure 1. Image taken with 20-cm Schmidt-Cassegrain at f/20, 1997 FEB 16, 01^{h}01^{m} UT (H = 2°.97 , A = 092°.37 , C = 013°.00). Following O'Connell, the tip of the southern, longest shadow is bent toward the south, creating the appearance of Wilkins and Moore's hook-like shadows. (H = solar elevation, A = solar azimuth, and C = solar colongitude.)

OUR CCD IMAGES

In our CCD archives we found the images reproduced in *Figures 3-7* (pp. 128-131). In Figures 3-5, with low solar elevations, shadows similar to those imaged by O'Connell are evident. The southern peak with the longest shadow has a curved northern profile, but not curved enough, in our opinion, to reproduce the "hook." Moreover, the overall shadow profile appearing in the three images is incompatible with that of the 1952 drawings. Figure 5 shows also the northern peculiar shadow found in the Wilkins and Moore drawings, attributed by us as cast by a shelf. Our image reveals that this feature comes from the fusion of the east wall shadow with the shadow of a hill located on Plato's floor, at the foot of the northern wall.

Figure 6 displays a shadow outline different from those of the last three images, but similar to those appearing in the drawings by Wilkins and Moore.

Figure 7 shows an even closer similarity to the 1952 drawings. The solar elevation above Plato's floor in Figure 6 is nearly 11° and in Figure 7 is nearly 9°, so the east wall shadow has less irregularities and now shows a more regular outline, probably originating from the inner wall terraces. At the foot of the southern terraces now appears an elongated and complex hill (labeled subsequently as "ch") whose curved shadow combines with the east wall shadow to create the hook-like feature.

The Coordinates of the Features Described

An image of Plato extracted from Plate D2-a of the *Orthographic Atlas of the Moon*, by Arthur and Whitaker (1960), was sent to us by Harry Jamieson. Plate D2-a is part of plate W121 taken at the Mount Wilson Observatory on 1919 Sep 15, at 13^h23^m UT (solar elevation, H = 9°.49; solar azimuth, A = 255°.53; colongitude [western longitude of sunrise terminator], C = 172°.10). Comparing this grided photograph with our Figure 3, we estimated the coordinates of the principal features under discussion.

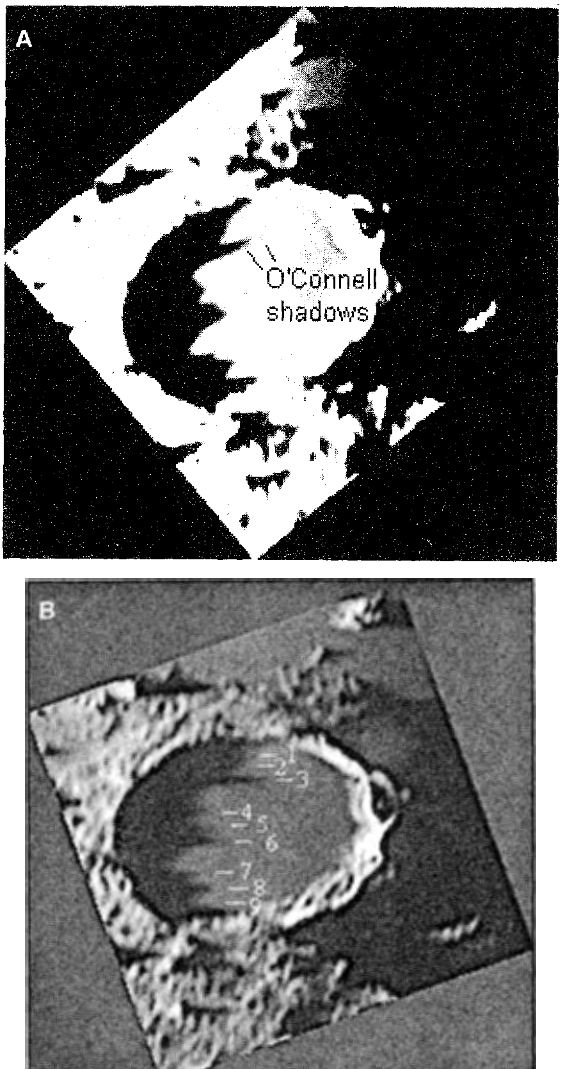


Figure 3. (A) CCD image of Plato taken by G. Favero on 25 Jan 1999 at 18^h21^m UT (H = 2°.96 , A = 092°.96 , C = 013°.46) with a PXL 211 camera (TC-211 sensor) fitted to a 35.5-cm Newtonian, effective f/16.8. The profile of the shadow on Plato's floor looks very similar to that recorded by O'Connell, whose hook-shadow is marked. Just north of the tip of the southern and longest peak, the shadow of a craterlet is visible which could bend the shadow tip as in the O'Connell image.

(B) Numbers 1-9 indicate the tips of the shadows and the corresponding positions (white dot) of the relevant peaks on the east wall rim.

As a first step, Figure 3 was rotated until the axes of the shadows on Plato's floor appeared horizontal. The result can be seen in Figure 3B, where the shadows are labeled 1-9. In this image, each peak on the eastern wall which casts a shadow and the tip of that shadow lie on the same horizontal line. Comparing our Figure 3, taken at sunrise (H = 2°.96 , A = 092°.96), with the *Orthographic Atlas* Plato image, taken at sunset (H = 9°.49 , A = 255°.53), both under a grazing illumination, we obtained the rim profile of the eastern wall. This profile is the line along the crater rim separating the shadow from the sunlit surface. The rim profile line has the same shape in the two images despite of the opposite illumination because of its grazing angle It is highly probable that the tops of the peaks casting the pointed shadows recorded in Figure 3 lie on this rim profile line. The intersections between the profile line of the east wall rim and the horizontal lines defined from the shadows (as previously described) identify the most probable positions of the peaks casting the shadows.

In Figure 3B each white point indicates where a peak probably lies on the east wall rim. The peak top is located at the left of the white point, on the line separating the lighted surface from shadowed one. The longest shadow, labeled "3" in Figure 3B, is

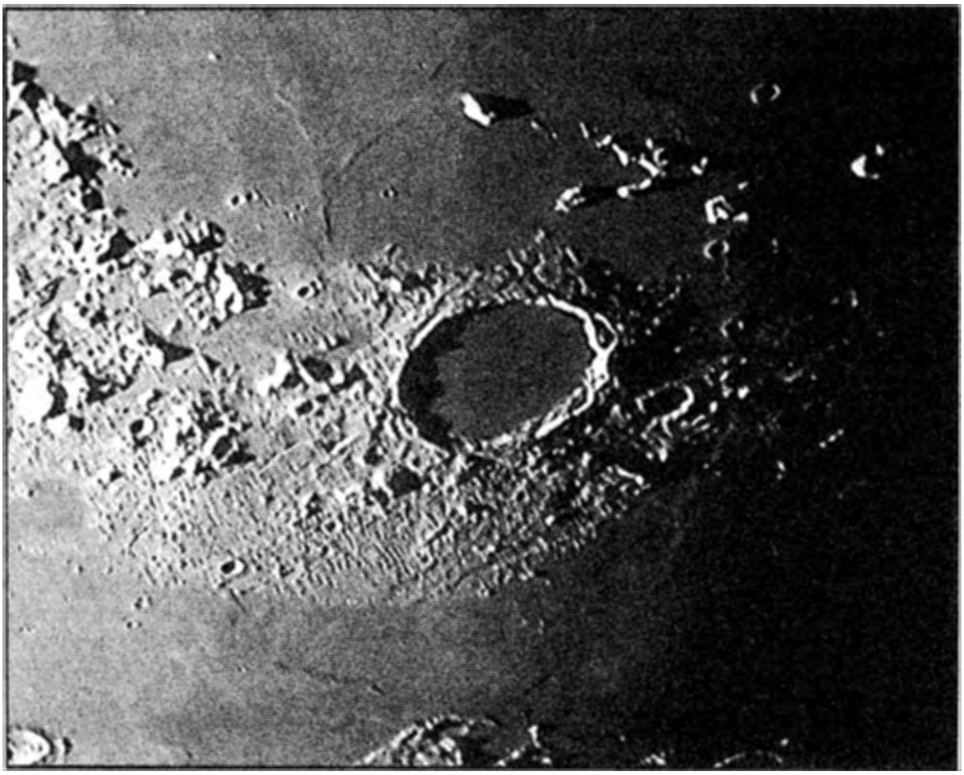


Figure 4. CCD image of Plato taken by G. Mengoli on 14 MAR 2000, 17^h56^m UT (H = 5°.15 , A = 098°.50 , C = 019°.16) with an HX516 camera fitted to a Meade 15.2-cm refractor with a Barlow lens at 1.83X. Given the solar-lighting data, the shadows should be similar to those on Figure 1. On the contrary, the shadows on Plato's floor are similar to those on Figures 2 and 3.

the shadow that O'Connell defined as the "hook" shadow (compare with Figure 2). It is cast by the peak (which we also label 3) at the head of the curved mountain chain directed initially to the south-east then abruptly turning nearly 90° to the south-west.

The coordinates of Hill "ch" and Peaks 1-9 are given in *Table 1* (below).

Figure 4 (above; H = 5°.15 , A = 098°.50 , C = 019°.16) shows the shadows on Plato's floor under nearly the same lighting conditions computed for the 1952 drawings (H = 5°.32 , A = 094°.95 , C = 016°.48). Comparing Figure 4 with Figures 1-3 shows that: (1) In Figure 4 the shadow shows a profile similar to that in Figures 2 and 3, but is obviously shorter; (2) this shadow profile is different from that in Figure 1. It seems unlikely that Shadow 3 may be the "hook," as it lacks any curvature.

Table 1. Coordinates of the complex hill ("ch"; see text) and of the peaks on the eastern wall of Plato that cast shadows 1-9 at sunrise (Figure 3B).

Peak	ξ	η	Latitude °	Longitude °
ch	0.7693	-0.0875	50.29	-7.87
1	0.7700	-0.0822	50.35	-7.40
2	0.7715	-0.0800	50.49	-7.22
3	0.7724	-0.0759	50.57	-6.86
4	0.7800	-0.0727	51.26	-6.67
5	0.7830	-0.0719	51.54	-6.64
6	0.7859	-0.0716	51.80	-6.65
7	0.7905	-0.0729	52.23	-6.84
8	0.7941	-0.0748	52.57	-7.07
9	0.7968	-0.0769	52.84	-7.31

Note: ξ (xi) and η (eta) are rectangular coordinates, expressed in units of the Moon's radius, with their origin at the mean center of the disk; the ξ-axis runs east-west, positive to the north (as is latitude), while the η-axis runs east-west, positive to the east (as is longitude).

We measured a differential latitude for the base of the hooked shadow on the 1952 drawings along the meridian passing through its base and intersecting the northern rim of Plato near a shadow-filled valley. Assigning a value of 0.00 to the point where this meridian intersects the southern crater rim, and a value of 1.00 to the point where it crosses the northern rim, the base of the hooked shadow appears centered at a value of 0.12 in both drawings. From Figure 5, the base of shadow 3 was so measured to be 0.21; even allowing for the imprecision of the visual estimates, this value is incompatible with the 1952 values. Moreover, in Figure 4 Shadow 3 does not display any curvature. Inspection of Figures 6 and 7 reveals a shadow profile

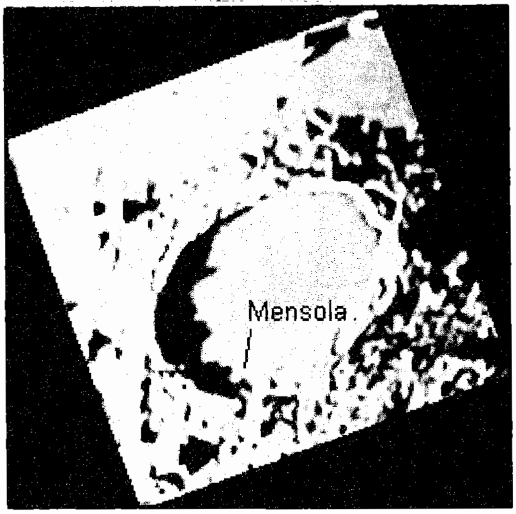


Figure 5. CCD image of Plato taken by G. Favero on 14 MAR 2000, 21h43m UT (H = 6°.33 , A = 100°.03 , C = 021°.08) with the same instrumentation as in Figure 3. On the north-northeast part of the floor the shelf shadow is indicated (named "Mensola" in the frame), which is caused by the merging of the east wall shadow with a curved shadow cast westerly by a round hill on Plato's floor.

on Plato's floor very similar to that shown in Figure 1; the only difference is the location of Shadow 3 in our images. In Figures 6 and 7, taken with solar elevations of 10°.7 and 8°.9 respectively, a hooked shadow is evident near the foot of the southern wall of Plato. In fact, this is the shadow of an oval complex hill, with a major axis from northeast to southwest ("ch" in Figure 7B, where other shadows are labeled) whose coordinates are given in Table 1. The fractional latitude of the eastern base of the hill's hooked shadow, measured along its meridian in Figure 7, is 0.10, comparable with the values estimated in the 1952 drawings (0.12). In the same figure Shadow 3 is shown well, with a fractional latitude 0.22 and without any curvature.

CONCLUSIONS

The hook-like shadow reported by Wilkins and Moore on their 03 APR 1952 drawings is a real feature visible with an 8°-11° altitude of the Sun above Plato's floor. It is not the shadow proposed by O'Connell, which is cast by the tallest peak (Peak 3 in this paper) present on the the east wall of Plato, which does not show any curvature at any solar elevation and is always located very far from the 1952 "hook."

We suggest that the hook-like shadow is cast by an elongated hill present on Plato's floor, at the foot of the south wall, which becomes visible when the Sun rises 8°-11° above the floor. This elongated, complex hill, oriented northeast-southwest, is clearly shown on *Figure 8* (p. 131), an image from Lunar Orbiter 4.

A similar explanation may apply to the northern shelf shadow.

It is worth noting that the solar elevation for Plato calculated for the 1952 APR 03 observations (5°.32) is incompatible with the solar elevation that produces the hook-like combined shadow observed by us (8°-11°). Also, the shadow length measured on the 1952 drawings (0.21-0.22 of Plato's major axis) is incompatible with the value measured on our CCD frames (0.10-0.12). We can only suggest that the 1952 observations were not made

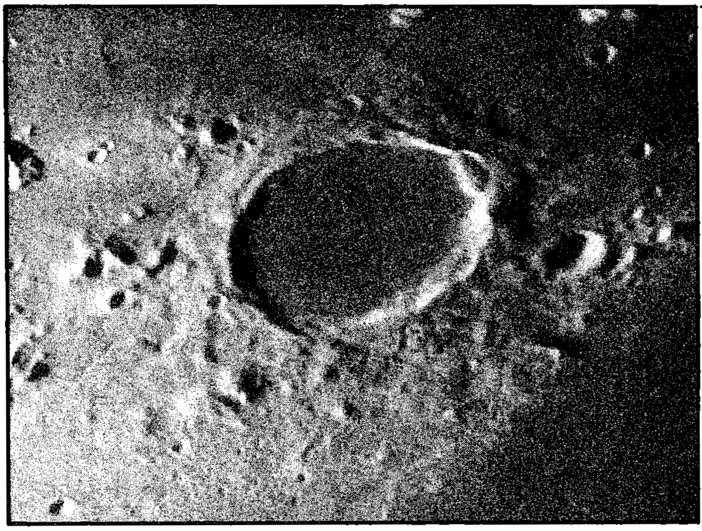
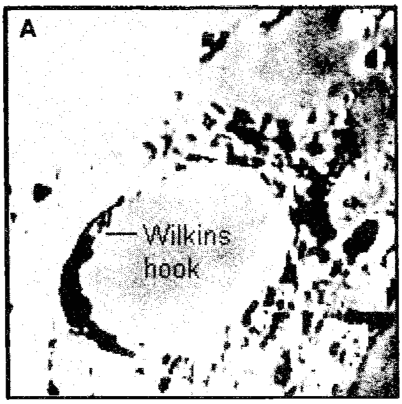


Figure 6. CCD image of Plato taken by A. Cipolat and P. Gualdoni on 14 FEB 2000, 20h30m UT (H = 10°.70 , A = 104°.75 , C = 027°.45) with an HX516 camera fitted to a Mewlon Takahashi 25.0-cm telescope at f/12. The east-wall shadow is considerably shorter than in the previous images, and its contour looks much like those reported in Wilkins and Moore's drawings. A curved shadow is evident near the south-east wall, in the correct position for Plato's "hook."



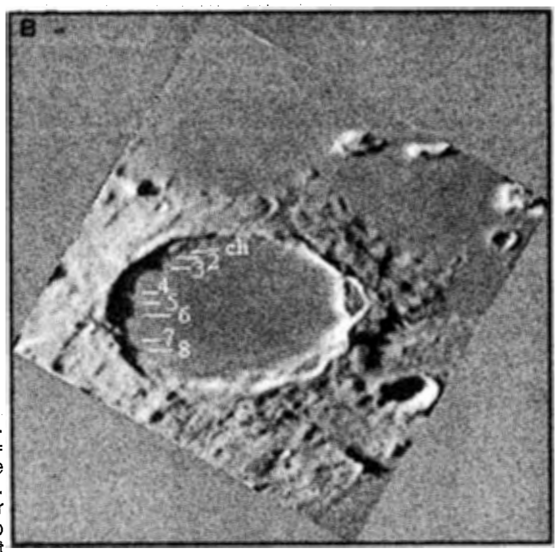


Figure 7. (A) CCD image of Plato taken by G. Favero on 16 FEB 1997 at 20h00m UT (H = 8°.90 , A = 09.99°, C = 022°.62) with the same instrumentation as for Figures 3 and 5. The shadow on Plato's floor is slightly longer than in Figure 6 and its contour is similar to that one recorded by Wilkins and Moore. It shows a curved shadow coincident in position and shape with Plato's "hook" in Figure 1, and is created by the merging of the east wall shadow with the shadow of an elongated and complex hill on Plato's floor. (B) The shadow tip designations and the identification (white dot) of the complex hill (ch) responsible for the curved shadow.

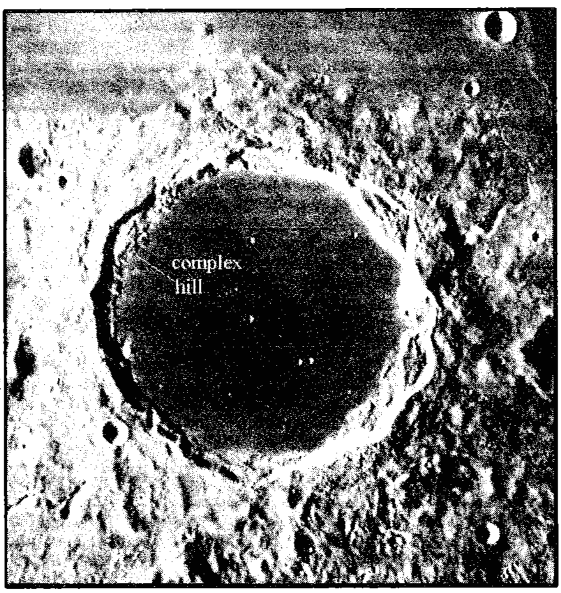


Figure 8. Lunar Orbiter 4 high-resolution image 127-H3, taken on 20 MAY 1967, 06h26m UT (H = 20°.79 , A = 117°.47 , C = 043°.25). It shows the elongated and complex hill near the southeast wall of Plato, whose shadow forms Plato's "hook" when the solar elevation is about 8°-11°.

on 1952 APR 03 at 21h30m UT, but actually slightly later, when the elevation of the Sun over Plato was higher than 5°.32. This opinion is shared by Patrick Moore (private communication).

If we are correct, this conclusion can also explain why the hook-like shadow escaped 48 years of observations scheduled for solar elevations of about 5°, which would have been too low for this peculiar feature to be observable.

ACKNOWLEDGEMENTS

The authors acknowledge the contribution to the observations by Paolo Morini and Piergiovanni Salimbeni. We acknowledge H. D. Jamieson of the Association of Lunar and Planetary Observers for the software tools which allowed the calculation of the solar altitude over the Moon's features to be done, for furnishing the orthographic map of Plato and for many stimulating discussions. The fundamental contribution to the paper and the encouragement of Dr. Patrick Moore are gratefully acknowledged.

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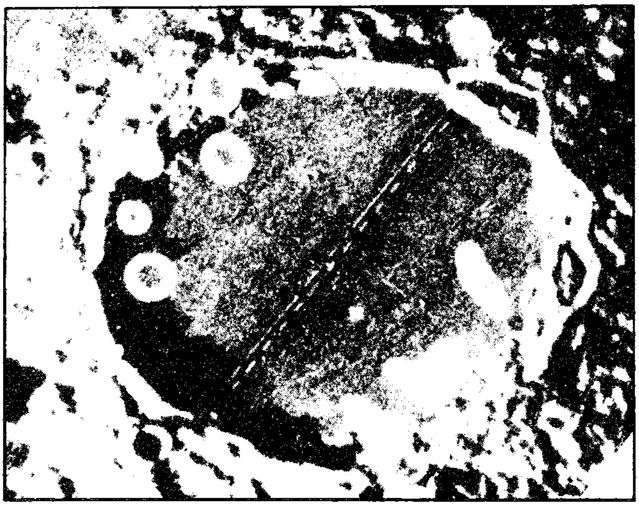

Figure 9. Lunar Orbiter 4 medium-resolution frame 104, taken 1967 May 18, $06^h57^m08^s$ UT (H = 7°.17, A = 096°.72, C = 019°.10). South to the upper left; the white marks are processing defects and the diagonal white lines are frame edges. The "hook" shadow appears in the upper portion of the east-wall shadow, with an appearance and an illumination somewhat similar to Figure 1.

Figure 10. CCD frame taken by J. Westfall on 1993 Mar 02, 04^h26^m UT. 28-cm Schmidt-Cassegrain, f/21, 0.10 sec. H = 3°.04, A = 094°.42, C = 014°.44. The "hook" shadow, only slightly curved in this view, is in the upper-left portion of Plato's floor. The contrast has been stretched to accentuate the shadows; the light border to the east-wall shadow is an artifact caused by unsharp masking.

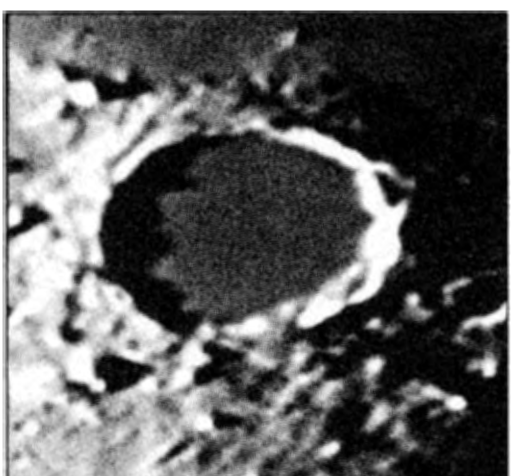

Figure 11. CCD frame taken by J. Westfall on 1994 Mar 21, 03^h56^m UT. 28-cm Schmidt-Cassegrain, f/21, 0.15 sec. H = 4°.70, A = 093°.81, C = 015°.20. The "hook" shadow is also evident under this lighting, slightly higher than in Figure 10. The contrast in this image has been stretched better to show the boundary of the wall shadow.

Three Additional Views of the "Hook" Shadow on Plato's Southeast Floor

The Editor has here appended three additional views of Plato under low morning lighting that show the "hook" shadow cast on the southeast floor of the crater *(Figures 9, 10* and *11*; left, lower left and bottom left, respectively).

Note that the rather low-quality Lunar Orbiter view in Figure 9 was taken when the Orbiter's nadir was located at about 72° N latitude, 16° E longitude, giving a perspective significantly different from the earthbased views shown in *Figures 1-7, 10* and *11.* Unfortunately the high-resolution frames taken at the same time did not cover Plato, while those high-resolution frames showing Plato were taken under higher solar lighting.

The CCD images in Figures 10 and 11 show the "hook" shadow, although its curvature is not as pronounced as in the traced shadow outline in Figure 1 (p. 127). Compare with Figure 4 (p. 129), where the outline of the east wall shadow closely resembles those shown in Figures 10 and 11.

A.L.P.O Minor Planets Section Report and Review for 1999: Part I— Review of the Minor Planets Section

By: Lawrence Garrett, Assistant A.L.P.O. Minor Planets Coordinator, with Frederick Pilcher, Minor Planets Coordinator; Petr Pravec; Richard Binzel, and Gerard Faure

Abstract

Part I of this article reviews the Minor Planets Section's progress, goals and importance in the minor planet community and describes the research programs of the Section.

Foreword

Welcome to the Minor Planets Section's first review of its observations and activities to appear in the *J.A.L.P.O.* since 1976! Imagine if such a article had not appeared on Jupiter or Mars since the bicentennial! A full review of 24 years of observations would be impossible, even if astronomy stood still the whole time. Unlike a single planet, a review of the minor planets would have to include thousands of objects. Also, a review of the observations would also have to include the state of science at the time of the observations, rather than today's interpretations.

Surveying The Minor Planets: Favorable Research Targets

Each year the Section's Coordinator, Frederick Pilcher, publishes his annual report on favorable objects for the upcoming year in the *Minor Planet Bulletin* (MPB). In years past, this was the "Minor Planets at Unusually Favorable Opposition" report. But now a new database search method is used, based on maximum elongation. This method can identify favorable objects that opposition-based searches can miss. The current "Minor Planets at Unusually Favorable Elongation" report highlights each year's suggested research targets. The magnitude limit is $M_V \leq +14.5$, but is fainter for special objects, such as very-close-approach (near-Earth) asteroids or asteroids rarely visible. As needed, Coordinator Pilcher issues a "Call for Observations" which is posted at the A.L.P.O. homepage and on the Magnitude Alert Program (MAP) mailing list. These again bring attention to any special objects or update readers to new information.

Research Programs of the Minor Planets Section

Possible research programs for the amateur observer are many. Over the years these have increased in complexity to where professional results are now achieved by many. From the numerous projects, observers chose their programs based on their interest and equipment. The choices are as follows.

1. Visual Observing

- Visual astrometry.
- Visual photometry.
- Minor Planet "tracking."

2. Imaging (both film and charged-coupled-devices)

- Minor Planet discovery.
- Astrometry.

3. Photometry

- Magnitude Alert Program.
- Absolute magnitudes (H-values).
- Light curve work; amplitude and minor-planet rotation periods.

4. Occultation Observations

- Determine asteroid diameters by timing observations of stellar "eclipses."

5. Minor Planet Community

Minor Planet Mailing List.
Minor Planet Amateur-Professional Workshop 1999.

Visual Minor Planet Observation

Since the Section's founding in 1973, visual observations have accounted for the majority of the published data. In the mid-1970s observers were limited by both the star atlases available and the quality of orbital elements.

At the time the author joined the section (1976), the 1975 General report by then-Recorder Richard G. Hodgson listed 227 objects observed. Of these 12 objects had positional errors of up to 2.3^m in right ascension and 13′ in declination (Pilcher observations). Thus, visual astrometry was still possible, using *Atlas Falkau* or *Atlas Stellarum.* While refining orbits with visual observation in conjunction with these atlases was not possible, bringing attention to these large errors was quite easy and useful.

By the late 1980s, minor planets elements were much better known, ending the use of easy visual observations of positional errors. However, observing new minor planets for positional error *before* firm elements are announced is still possible. By seeking objects from the Near Earth Object Confirmation Page (NEOCP) at the Minor Planet homepage, objects brighter than Mv ~+15.0 can be attempted. This was accomplished by Michael Mattiazzo on 2000 Jul 25, 12^h55^m UT (Universal Time) with the Minor Planet G70139=2000 OL, Mv ~+13.6, and by this author on 2000 Jul 26. While again positions cannot yield useful data to upgrade the orbit, magnitude observations are very useful to compare with the CCD values published for the object.

While minor planet "tracking" (i.e. observing for pure pleasure) is falling from favor as CCDs are capable of discovery and astrometry, spotting the brighter objects and adding to one's "life list" of minor planets is a must for a well-rounded visual observer. Keeping eyes sharp and well trained in the appearance of the full range of magnitudes that one surveys will lead to much easier detection of suspect magnitude errors. Only with such a routine can observers hope to contribute photometry to the Magnitude Alert Program (MAP).

Minor Planet Imaging

A full review of the revolutionary change from photographic film to charged coupled devices (CCDs) in astronomy since 1976 is beyond the scope of this article. Articles in the MPB have featured many examples of precise astrometry over the years. The change from measuring film to modern computer software has brought this project from an almost impossible task for most to a nearly "off the shelf" project. And, as progress placed more equipment in the hand of more observers, asteroid discovery became possible for many observers. Observers who proved their skills to the Minor Planet Center (MPC) receive observatory codes. Results from these "approved astrometric sites," once bound for the pages of the MPB, now go directly to the Minor Planet Center, being now of professional quality. While the MPB does still publish astrometric work submitted, the current trend in minor planet research is moving more and more towards photometry.

Minor planet Photometry

Currently, minor planet photometry for the Section is divided into two main programs, light curve work and H-value revision.

Establishing minor planet periods of rotation is a quickly growing field, with excellent results from our members. With professional astronomers contributing much help and advice in these photometric projects, the MPB is surely a semi-professional publication. Favorable photometric objects are reviewed by Petr Pravec (with other co-authors) and appear in each issue of the MPB.

The second photometric program involves the revision of H magnitudes (absolute magnitudes). When H-values are found to be in error, the suspected mean diameter is also in error. Thus detection leads to better understanding of both brightness and mean size. This program is the Magnitude Alert Program or MAP.

Magnitude Alert Program: Internet Photometric Research Project

Founded by the author in 1996, this program's goals are to discover magnitude errors and record observations in order to publish suggested revised H-values in the MPB. Discovery of variable asteroids is also done. While establishing periods is not possible with limited visual work, the work produces an excellent target list for those who can do such "absolute photometry." Thus the value of such visual work is high. CCD observers and visual observers observe independently and report any suspected errors to the author. A MAP Alert is sent to direct the group to the target. Once another observer confirms a suspected error, the results appear in an Update/Review or in the next alert. Negative observations and objects observed as predicted are also reported. This quick interaction between observers has lead to many more observations then under the old system of publishing annual results. The results of MAP will be presented in a later article. Currently, the Minor Planet Center does not process new suggested H-values from MAP, which we publish in the MPB. This author looks forward to any future progress from the MPC in this area.

Gerard Faure of France serves as MAP European Manager, keeping the MAP database, and working with the author on all aspects of this observing program. His contribution and very hard work are priceless to the work of the minor planet section and MAP.

Minor Planet Occultation Observations

Currently, the Section does not have an organized occultation program. Observers are urged to seek out David Dunham of I.O.T.A (International Occultation Timing Organization) and submit observations to both IOTA and the MPB for possible publication.

An important occultation paper was published by David Dunham (MPB Vol. 6, No. 2 [1978]) and involved the discovery of a satellite of 532 Herculina. The complete article, with two additional reviews, covered this event is detail, and is presented on our CD-ROM (see below) in jpeg format. The Herculina system suggested by the results is presented here. Herculina has been joined by 243 Ida (satellite Dactyl), and 45 Eugina (satellite Petit-Prince), since the article was published in 1978.

Minor Planet Community

With the growing contributions by amateur observers, ties among amateur and professional researchers have reached a high level. A true sense of a "Minor Planet Community" now exists, in which close communication takes place on the "Minor Planet Mailing List" (MPML). This project, created by Richard Kowalski (minor planet 7392 Kowalski) brings a daily dialog of notes of interest, questions and comments to readers.

Another key event took place at Lowell Observatory in Flagstaff Arizona in April 1999, the first annual Minor Planet Amateur Professional Workshop (MPAPW99), also organized by Richard Kowalski This gathering of just over 100 observers from as far away as Japan, Europe, and the South Pacific, made for the largest professional-amateur conference yet held. This author was selected as one of the original 16 speakers to address the group. But when so many important individuals announced their attendance, the speakers grew to 28, more then a quarter of the group! Petr Pravec also spoke, directly following myself.

Minor Planets Section CD-ROM

In an effort to record and present as much information as possible on the section, a MPS CD-ROM will become a standing record for the section activities. The contents will grow as observations and results are added, keeping up to date with Coordinator Pilcher's General report, MAP H-value results, along with other selected items of interest. Complete MAP Alerts/Reviews will allow readers to track this work from initial observations to suggested revised H-values. However, due to the large size of JPEG files, the complete MPB will not appear, perhaps a MPB disk only should be composed. To obtain the disk, please send a

CD-RW with return postage. You will then receive the latest issue of the MPS CD.

Year Two Thousand Comments

For many of use, the year 2000 has stood far in the future, but now is headed for the history books nearly as this is written. What would we have thought, if in 1976 we had read these "predictions"?

In the year 2000, amateur minor planet discovery is commonplace, along with the use of computers. Recording 21st-magnitude objects is now possible for many. *Owning* a moon rock, a Mars rock, or a suspected piece of 4 Vesta, is just a matter of using the internet, your credit card, and a few mouse clicks, not even a big deal any more!

Having looked back to 1976, and at today, what is in store for the year 2025? I propose a time capsule of sorts, to be placed on the MPC CD. In this file I invite readers to place their ideas of advancements in amateur minor planet observing by the far-off future year of 2025! I hope that readers will enjoy sharing their thoughts and predictions as much as I will publishing them in the *J.A.L.P.O.* in the year 2025! The closing date to contribute to this file is December 31, 2001. Details will follow.

Closing

The author wishes to thank Frederick Pilcher, Richard Binzel, Petr Pravec and Gerard Faure for all their years of friendship and help to date, and for many years to come.

Later articles will also include the general report, 1999 MAP results, and suspected minor planet satellite observation.

A.L.P.O Minor Planets Section Report and Review for 1999: Part II—Magnitude Alert Project: Suggested Revised H-values of Selected Asteroids for 1999

By: Lawrence Garrett, Assistant A.L.P.O. Minor Planets Coordinator, and Gerard Faure

Note: This article appeared in the April 1999 Issue of the *Minor Planet Bulletin.*

In 1998, the Magnitude Alert Project (MAP) continued to grow in both membership and observations received. MAP now includes 19 members in five countries.

The work of MAP has expanded to now include asteroids whose magnitudes have been found in error by the Minor Planets Section from 1990 to 1996, as well as newly discovered asteroids in error since the founding of MAP in 1997.

Our MAP Database contains observations for each object observed since May 18, 1998 and will be extended to the objects observed in 1997 and in the beginning of 1998. It is managed by both Gerard Faure (for the network AUDE in France) and Lawrence Garrett.

Observations for the following asteroids have lead to the suggested revised H-values given in *Table 1* (p. 137). The revised absolute magnitude, H, is the mean of the mean magnitudes calculated for each night of observation. These values are based on both visual- and CCD-measured magnitudes. Comparison objects used for estimates were USNO catalog stars, Hubble catalog stars, and other asteroids without known magnitude errors. A range of possible H-values based on all observations submitted is also included. Full details on these observations will appear in the General Report of observations for 1998 by the Section Coordinator, Frederick Pilcher.

Table 1. Current and Revised H-values (absolute magnitudes) of Asteroids, 1999.

Asteroid Number and Name	H-Magnitude Current ±	H-Magnitude Revised ±	Number of Observations	H-Mag. Range ±	Observer(s)
982 Franklina	9.9	9.3	4	9.3	Claude Boivin, Lawrence Garrett
1155 Aenna	11.5	11.8	4	11.8-11.9	Gerard Faure, Lawrence Garrett
1178 Irmela	11.8	11.4	9	11.3-11.6	Pierre Antonini, Claude Boivin, Robin Chassagne, Bernard Christophe, Lawrence Garrett
1384 Kniertje	9.7	11.1	16	10.9-11.4	Pierre Antonini, Gerard Faure, Jean-Marie Llapasset, Rene Roy, Stephano Sposetti
1449 Virtanen	12.4	11.9	27	11.4-12.4	Pierre Antonini, Gerard Faure, Lawrence Garrett, Alain Klotz, Jean-Marie Llapasset, Rene Roy, Stefano Sposetti
1909 Alekhin	12.3	12.9	6	12.7-13.1	Pierre Antonini, Gerard Faure, Roger Harvey
2939 Coconino	12.6	13.2	4	13.0-13.5	Pierre Antonini, Roger Harvey
3198 Wallonia	12.3	13.2	3	13.1-13.5	Gerard Faure, Lawrence Garrett, Tom Laskowski
3904 Honda	11.3	11.7	27	11.2-12.1	Pierre Antonini, Bernard Christophe, Gerard Faure, Roger Harvey, Jean-Marie Llapasset, Philippe Martinole
4709 Ennomos	8.9	8.5	15	7.9-8.7	Pierre Antonini, Claude Boivin, Robin Chassagne, Gerard Faure, Lawrence Garrett, Rene Roy
5641 Mc Cleese	12.7	14.0	10	13.3-14.4	Pierre Antonini, Roger Harvey, Philippe Martinole, Rene Roy
6009 1990 FQ1	12.3	12.6	40	12.6-13.1	Pierre Antonini, Robin Chassagne, Gerard Faure, Sergio Foglia, Roger Harvey, W. Marinello, Gianopaolo Pizzetti, Rene Roy, Stefano Sposetti, Brian Warner
6249 Jennifer	12.4	12.7	4	12.7-13.2	Maurizio Bignotti, Sergio Foglia, Lawrence Garrett, Tom Laskowski, Gianopaolo Pizzetti
7778 1993 HK1	12.5	13.1	8	13.0-13.2	Sergio Foglia, Lawrence Garrett, Frederick Pilcher, Gianopaolo Pizzetti
8201 1994 AH2	16.3	15.9	40	15.2-16.5	Pierre Antonini, Claude Boivin, Robin Chassagne, Gerard Faure, Lawrence Garrett, Rene Roy, Stefano Sposetti
9083 1994 WC4	11.9	12.4	5	12.1-12.8	Pierre Antonini, Gerard Faure, Roger Harvey
1987 OA (9162)	18.5	17.3	9	16.9-17.5	Stefano Sposetti, Rene Roy
1998 QP	22.0	21.5	46	21.3-21.7	Claude Boivin, Gerard Faure, Lawrence Garrett, Roger Harvey, Tom Laskowski

Asteroids found to be only variable, but with more research needed:

Asteroid Number and Name	Magnitude Range	Number of Observations
1025 Riema	0.4 mag ?	16 measures
1476 Cox	0.6 mag ?	18 measures
3913 Chemin	1.0 mag	20 measures

[Note by Editor: H, the absolute magnitude of an asteroid, is its stellar magnitude (in the visual band unless otherwise specified) at phase angle 0° when one astronomical unit distant from the Sun and the Earth. (The phase angle, α, is the angle at the asteroid between the Sun and the Earth. One astronomical unit is the mean distance between the Sun and the Earth, 149,597,870 km.)]

The New A.L.P.O. Journal and What it Means to You

By: Harry D. Jamieson

Several months ago, members were asked questions about a number of things that touched upon most aspects of the A.L.P.O. membership experience, including the Journal, our web site, and the A.L.P.O. Ephemeris, and your answers were revealing. Board Member Matthew Will published the results in Volume 41, Number 1 of the Journal. When asked about improvements that you would like to see to the Journal, your top ten responses were:

1. Timely publication.
2. Telescopic and observing techniques and "how to" articles.
3. More timely articles or at least interim apparition reports.
4. Articles for newcomers.
5. Increase page count.
6. Present material, apparition reports, should be better written.
7. Needs more general articles that are "non technical."
8. Color photos.
9. Articles on history of astronomy/ A.L.P.O. history.
10. Change the layout, less dense typography, glossy paper better quality images.

We have been listening to you, and I am now happy to report that our efforts to address all of these concerns are now well advanced. Beginning with volume 43, number 1, the following changes to the Journal and the way that we publish and distribute it will be made.

1. The Journal will now contain six issues per volume, and these issues will be published bi-monthly.

2. The Journal will now be available to members as a downloadable Adobe Acrobat .pdf file from our web site, as a traditionally printed magazine, or both. The format and content of both versions will be the same. I will refer to these as the "digital" and "paper" versions below.

3. The layout of the Journal will be extensively changed, and color will be widely used in the digital version. Eventually, we would also like to have the paper version in color as well. The paper version will be 8.5" X 11" in size starting with volume 43.

4. The staff of the Publications Section has been dramatically increased in order to divide the editorial work and include permanent staff writers, language translators, writing tutors, and a graphics person. These additional people should insure timely publication, new regular features, and a more readable Journal.

5. Our goal will be to have more pages per issue, but never to fall below the 32 pages per issue that would give the same number of pages per volume that we have now with a quarterly Journal.

6. All papers to be submitted for publication in the Journal must now be sent directly to the writer, who now serves as the Journal's Publisher. My job will be to keep a computerized log of the papers coming in and distribute them to the appropriate editor, keeping the workload balanced. Sending a paper directly to one of the editors or anyone else on the Publications Section staff will only delay and complicate things, as papers not in the log will not be published.

7. Though one of our goals is a freer and more readable Journal, the Publications Guidelines initiated some years ago by John Westfall will continue to be enforced.

Although we have now appointed several volunteers to posts in the Public ations Section, we still have room for additional people with good writing skills who are also fluent in another language. We get a lot of material from our overseas members who, while very knowledgeable about their subject matter, are nevertheless not fluent in English. People who are fluent in their language as well as in English could provide a real service here by helping them to say exactly what they want to say in English. Every major language will be needed at one time or another, although Italian has been needed a lot recently! We currently have people who have volunteered to translate from French and Spanish into English. Members interested in volunteering to help with the new Journal or who just want to know more about what is needed should contact me.

As of now, we are planning to stay with our current dues structure through 2001. The only exception will be the dues for the new digital (Acrobat Reader) version of the Journal, which will be $10.00 for one volume or $17.00 for two volumes. Since the digital version will be distributed over the internet, the price will be the same regardless of where the member lives. Members subscribing to the digital version will be e-mailed a password when each new issue is ready for download, and so digital subscribers must keep me informed of changes to their e-mail addresses just as they do changes to their snail mail addresses now. Members will be permitted to computer print copies of their digital issues for their own use only. Members may subscribe to both the digital and the paper versions. The cost would simply be the cost of the paper and digital versions added together. Sustaining and Sponsor members will be automatically entitled to both versions. Members should also know that they can convert their current paper Journal subscription to a digital subscription simply by writing to me and requesting the change. Since the subscription for the digital version is about 230% cheaper than the amount for the paper version, converting to a digital subscription will automatically entitle you to about 230% more issues than you currently have coming now at no additional cost. The chart below shows various paper Journal expiration issue numbers and their corresponding digital expiration numbers for those converting before receiving volume 43 number 1. Those wishing to continue to receive the paper Journal need do nothing at all.

As always, your feedback on these changes is not only welcome but also needed. We think that you will like the new Journal with its new features and, certainly, its more frequent appearance.

42.4 Base	1 Vol DJALPO	2 Vol DJALPO	1 Vol JALPO	2 Vol JALPO	
258	10	17	23	40	
If Member Previously Paid for One Volume					
If Member Expires With JALPO			**Member Will Expire With DJALPO**		
Volume	**Number**	**Issues Owed**	**Volume**	**Number**	**Issues Owed**
43	1	1	43	2	2
43	2	2	43	5	5
43	3	3	44	1	7
43	4	4	44	3	9
43	5	5	45	1	12
43	6	6	45	2	14
If Member Previously Paid for Two Volumes					
If Member Expires With JALPO			**Member Will Expire With DJALPO**		
Volume	**Number**	**Issues Owed**	**Volume**	**Number**	**Issues Owed**
43	1	1	43	2	2
43	2	2	43	5	5
43	3	3	44	1	7
43	4	4	44	3	9
43	5	5	45	1	12
43	6	6	45	2	14
44	1	7	45	4	16
44	2	8	46	1	19
44	3	9	46	3	21
44	4	10	47	1	24
44	5	11	47	2	26
44	6	12	47	4	28

Minutes of the Board of Directors Meeting, Association of Lunar and Planetary Observers, Ventura, California, July 19 and 20, 2000

Recorded by: Elizabeth Westfall, A.L.P.O. Secretary

All nine Board members were present:

Don Parker, outgoing Executive Director
Julius Benton, incoming Executive Director
Walter Haas, A.L.P.O. Founder
Rik Hill
Harry Jamieson, Treasurer
Richard Schmude
Beth Westfall, Secretary
John Westfall
Matt Will

1. Julius Benton opened the meeting by presenting sixteen goals he hopes to accomplish during his directorship. They are:

a. Maintain an electronic/paper Journal to be published six times a year without diminishing the content.

b. Revitalize the subject matter of the Journal to make it more interesting without sacrificing the scientific and technical quality.

c. Accelerate the development of and launch the electronic version of the *J.A.L.P.O.*

d. Encourage Sections to use the *J.A.L.P.O.* or Website for Observing Alerts; encourage substantial articles now published in section newsletters to be published in the Journal instead.

e. Improve quality and frequency of communication between and among staff, Board, and sections.

f. Require semiannual Section Status Reports (not apparition reports) to the Director.

g. Prohibit Sections from becoming autonomous entities from the rest of the A.L.P.O.

h. Intensify efforts to recruit and retain youth and new members.

i. Encourage new technology in observing programs while maintaining proven traditional approaches to observational work.

j. Encourage professional/amateur cooperation on topics of mutual interest.

k. Initiate "right-sizing" of A.L.P.O. Sections.

l. Eliminate programs no longer of observer interest.

m. Establish links between sections on special projects.

n. Encourage and assist sections in electronically archiving observational data.

o. Initiate work to find a safe central repository for A.L.P.O. observational data and library holdings.

p. Select an author and plan for completion of a History of the A.L.P.O.

2. The A.L.P.O. Handbook—Ken Poshedly presented to the Board a proposal for a member handbook to be distributed by paper and/or via the Web. There was discussion regarding the content, and it was felt that the Staff Guidelines should be included rather than the Bylaws and Articles of Incorporation. The Staff Guidelines contain information of greater usefulness to members. No further action was taken by the Board.

3. Staff Guidelines—Matt Will reviewed the development of the Staff and Board Guidelines, which he had previously sent to each Board member for comments. He will continue to incorporate revisions and present a final version by mail during the coming year. The Board thanked Matt for his work on such an important project and looks forward to the final versions.

4. Electronic (or Digital) Journal–This was proposed to the Board after extensive work by Harry Jamieson, Julius Benton, and Ken Poshedly. After discussion, the Board approved the proposal to publish an electronic and paper *J.A.L.P.O.* six times a year, to begin in early 2001. The content and pagination of the two versions will be identical. To accomplish this new process, Ken Poshedly will create a "mock" issue based on the text and graphics files John Westfall will provide to him from the recent issue. Ken will complete the sample journal in 60 days so that the Board can review the results and Rik Hill can test the electronic distribution plans. Final go-ahead for the electronic version depends upon successful completion of this test issue. As part of this reorganization, the editorial process is being revised to increase the contributors, spread the editorial work, and have one person (Ken Poshedly) concentrate on the assembly and production of the Journal. Harry will investigate a printer and mailing support in the Memphis area. Finally, pricing for memberships with the two versions of the Journal will be decided later, once details fall into place.

5. Financial Report:

Memphis Account (primary account)	$ 5,000
San Francisco account (monographs, *J.A.L.P.O.* FedEx)	$ 3,417
Las Cruces account (*J.A.L.P.O.* mailing)	$2,800
Total:	$11,217
Endowment Fund	$9,309

The Board approved a motion that Sustaining and Sponsor Memberships amounts in excess of the basic membership rate be transferred into the Endowment Fund. In addition, the Board endorsed the further development of fund-raising plans and publicizing the Endowment Fund.

6. Membership Statistics—Membership is 462, down from 480 one year ago, a statistic of concern to the Board. There were several suggestions: Walter will change the way he places the renewal notice to be sure it is not overlooked. Some suggested setting up A.L.P.O. "centers" in areas of concentration of members. Julius and Richard will continue work on development of the Youth Program.

7. Future Meetings—July 24-28, 2001, at Frederick, Maryland with the Astronomical League, approved.

2002: The Astronomical League has invited us to join them in Salt Lake City. No action taken.

2003: The Mahoning Valley Astronomical Society invited the A.L.P.O. to hold a meeting co-sponsored with them. Approved after receiving supplemental information a few weeks after the meeting.

8. A.L.P.O. Ephemeris: The Computing Section has been working on reviving an A.L.P.O. Ephemeris, and Julius will check on its status. Meanwhile, Rik Hill will create a link to a JPL Web site with their ephemeris-generating program. If we decide not to publish our own, we may ask coordinators to make paper copies available for specific object(s) upon request from members.

9. Actions on Sections and Coordinators:

Solar: Tony Grigsby removed; Brad Timerson changed from Acting to Assistant Coordinator.

Mars: Jim Bell resigned.

Minor Planets: Lawrence Garrett changed from Acting to Assistant Coordinator .

Jupiter: Damian Peach changed from Acting to Assistant Coordinator.

Meteors: Mark Davis removed, replaced by Robin Gray, Acting Assistant Coordinator.

History: Section changed from Provisional to Permanent. Gary Cameron removed, Richard Schmude appointed as Acting Coordinator.

Instruments: Will now include CCD issues.

Mentorships: To provide specialized training to members, the following mentors are announced:

Don Parker, mentor for CCD imaging.
Richard Schmude, mentor for photoelectric photometry.

10. The Board officially elected Julius Benton as the new A.L.P.O. Executive Director for a two-year term.

There being no further actions, the meeting was adjourned.

A.L.P.O. ANNOUNCEMENTS

New Meteorites Section.—A provisional Meteorites Section has been established by the A.L.P.O. Board, headed by Acting Coordinator **Dolores Hill**, a professional meteoriticist. Some of the Section's efforts will be directed toward helping amateurs recognize meteorites and learn how meteorites are related to some of the solar system objects that they observe. Dolores Hill's address is: Lunar and Planetary Laboratory, University of Arizona, Tucson, Arizona 85721 (E-mail: dhill@lpl.arizona.edu).

New Minor Planets Section Staff.—Two new staff staff members have been added to the Minor Planets Section: **Richard Kowalski**, Acting Assistant Coordinator, and **Steve Larson**, Acting Scientific Advisor, both of whom will be concerned with near-earth asteroids (NEAs). Their addresses are: Richard Kowalski, Quail Hollow Observatory, 7630 Conrad Street, Zephyrhills, FL 33544-2729 (E-mail: btink@bitnik.com); Steve Larson, Director Catalina Sky Survey, Lunar & Planetary Laboratory, University of Arizona, Tucson, AZ 85721 (E-mail: slarson@lpl.arizona.edu).

New Instruments Section Staff.—**Richard J. Wessling**, an experienced telescope maker, has been appointed as Acting Assistant Instruments Section Coordinator; his address is: Richard J. Wessling, 5429 Overlook Drive, Milford, OH 45150-9651 (E-mail: pinesop@aol.com).

New Name and Coordinator for Youth Programs Section.—**Richard W. Schmude, Jr.** has been appointed as Acting Coordinator of the A.L.P.O. Youth Programs Section (previously the Juniors Section), a section concerned with the recruitment and training of young persons in the study of planetary astronomy. His postal address is: Gordon College, Division of Natural Sciences and Nursing, 419 College Drive, Barnesville, GA 30204; E-mail address: Schmude@Falcon.gdn.peachnet.edu .

New Appointments for Expanded Publications Section (see also announcement on pages 138-139 of this issue).—The Publications Section has been enlarged and now consists of the following persons: **Publisher: Harry D. Jamieson** (Acting; P.O. Box 171302, Memphis, TN 38187-1302, E-mail: hjamieso@bellsouth.net). **Science Editors: Klaus R. Brasch** (29162 Rock Crest Court, Highland, CA 92346-3929, E-mail: kbrasch@wiley.csusb.edu), **Richard K. Ulrich** (Acting; Department of Chemical Engineering, 3202 Bell Engineering Center, University of Arkansas, Fayetteville, AR 72701, E-mail: rulrich@engr.uark.edu), **John E. Westfall** (5061 Carbondale Way, Antioch, CA 94509, E-mail: 73737.1102@compuserve.com). **General Editors: Robert A. Garfinkle** (Acting, Special Projects; 32924 Monrovia Street, Union City, CA 94587-5433, E-mail: ragarf@ix.netcom.com); **Ken Poshedly** (Acting, Magazine Markup and Assembly; 1741 Bruckner Court, Snellville, GA 30078-2784, E-mail: ken.poshedly@mindspring.com); **Roger J. Venable** (Acting, Special Projects; 3405 Woodstone Place, Augusta, GA 30909-1844, E-mail: rjvmd@knology.net). **Book Review Editor: Jose Olivarez** (Chabot Space and Science Center, 10000 Skyline Boulevard, Oakland, CA 94619, E-mail: jolivarez@cosc.org). **Graphics: John Sanford** (Acting; P.O. Box 1000, Springville, CA 93265-1000, E-mail: johnsan@sosinet.net). **Staff Writers: Eric Douglass** (Acting; 10326 Tarieton Drive, Mechanicsville, VA 23116-5835, E-mail: ejdftd@interpath.com), **James S. Lamm** (Acting: 9211 13th Avenue Circle NW, Bradenton, FL 34209, E-mail: jlspacerox@aol.com), **Richard J. Wessling** (Acting; 5429 Overlook Drive, Milford, OH 45150-9651, E-mail: pinesop@aol.com). **Translators: Richard J. Mc Kim** (French Language Submissions; Acting; Cherry Tree Cottage, 16 Upper Main Street, Upper Benefield, Peterborough PE8 5AN, United Kingdom, E-mail: rmckim5374@aol.com), **Guido E. Santacana** (Spanish Language Submissions; Acting; Nuevo Laredo 1678, Venus Gardens, Rio Piedras, PR 00926, E-mail: laffitte@prtc.net). **Assistant Webmaster: Jonathan D. Slaton** (Acting; 1025 George, Alton, IL 62002-2561, E-mail: jd@justfurfun.org).

***A.L.P.O. Webmaster.*—Richard Hill** has been managing the A.L.P.O. web page for about five years, so it was overdue that his services were recognized when he was recently appointed Webmaster by the A.L.P.O. Board. His address is: Richard Hill, Lunar and Planetary Laboratory, University of Arizona,Tucson, AZ 85721 (E-mail: rhill@lpl.arizona.edu).

***Address Changes.*—**Note that the postal addresses of both Book Review Editor **Jose Olivarez** and Acting Eclipse Coordinator **Michael D. Reynolds** are now: Chabot Space and Science Center, 10000 Skyline Boulevard, Oakland, CA 94619.

The E-mail address of **Sanjay Limaye**, Jupiter Section Assistant Coordinator and Scientific Advisor, has been changed to sanjayl@ssec.wisc.edu ; while that of **Damien Peach**, Assistant Jupiter Coordinator, is now dpeach78@netscapeonline.co.uk.

***Welcome Donation.*—**A.L.P.O. member **Thomas R. Williams** has generously donated $250 to the A.L.P.O. (Dr. Williams' photograph can be seen on the lower-right front cover of our last previous issue.)

OTHER AMATEUR AND PROFESSIONAL ANNOUNCEMENTS

Roster of Upcoming Meetings

December 5-7, 2000: ISCO 2000, International Conference on Space Optics. At Toulouse Labège, France. [Agence DAG-25, rue Saint Guilhem, 31400 Toulouse, France. Telephone: 33-05-61-25-15-00; E-mail: isco@dag.fr; Website: http://www.cnes.fr/colloque]

January 4-8, 2001: Small-Telescope Astronomy on Global Scales. IAU Colloquium 183. At Kenting National Park, Taiwan. The conference is intended to foster international cooperation on variability or wide-field survey/monitoring projects for telescopes of 1 m or less. [Ms. Kelly Chen, c/o IAUC183, Graduate Institute of Astronomy, National Central University, Chung-Li 32054 Taiwan. Telephone: +886-3-426-2302; FAX: +886-3-426-2304; E-mail: iauc183@joule.phy.ncu.edu.tw; Website: http://www.astro.ncu.edu.tw/iauc183]

January 7-11, 2001: 197th Meeting of the American Astronomical Society. At San Diego, California. Held with the American Association of Physics Teachers. Workshops and tours deadline 8 December 2000; hotel reservations deadline 13 December 2000. [Preliminary announcement at: http://www.aas.org/meetings/aas197/prelim/prelim.html]

June 25-30, 2001: Conference on Jupiter—Planet, Satellites and Magnetosphere. At the Harvest Regal Hotel, Boulder, Colorado. [Fran Bagenal, Professor of Astrophysical & Planetary Sciences, CB 391, University of Colorado, Boulder. Telephone: 303-492-2598; FAX: 303-492-6946; E-mail: bagenal@colorado.edu; Website: http://dosxx.colorado.edu/JupMeet.html]

July 24-28, 2001: ALCON 2001. Astronomical League-A.L.P.O. Convention, hosted by the Astronomi-cal League and the Mid-East Region of the Astronomical League. At the Holiday Inn and Francis Scott Key Conference Center. [Holiday Inn reservations: telephone 301-694-7500 or 800-868-0094. Meeting information, contact Frank Moon, Chair ALCON 2001, 7210 E. Sundown Court, Frederick, MD 21702; E-mail: ALCON 2001Chair@aol.com]

PUBLICATIONS OF THE A.L.P.O.

A.L.P.O. MONOGRAPH SERIES

A.L.P.O. monographs are publications that we believe will appeal to our members, but which are too lengthy for publication in our Journal. They should be ordered from: A.L.P.O. Monographs, P.O. Box 2447, Antioch, CA 94531-2447 U.S.A. for the prices indicated, which include postage. Checks should be in U.S. funds, payable to "A.L.P.O."

Monograph Number 1. ***Proceedings of the 43rd Convention of the Association of Lunar and Planetary Observers. Las Cruces, New Mexico, August 4-7, 1993.*** 77 pages. Price: $12.00 for the United States, Canada, and Mexico; $16.00 elsewhere.

Monograph Number 2. ***Proceedings of the 44th Convention of the Association of Lunar and Planetary Observers. Greenville, South Carolina, June 15-18, 1994.*** 52 pages. Price: $7.50 for the United States, Canada, and Mexico; $11.00 elsewhere.

Monograph Number 3. ***H.P. Wilkins 300-inch Moon Map.*** 3rd Edition (1951), reduced to 50 inches diameter; 25 sections, 4 special charts; also 14 selected areas at 219 inches to the lunar diameter. Price: $28.00 for the United States, Canada, and Mexico; $40.00 elsewhere.

Monograph Number 4. ***Proceedings of the 45th Convention of the Association of Lunar and Planetary Observers. Wichita, Kansas, August 1-5, 1995.*** 127 pages. Price: $17.00 for the United States, Canada, and Mexico; $26.00 elsewhere.

Monograph Number 5. ***Astronomical and Physical Observations of the Axis of Rotation and the Topography of the Planet Mars. First Memoir, 1877-1878.*** By Giovanni Virginio Schiaparelli, translated by William Sheehan. 59 pages. Price: $10.00 for the United States, Canada, and Mexico; $15.00 elsewhere.

Monograph Number 6. ***Proceedings of the 47th Convention of the Association of Lunar and Planetary Observers, Tucson, Arizona, October 19-21, 1996.*** 20 pages. Price $3.00 for the United States, Canada, and Mexico; $4.00 elsewhere.

Monograph Number 7. ***Proceedings of the 48th Convention of the Association of Lunar and Planetary Observers. Las Cruces, New Mexico, June 25-29, 1997.*** 76 pages. Price: $12.00 for the United States, Canada, and Mexico; $16.00 elsewhere.

Monograph Number 8. ***Proceedings of the 49th Convention of the Association of Lunar and Planetary Observers. Atlanta, Georgia, July 9-11, 1998.*** 122 pages. Price: $17.00 for the United States, Canada, and Mexico; $26.00 elsewhere.

Monograph Number 9. ***Does Anything Ever Happen on the Moon?*** By Walter H. Haas. Reprint of 1942 article. 54 pages. Price: $6.00 for the United States, Canada, and Mexico; $8.00 elsewhere.

OTHER PUBLICATIONS OF THE A.L.P.O.

(Checks must be in U.S. funds, payable to an American bank with bank routing number.)

Order from: A.L.P.O., P.O. Box 2447, Antioch, CA 94531-2447, U.S.A:

An Introductory Bibliography for Solar System Observers. Free for a stamped, self-addressed envelope. A 4-page list of books and magazines about Solar System bodies and how to observe them. The current edition was updated in October, 1998.

Order from: A.L.P.O. Membership Secretary, P.O. Box 171302 Memphis, TN 38187-1302 U.S.A:

A.L.P.O. Membership Directory. $5.00 in North America; $6.00 elsewhere. Continuously updated list of members on 3.5-in MS-DOS diskette; either DBASE or ASCII format. Make payment to "A.L.P.O." Also available as an e-mail downloaded file, given the requester's e-mail address. Provided at the discretion of the Membership Secretary.

Order from: Walter H. Haas, 2225 Thomas Drive, Las Cruces, NM 88001, U.S.A. (E-mail: haasw@zianet.com):

Back issues of *The Strolling Astronomer (J.A.L.P.O.).* Many of the back issues listed below are almost out of stock, and it is impossible to guarantee that they will remain available. Issues will be sold on a first-come, first-served basis. In this list, volume numbers are in italics, issue numbers are in plain type, and years are given in parentheses. The price is $4.00 for each back issue; the current issue, the last one published, is $5.00. We are always glad to be able to furnish old issues to interested persons and can arrange discounts on orders of more than $30. Make payment to "Walter H. Haas."

$4.00 each: *1* (1947); 6. *8* (1954); 7-8. *11* (1957); 11-12. *21* (1968-69); 3-4 and 7-8. *23* (1971-72); 7-8 and 9-10. *25* (1974-76); 1-2, 3-4, and 11-12. *26* (1976-77); 3-4 and 11-12. *27* (1977-79); 3-4 and 7-8. *31* (1985-86); 9-10. *32* (1987-88); 11-12. *33* (1989); 7-9. *34* (1990); 2 and 4. *37* (1993-94); 1, 2 and 3. *38* (1994-96); 1, 2, and 3. *39* (1996-97); 1, 2, 3 and 4. *40* (1998); 2 and 4. *41* (1999); 1, 2, 3, and 4. *42* (2000), 1 and 2.

Current Issue [*42*, 3]; $5.00.

PUBLICATIONS OF THE SECTIONS OF THE A.L.P.O.

Order the following directly from the appropriate Section Coordinator; use the address in the staff listing (next two pages) unless another address is given below.

Lunar and Planetary Training Program (Robertson): *The Novice Observers Handbook,* $15.00. An introductory text to the Training Program. Includes directions for recording lunar and planetary observations, useful exercises for determining observational parameters, and observing forms. To order, send a check or money order made out to "Timothy J. Robertson."

Lunar (Benton): (1) *The ALPO Lunar Section's Selected Areas Program (SAP),* $17.50. Includes a full set of observing forms for the assigned or chosen lunar area or feature, together with a copy of the *Lunar Selected Areas Program Manual.* (2) *Observing Forms Packet,* $10.00. Includes observing forms to replace the quantity provided in the Observing Kit above. Specify the Lunar Forms. (See note for Venus.)

Lunar (Dembowski): *The Lunar Observer,* a monthly newsletter, is available online at the A.L.P.O. Homepage, http://www. lpl.arizona.edu/alpo/ . Hard copies may be obtained by sending a set of self-addressed stamped envelopes to Bill Dembowski at his address in our staff listing.

Lunar (Jamieson): *Lunar Observer's Tool Kit,* consisting of a 3-1/2-in. MS/DOS diskette containing an observation-planning program and a lunar dome data base with built-in instructions. Price $25.00.

Venus (Benton): (1) *The ALPO Venus Observing Kit,* $17.50. Includes introductory description of A.L.P.O. Venus observing programs for beginners, a full set of observing forms, and a copy of *The Venus Handbook.* (2) *Observing Forms Packet,* $10.00. Includes observing forms to replace the quantity provided in the Observing Kit above. Specify the Venus Forms. (To order the above, send a check or money order made out to "Julius L. Benton, Jr." All foreign orders should include $5.00 additional for postage and handling; for domestic orders, these are included in the prices above. Shipment will be made in two to three weeks under normal circumstances. NOTE: Observers who wish to make copies of observing forms have the option of sending a SASE for a copy of forms available for each program. Authorization to duplicate forms is given only for the purpose of recording and submitting observations to the A.L.P.O. Venus, Saturn, or Lunar SAP Section. Observers should make copies using high-quality paper.)

Mars (Troiani): *Martian Chronicle;* available by e-mail. Contact Mars Coordinator Daniel M. Troiani at dantroiani@earthlink.net .

Mars (Astronomical League Sales, P.O. Box 572, West Burlington, IA 52655 U.S.A.): *ALPO's Mars Observer Handbook,* $9.00.

Jupiter: (1) "Jupiter Observer's Start-Up Kit" is available for $3.00 from David J. Lehman. (2) *Jupiter*, the newsletter of the Jupiter Section is available on the Internet at the Jupiter Section Web page or by mail: send SASEs to David J. Lehman. (3) To join the Jupiter Section's E-mail network, "J_Net," send an E-mail message to David J. Lehman at DLehman111@aol.com, write "subscribe J_Net" in the subject field. (4) *Timing the Eclipses of Jupiter's Galilean Satellites;* send a SASE with 55 cents in stamps to John Westfall. This is the project "Observing Kit" and includes a report form.

Saturn (Benton): (1) *The ALPO Saturn Observing Kit,* $20.00. Includes introductory description of A.L.P.O. Saturn observing programs for beginners, a full set of observing forms, and a copy of *The Saturn Handbook.* (2) *Observing Forms Packet,* $10.00. Includes observing forms to replace the quantity provided in the Observing Kit above. Specify the Saturn Forms. (See note for Venus.)

Meteors (Astronomical League Sales, P.O. Box 572, West Burlington, IA 52655 U.S.A.): (1) The pamphlet, *The A.L.P.O. Guide to Watching Meteors* is available for $4.00 (price includes postage). (2) The *Meteors Section Newsletter* is published quarterly (March, June, September, and December) and is available free of charge if you send 33¢ in postage per issue to Coordinator Robert D. Lunsford, 161 Vance Street, Chula Vista, CA 91910 U.S.A..

Minor Planets (Derald D. Nye, 10385 East Observatory Dr., Corona de Tucson, AZ 85641-2309 U.S.A.): Subscribe to: *The Minor Planet Bulletin;* quarterly, $9.00 per year for the United States, Mexico and Canada; or $13.00 for other countries (air mail only).

Computing Section (McClure): A Computing Section Newsletter, *The Digital Lens,* is available via e-mail. To subscribe or to make contributions, contact the editor, Mike W. McClure, at: MWMCCL1@POP.UKY.EDU .

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