ISSN-0039-2502

Journal of the Association of Lunar & Planetary Observers

The Strolling Astronomer

Volume 44, Number 4, Autumn 2002

Now in Portable Document Format (PDF) for MacIntosh and PC-Compatible Computers

Inside...

Phillip W. Budine of the ALPO Jupiter Section accounts for his 50-year personal observing program of Jupiter's Great Red Spot. Using a variety of telescopes over the years, Phil notes variations in this over-300-year-old storm on Jupiter.

At right is a montage comprising a sort of Jovian family portrait not taken by Phil, but instead imaged by NASA's Galileo and Voyager spacecraft; shown are the Great Red Spot with Galilean satellites (top to bottom) Io, Europa, Ganymede and Callisto.

Also . . .

* Counting meteors with an FM radio

* Reports on Mercury and Venus during their recent apparitions

* A look at the lunar crater Alphonsus

* Yet another report on the lunar phenomenon "Plato's Hook"

* A piece on the upcoming Mars apparition

. . . and much, much more.

Bonus!

ALPO Mercury Section Observing Report Form in This Issue

Journal of the Association of Lunar & Planetary Observers, The Strolling Astronomer

Volume 44, No. 4, Autumn 2002
This issue published in December 2002 for distribution in both portable document format (pdf) and also hard-copy format.

This publication is the official journal of the Association of Lunar & Planetary Observers (ALPO).

The purpose of this journal is to share observation reports, opinions, and other news from ALPO members with other members and the professional astronomical community.

For membership or general information about the ALPO, contact:

Matthew Will
ALPO Membership Secretary/Treasurer
P.O. Box 13456
Springfield, Illinois 62791-3456

E-mail to: will008@attglobal.net

Visit the ALPO online at:
http://www.lpl.arizona.edu/alpo

In This Issue:

The ALPO Pages

Features

ALPO Resources

Inside the ALPO

Member, section and activity news

Association of Lunar and Planetary Observers (ALPO)

Board of Directors

Executive Director (Chair); Donald C. Parker
Associate Director, Richard W. Schmude, Jr.
Founder/Director Emeritus; Walter H. Haas
Member of the Board; Julius L. Benton, Jr.
Member of the Board; Richard Hill
Member of the Board; Ken Poshedly
Member of the Board; John E. Westfall
Member of the Board, Secretary; Elizabeth W. Westfall
Member of the Board, Treasurer and Membership Secretary; Matthew Will

Publications

Acting Editor & Publisher, Ken Poshedly

Primary Observing Coordinators, Other Staff

(See full listing in *ALPO Resources* at end of book)
Lunar and Planetary Training Program: Coordinator; Timothy J. Robertson
Solar Section: Coordinator, *Website, SolNet, Rotation Report,* handbook; Richard Hill
Mercury Section: Acting Coordinator; Frank Melillo
Venus Section: Coordinator; Julius L. Benton, Jr.
Mercury/Venus Transit Section: Coordinator; John E. Westfall
Lunar Section: Coordinator; *Selected Areas Program;* Julius L. Benton, Jr.
Mars Section: Coordinator, *all observations, U.S. correspondence;* Daniel M. Troiani
Minor Planets Section: Coordinator; Frederick Pilcher
Jupiter Section: Coordinator; Richard W. Schmude, Jr.
Saturn Section: Coordinator; Julius L. Benton, Jr.
Remote Planets Section: Coordinator; Richard W. Schmude, Jr.
Comets Section: Coordinator; Gary Kronk
Meteors Section: Coordinator; Robert D. Lunsford
Meteorites Section: Coordinator; Dolores Hill
Computing Section: Coordinator; Mike W. McClure
Youth Section: Acting Coordinator; Timothy J. Robertson
Historical Section: Coordinator; Richard Baum
Instruments Section: Coordinator; R.B. Minton
Eclipse Section: Coordinator; Michael D. Reynolds
Webmaster: Coordinator; Richard Hill

Point of View: A Road Well-Traveled

By Charles Laird Calia

I'll admit it. I missed astronomy.

The layoff was a long one, almost 25 years. The last time I looked through an eyepiece, in the 1970s, there were no computerized telescopes, no CCD photography or hydrogen-alpha filters – at least not in the hands of amateurs. But there was an ALPO.

ALPO and the Jupiter studies that I undertook were foundations of my teenage years. They gave a context to what I was observing and offered me the opportunity, as a 16-year-old, to mix with other serious amateurs and some professional astronomers, something nearly impossible in my own small town. ALPO or more specifically, this journal, the *Strolling Astronomer*, also gave my real dream, that of writing, a jump-start. It was first in the *Strolling Astronomer* that I saw my name in print, a heady concoction to be sure, and one, I fear, that I have yet to get over.

I grew up, moved away, went to college The telescopes were sold, books donated, copies of the *Strolling Astronomer* lost.

Like many amateurs I found other passions and challenges in my life and yet there was that inkling, long buried for almost a quarter century, that something vital had been missing – namely, a sense of scientific adventure. So here I am, back where I began, a new old member on a road I recognize all too clearly.

I'm not the observer that I was as a teenager to be sure. My eyes, though better trained, are older and I've lost what little knowledge that I've accumulated from those years. But one thing that I haven't relinquished is this – the night sky still fascinates me. And that perhaps is enough of a reason for coming back to ALPO, for the sheer love and passion of the sport.

(Charles Laird Calia is a novelist and amateur astronomer and lives somewhere in Connecticut; but he's moved and left no new address or phone. Charles, Please contact us!)

Letters

The opinions expressed in the “Letters” section of this Journal are those of the writer and do not necessarily reflect the official policies of the ALPO.

Pluto-Charon

Sirs,

In the last issue of the JALPO, I read with great interest the report on the remote planets. But I would like to correct a statement by the author about Roger Venable and other members of the Augusta Astronomy Club as “the first people to see Pluto and Charon separated from one another.”

It would be more exact to write that they are probably the first to resolve Charon with amateur means.

In the French journal *Pulsar* for January 1988, there's a paper by David Tholen (originally published in the newsletter " Ninth Planet News ") about the sighting of Charon by some observers.

The first report was by Roy Tucker in 1981 or 1982, who saw on the control monitor of the Multi-Mirror Telescope (MMT) an elongated image of Pluto.

In 1986 and 1987, Charon appeared visually as an excrescence to Pluto's image for Jean Francois Le Borgne (1 meter telescope at the Pic du Midi Observatory), David Tholen and Marc Buie (2.24 meter telescope on the Mauna Kea).

In 8 June 1987, David Tholen saw Charon perfectly separated from Pluto: “yes, there was black between the two components”.

In *Sky & Telescope* magazine, January 1993, William Sheehan reported his observation of the double planet with the 1 meter telescope of the Pic du Midi: “In rare moments with averted vision, we both believe we see a double Pluto!”.

There are probably many more instances of this difficult observation, nevertheless the Roger Venable observation is really remarkable with so small a telescope.

(Signed) LECOMTE Stéphane
4 Passage Bartholdi
31130 BALMA
France
stlecomte@wanadoo.fr

Herodotus Correction

I must apologize to the readers for some errors in the data in Table 1 of my Herodotus shadow paper in JALPO 44,3 , pg. 5. I failed to note a displaced minus sign in the column for the Sun's selenographic latitude in the American Ephemeris and Nautical Almanac for 1954. This quantity was then used as 0.85 when it was really -0.85. The result was to make the Sun's height in Table 1 too large by about 0.7 degrees on August 11 and by about 0.9 degrees on October 9. The published azimuths need to be increased by one to two degrees , but this correction is probably of no importance at all. In Table 2 the times for matching the solar height at 2:28 , UT on August 11 , 1954 then need to be earlier by about an hour and 20 minutes since the Sun was lower in the lunar sky. Dr. Anthony Cook , our LTP Coordinator, plans to have an extensive schedule of future observing opportunities available , showing when the solar lighting will be the same as when the odd shadow was recorded.

Below are the corrected values of the Sun's height and azimuth in Table 1.

Date	U.T.	Sun's Height	Sun's Azimuth
!954, Aug 11	2:28	3.45	92.41
""	3:03	3.72	92.53
"	4:05	4.21	92.74
"	5:20	4.79	92.99
1954, Oct 09	1:45	2.87	92.89
"	2:36	3.27	93.06

Walter Haas

Reminder: Address changes

Unlike regular mail, electronic mail is not forwarded when you change e-mail addresses unless you make special arrangements.

More and more, e-mail notifications to members are bounced back because we are not notified of address changes. Efforts to locate errant members via online search tools have not been sucessful.

So once again, if you move or change Internet Service Providers and are assigned a new e-mail address, please notify Matt Will at will008@attglobal.net as soon as possible.

****

October 21, 2002
To: Thomas R. Williams
From: Matthew L. Will,
Membership Secretary and Treasurer
Association of Lunar and Planetary Observers

Hi Tom,

On behalf of the ALPO Board and Staff, I would like to extend a very special thank you to you for your latest contribution to the ALPO Treasury. Your latest check of $250.00 for your present renewal is most appreciated. I note that you are one of our "long time" Sponsors. You have kindly contributed $100.00 with your previous renewal and $250 a couple of renewals ago. The generosity of people like yourself helps to sustain our organization.

The ALPO is making great efforts to become more financially stable. Through a combination of dues increases and economizing, we hope to make contributions like yours, count more toward growing our endowment and our organization as a whole. The Journal ALPO is now being produced more efficiently through offering it digitally and producing the hard copy version through more cost effective means, without sacrificing quality.

Tom, you will be receiving a formal acknowledgment of renewal in the postal mail, shortly. I thought I would drop you this line just to thank you again for your long time support.

Best regards,

Matt

New Dues Structure

Faced with increased costs all around, the ALPO membership dues structure will change effective January 1, 2003.

Please see the last page of the *ALPO Resources* section of this Journal for complete details.

Our Advertisers

As we all know by now, there is no free lunch. Everything costs money. This Journal and various matters of the ALPO require funding. One way to help offset the costs of producing and mailing the hardcopy version of this publication is through advertising.

We are lucky in this issue to include not only our good friends at Sky Publishing, but a new addition, Midwest Astronomy.

Please show your support of them as they show their support for us.

ALPO Conference News

The next annual meeting of the Assn. of Lunar & Planetary Observers will be Thursday through Saturday, August 7 - 9, 2003, at the Holiday Inn- Boardman, Ohio, 7410 South Avenue.

A block of rooms has been resererved for the meeting at a special rate of $89 per night; this rate is good until July 17, 2003. All attendees should make their own reservations directly with the hotel. It is preferred that rooms be held with any major credit card.

While a larger writeup of the event will appear in the next Journal, this event will have special significance. ALPO founder and director emeritus Walter Haas was born in New Waterford, Ohio, about 15 miles to the south of this meeting site. While this will not be Walter's first return to the area, it will be one in which he will have his ALPO friends and family joining him. We hope that all ALPO members will consider attending this special meeting.

The registration fee and other details are being finalized now. Contact the Holiday Inn at 330-729-1611, website: www.hilboardman.com

Observing Section Reports

Minor Planets Section

By Derald D. Nye

The subscription rate for the quarterly publication *Minor Planet Bulletin* is increasing to $14 per year, effective immediately, for those in the U.S., Mexico and Canada, and $19 per year elswhere.

Send check or money order payable to “Minor Planet Bulletin” to 10385 East Observatory Dr., Corona de Tucson, AZ 8564I-2309.

Jupiter Section

By Richard Schmude, coordinator

Richard Schmude has just finished writing the 2001-02 Jupiter apparition report. Over 60 people sent in observations during the 2001-02 apparition. Three highlights of the 2001-02 apparition were the transit of oval BA past the Great Red Spot, the widening of the North Equatorial Belt and the appearance of over a dozen dark elongated features (barges) within the North Equatorial Belt.

Oval BA passed the Great Red Spot on Feb. 25, 2002. The data indicate that oval BA was pushed into a more southerly latitude as it passed the Great Red Spot; furthermore, oval BA may have slowed down a bit just before it passed the Great Red Spot.

The barges within the North Equatorial Belt moved at an average rotation rate of 9h 55m 37s, which is unusual since the barges were at the center and at the northern edge of the North Equatorial Belt and we know that features in the center of this belt move much faster than do features at the northern edge of the belt.

Jupiter had about the same brightness and color in late 2001 as it did in 1999 and 2000. The amount of polarized light reflected by Jupiter was below 1% in early 2002.

People have already begun imaging Jupiter in late 2002. The Great Red Spot is reported to have become darker in the last few weeks. The North and South Equatorial Belts are still distinct as of Oct. 15. Several barges were imaged in September and October 2002; three of these barges are at system II longitudes of 120, 280 and 330 degrees.

John McAnally is continuing to work on the 2000-01 Jupiter transit times and he is also writing up a report about oval BA and the GRS. Damian Peach has been busy imaging Jupiter and Saturn. Craig MacDougal has published at least one Jupiter Section Newsletter for the 2002-03 apparition. Please contact Craig if you want an electronic copy of the newsletter.

Remote Planets Section

By Richard Schmude, coordinator

Both Uranus and Neptune are located in the southwestern sky after sunset and it is still not too late to make observations of these two planets. A total of 12 people (Michael Amato, Brian Cudnik, Barrett Duff, Mario Frassati, Ed Grafton, Walter Haas, David Hufnagel, Gabor Kiss, Frank Melillo, Don Parker, Richard Schmude, Jr. and Doug West) have sent in observations of the three most distant planets this year. Don Parker sent in a CCD image of Uranus, which he made in early October; this image shows a slight asymmetry in the limb darkening. People with excellent seeing are encouraged to study the limb darkening of Uranus in November and to report any asymmetry to the coordinator at Schmude@gdn.edu.

Uranus continues its dimming trend. In mid-2002, Uranus was about 1percent dimmer than what it was in 2001. Neptune on the other hand has not continued to brighten in 2002. In fact, Neptune may have dimmed a bit in 2002. Melillo and West have recorded CCD images of Pluto.

Interest Section Reports

Instruments Section

By Dick Wessling, assistant coordinator

No activity this time to report. I have been busy finishing my 14.75-inch, f/5.5 Dobsonian as pictured below as well as working on my 25-inch Cassegrain. Getting ready for Mars next summer.

ALPO-Member-Discussion Listserv

By Ken Poshedly, list moderator

All members of the Assn. of Lunar & Planetary Observers are encouraged to join and participate on this online feature. Initially, all members with electronic mail addresses were subscribed; many stayed on, but various members dropped off, some due to already too many e-mails from other sources. But those who have stayed on have found it to be a true benefit in learning what other ALPO members have to say about either organizational matters, observing techniques or equipment, or various solar system bodies and events.

Thus far, we have been "spam-free" (no unwanted advertisements), with this trend hopefully to continue indefinitely.

For more information or to join in, send an e-mail to:

poshedly@bellsouth.net

About the Authors (alpha order)

Julius Benton (Venus, 1998-99 Apparition)

Dr. Julius L. Benton, Jr. is a native of Albany, Georgia, and joined the ALPO in 1967. He was appointed coordinator of the ALPO Lunar Section in 1970, heading up the Selected Areas Program, and in 1971, he assumed additional duties as coordinator of the Venus and Saturn Sections. He still holds all three posts today, after nearly three decades of successful leadership and administration of ALPO observing programs. In 1994, Julius was elected to the board of directors of the ALPO, and he has served as distribution editor for the *Journal of the ALPO* since 1996. In 1998 he became Associate Director of the organization. He completed his most recent term as chairman of the ALPO board of directors last summer. In addition to his professional research that has appeared in various technical journals, Julius has written extensively on the subjects of lunar and planetary astronomy for over 25 years. He can be reached via e-mail at either jlbaina@msn.com or jlbalpo@netscape.net

Eric Douglass (Crater Alphonsus)

Eric has published articles and/or photographs in

Sky & Telescope, the JALPO, *Astronomy*, and *Selenology*. The majority of these deal with planetary geology, but have also included materials on videoastronomy and seeing prediction systems. He is a coauthor in the new book *Videoastronomy* (published by *Sky Publishing*), is the editor of the *Digital Consolidated Lunar Atlas* (on line at: http://www.lpi.usra.edu/research/cla/menu.html; to be released on CD rom later this year by the Lunar and Planetary Institute), supplied the lunar atlas images to *Observing the Moon* (by Peter Wlasuk), and supplied images and geologic interpretation for the computer program *Lunaview* (by Steve Massey). His primary telescope is a 12.5 inch, f/6 Newtonian. For images, he uses eyepiece projection onto an Astrovid 2000 video camera. The feed from this goes into a digital video processor and is recorded on SVHS. Images are taken from the tape using a Snappy, and processed on the computer. Eric's primary interests are in planetary geology and photogeologic interpretation. E-mail Eric at ejftd@mindspring.com

Favero, et al (Plato's Hook, Part III)

Co-authored by Giancarlo Favero (Osservatorio Guido Ruggieri, Padova, Italy), Raffaello Lena (GLR, Geologic Lunar Researches, Italy), Fabio Lottero (GLR, Geologic Lunar Researches, Italy), and Giorgio Di Iorio, Alessandro Bares, Cristian Fattinnanzi (GLR, Geologic Lunar Researches, Italy)

Raffaello Lena founded the Geologic Lunar Research (GLR) group (http://digilander.iol.it/gibbidomine) and has published lunar articles in the *JALPO*, *Selenology* and Italian magazines. His primary interest is the study of lunar domes and their classification. The GLR group has members from several nations that participate in various lunar observing projects (domes, TLP, lunar flashes projects). Raffaello was recently named coordinator of the American Lunar Society's Lunar Impact Project. As such, he has done research on spurious flashes. He can be reached at e-mail address:

gibbidomine@libero.it

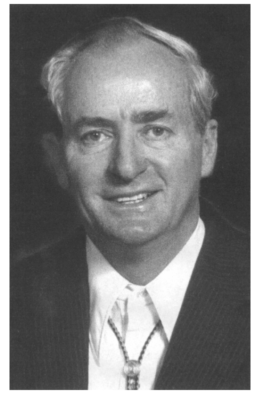
Giancarlo Favero's (no photo supplied) interest in planetary astronomy was inspired about 1960 while he was in high school by Guido Ruggieri, a leading Italian planetary observer. With a home-made 7-inch reflector Giancarlo started observing Jupiter, Mars and the Moon. He received his degree in chemistry in 1969 and maintained his interest in astronomy, frequenting the Padua Observatory and enjoying the friendship of its director, Prof. Leonida Rosino. Over the 1970s, Giancarlo directed the Jupiter Section of the Unione Astrofili Italiani (UAI) and published three papers in the *Journal of the Assn. of Lunar & Planetary Observers*. He was president of the UAI for six years, and for 30 years was professor of chemistry at the University of Padua. In 2000, he retired and subsequently joined the ALPO and returned to planetary astronomy, his youth's love.

No data supplied on Messrs. Lottero, Di Iorio, Bares, and Fattinnanzi.

Frank J. Melillo (Mercury Apparitions)

Frank has been interested in astronomy since the age of 11, when Apollo 11 went to the Moon and he was attracted by the beauty of the universe. He used a Tasco 4.5-inch refractor telescope throughout the 1970s. In 1980, he purchased a Celestron 8-inch Schmidt-Cassegrain, which he still has. He started doing astrophotography and joined the Astronomical Society of Long Island, then the AAVSO, the IAPPP and the ALPO in 1985. In 1997, Frank entered the world of CCD imaging and got more interested in planetary imaging. He is more active in ALPO than any other national organization, and is now the coordinator of the ALPO Mercury Section. Frank, his wife, Jean, and their 10-year-old daughter, Alyssa, live in Holtsville, New York, 50 miles east of New York City on Long Island.

R. B. Minton & Robert D. Lunsford (Counting Meteors with FM Radios)



The ALPO Instrument Section's R.B. Minton is retired and living in the high desert-low mountain area of Raton, New Mexico. This dark-sky and radio-quiet region is ideal for building and testing many types of astronomical instruments. He was a photographic technician at New Mexico State University Observatory (Las Cruces), a research assistant at the Lunar & Planetary Laboratory (Tuscon), and a software engineer (Denver). R. B. has ground mirrors and built telescopes from 4 to 17 inches in aperture. He also likes to buy orphaned computers and press them into astronomical service. His fondest job was working at NMSU with Clyde Tombaugh's team and trying to think of new "crow jokes", among other duties. His most memorable job was as a "threat analyst" for a Star Wars computer simulation at Martin-Marietta in Denver, and traveling to the U.S. Air Force AMOS optical tracking site near Maui, Hawaii, as well as the Pentagon.

Robert Lunsford has always held a fascination for naked eye astronomy, watching the motion of the moon and bright planets plus comets and meteor showers. Telescopes helped introduce him to deep sky objects, double and variable stars, but he found himself most attracted to visual studies of the planets and meteor showers, which led to his association with ALPO. His interest in meteor showers was stimulated with the 1966 Leonid display, which he partially observed from his suburban front yard. Robert has been recording and analyzing meteor showers ever since. He joined ALPO in the 1980's, contributing to various planetary sections; he became coordinator of the ALPO Meteors Section in 1988, but still tries to view the planets as much as possible.

A.L.P.O. Sponsors, Sustaining Members, and Newest Members

The A.L.P.O. wishes to thank the following members for voluntarily paying higher dues. The extra income helps in maintaining the quality of the *Journal* while helping to keep the overall cost of the *Journal* in check. Thank you!

As of December 1, 2002:

SPONSORS	CITY	STATE/PROV.	COUNTRY
JULIUS L BENTON, JR	SAVANNAH	GA	
HANK BULGER	GRANTS	NM	
LELAND A DOLAN	HOUSTON	TX	
ROBERT E DUNN	FLORAL PARK	NY	
GEOFF GAHERTY	TORONTO	ON	CANADA
ROBERT A GARFINKLE, FRAS	UNION CITY	CA	
PHILLIP R GLASER	LA JOLLA	CA	
MR AND MRS W P PALA, JR	CENTREVILLE	VA	
DONALD C PARKER	CORAL GABLES	FL	
JAMES PHILLIPS	CHARLESTON	SC	
GERALD WATSON	CARY	NC	
CHRISTOPHER C WILL	SPRINGFIELD	IL	
MATTHEW L WILL	SPRINGFIELD	IL	
THOMAS R WILLIAMS	HOUSTON	TX	

SUSTAINING MEMBERS	CITY	STATE/PROV.	COUNTRY
PAUL H BOCK JR	HAMILTON	VA	
RAFFAELLO BRAGA	CORSICO (MI)		ITALY
KLAUS R BRASCH	HIGHLAND	CA	
PHILLIP W BUDINE	BINGHAMTON	NY	
DONALD M CLEMENT	KENNER	LA	
WILLIAM DEMBOWSKI	WINDBER	PA	
THOMAS WESLEY ERICKSON	SAN LUIS REY	CA	
RICHARD R FINK	BRICK	NJ	
MICHAEL GRANGER	CHALON/SAONE		FRANCE
GORDON W GARCIA	HOFFMAN ESTATES	IL	
ROBIN GRAY	WINNEMUCCA	NV	
ROBERT H HAYS	WORTH	IL	
JOHN M HILL	TUCSON	AZ	
MIKE HOOD	KATHLEEN	GA	
DAVID A HURDIS	NARRAGANSETT	RI	
GEORGE KIDWELL	WACO	TX	
JIM LAMM	BRADENTON	FL	
DAVID J LEHMAN	FRESNO	CA	
ROBERT D LUNSFORD	CHULA VISTA	CA	
MICHAEL MATTEI	LITTLETON	MA	
CAPT. SYD PALMER	NANAIMO	BC	CANADA
DR. A K PARIZEK	PHOENIX	AZ	
CECIL C POST	LAS CRUCES	NM	
TIMOTHY J ROBERTSON	SIMI VALLEY	CA	
FRANCISCO J ROLDAN	LA CROSSE	WI	
TAKESHI SATO	HATSUKAICHI CITY	HIROSHIMA-PREF.	JAPAN
MARK L SCHMIDT	RACINE	WI	
LEE M SMOJVER	TUKWILA	WA	
ROGER J VENABLE	AUGUSTA	GA	
RICHARD J WESSLING	MILFORD	OH	
ELIZABETH W WESTFALL	ANTIOCH	CA	

The A.L.P.O. would like to wish a warm welcome to those who recently became members. Below are persons that have become new members from May 29, 2002, through December 1, 2002: where they are from and their interest in lunar and planetary astronomy. The legend for the interest code is located at the bottom of the page.

MEMBER	CITY	STATE/PROV.	COUNTRY	INTERESTS
MICHAEL J ANDERSON	BLUFFTON	SC		T
HARRY N BEARMAN	FT WORTH	TX		03456H
THOMAS A BECK	COLUMBUS	OH		03569ACDMPR
MICHAEL F BORMAN	EVANSVILLE	IN		03456CDIP
TODD BOUVEROT	BERGENFIELD	NJ		23456
GILLES CHAPDELAINE	STE-FOY	QC	CANADA	0356CPS
ROLANDO CHAVEZ	POWDER SPRINGS	GA		234578ACDP
JIM CONROY	WACO	TX		
ROBERT T CREWS	LOUISVILLE	KY		56I
THOMAS P DAVIS	SPADE	TX		356CH
THOMAS A DOBBINS	HOWARD	OH		
STEVEN J ERNST	HARKER HEIGHTS	TX		5AD
RICHARD EVELYN	MARIETTA	GA		5678AC
LARRY A HARDY	SPRINGFIELD	IL		
JASON P HATTON	SAN FRANCISCO	CA		12456
JEFFERY L HOPKINS	PHOENIX	AZ		03DPR
MARVIN W HUDDLESTON	MESQUITE	TX		345CDIS
JUDY JARVIS	MEDINAH	IL		03456CDIMP
ROY A KAELIN	RIVERSIDE	IL		3AMPS
CHARLES KLINGEL	CARPENTERSVILLE	IL		DHIOP
TERRY L MANN	WEST MANCHESTER	OH		0346ACPT
ROBERT D MC GOWN	PORTLAND	OR		34ACDHIMPR
STEVEN C ORLANDO	EAST NORTHPORT	NY		0356DIP
RICHARD OWENS	JUPITER	FL		035HP
JUDITH PARISEAU	SOUTH BRIDGE	MA		356
ROBERT PILZ	ASHEVILLE	NC		3456D
BILL PREST	MEMPHIS	TN		
JERRY M SHERLIN	CENTENNIAL	CO		
KENNETH R SIARKIEWICZ	TUCSON	AZ		3
LAURA SIEBEL	PITTSBURGH	PA		
C W SIMS, JR	KOUNITZE	TX		
CAPT W E "SMOKEY" SLOVER	MARYVILLE	TN		
CAROL J STEWART	CAPE CORAL	FL		03456
JIM TOMNEY	TOWSON	MD		456
GLENN TRIPP	FENTON	MI		0123456789ACDHIMPRST
TIMOTHY G WILSON	JEFFERSON CITY	MO		14
CHERYL LYNN YORK	OREGON CITY	OR		4S

Below are new members that joined the A.L.P.O. prior to May 29, 2002 but did not make it into the previous listings a couple of issues ago.

MEMBER	CITY	STATE/PROV.	COUNTRY	INTERESTS
MICHAEL L KARAKAS	WINNIPEG	MB	CANADA	
JEFF KEFFER	WINCHESTER	MA		
CHRISTOPHER C WILL	SPRINGFIELD	IL		
JAMES WILLIAMS	STOCKTON	CA		3ASID
MIKE WITTMEYER	MIAMI	FL		
WALTER YAKIMOWICZ	RUTHERFORD	NJ		

Interest Abbreviations

0 = Sun	5 = Jupiter	A = Asteroids	M = Meteors
1 = Mercury	6 = Saturn	C = Comets	O = Meteorites
2 = Venus	7 = Uranus	D = CCD Imaging	P = Photography
3 = Moon	8 = Neptune	E = Eclipses	R = Radio Astronomy
4 = Mars	9 = Pluto	H = History	S = Astronomical Software
		I = Instruments	T = Tutoring

ALPO Feature: Meteors

Using FM Radios to Count Meteors

By R. B. Minton, coordinator,
Instruments Section
Robert D. Lunsford, coordinator,
Meteors Section

Abstract

Meteors leave an ionized trail many kilometers long in the upper atmosphere. These electrons reflect and scatter radio waves with frequencies of tens of megahertz (MHz) to hundreds of MHz. The U.S. FM radio band (87.5 to 107.9 MHz) is an ideal frequency to monitor these radio signals. Inexpensive used FM car radios with their digital tuning, excellent noise rejection, and high sensitivity; are ideal receivers. Commercial FM radio stations that are over the horizon are the signal sources. A FM radio coupled to a PC compatible digital multimeter, and a computer, can record these signals 24 hours a day and 7 days a week (24/7) with little or no operator involvement. These computer files can then be plotted and analyzed, revealing much about meteor streams, various sources of noise; and strengths and weaknesses (quirks) of the radio meteor system (RMS) itself. Anyone with access to these simple hardware items, and my free supplied software can assemble a working FM RMS. In Meteor Showers [1], Dr. Fred L. Whipple recommends reading the book for pleasure, education, or research. One should build a RMS for the same reasons.

Introduction

An RMS is a powerful tool to detect and quantify meteor showers, primarily because it is exquisitely automated to operate 24 hours a day, 7 days a week, or "24/7." It is not necessary to be outside observing or imaging the sky, being at the mercy of weather, moonlight, daylight, and testing the limits of one's physical and mental endurances. RMS counts and their recorded times will show when a shower first increased above the normal background level, reached maximum, and became unobservable. These times give the duration of the shower. The Universal Times (UT) are used to compute solar longitudes, and give the positions of the meteor stream as it crossed the Earth's orbit.

A Leonid meteor moving at 71 km/sec creates a long ionized trail visible from about 125 km altitude down to about 95 km, depending on its mass [2]. This 5-to-30 km-long trail consists mainly of electrons stripped from atmospheric oxygen. This cloud of electrons is a very efficient reflector and scatterer of radio waves.

The FM RMS described herein favors the detection of short "echo durations", primarily because many noise sources have longer durations and this RMS discriminates against them, i.e., a noise event is not counted as a meteor event. The majority of meteor scatter receivers use high-power radio or television transmitters as the source of radio waves. A government or amateur radio operator (ham) transmitter can be used, but the power is usually much less, and one must be in a favorable location. In contrast, almost all locations in the U.S. are in range of a FM radio station. Meteor scatter signals can be heard from 28 to 432 MHz, but the best region is 30-100 MHz [3] p. 21.14. Short-wave and television bands in the 30-50 MHz region are favored in Europe.

A monthly publication detailing a variety of such receivers operating at other frequencies is the *Radio Meteor Observation Bulletins* (RMOB); which can be found on the Internet. Best reception of the reflected signal occurs when the meteor trail is roughly between the transmitter and receiver. This geometry favors what is called "forward scattering". Good primer material about forward scattering can be found at the American Meteor Society site on the World Wide Web. There are perhaps 25 different types of RMS's in current use, and it appears that no two systems are similar (unless so designed and funded). This results from the unique talents and resources of each researcher, and their success attests to the large amplitude of the reflected/scattered signal. The majority of researchers use automatic recording methods to count meteors or quantify the nature of the trail; but some simply sit, listen, and make a manual tally of meteor counts. This paper presents a simple alternative to the manual method - creating a 24/7 RMS unaffected by daylight, clouds, and precipitation. The FM RMS is a receiver only; no user radio transmissions are necessary, and no amateur (ham) radio operator license is required – this favors more widespread use.

Theory

This brief summary is primarily from reference [4]. A meteor trail (or part of) is "underdense" when the electron density is 10^{14} (or less) electrons per meter of path length (e/m). Greater densities are considered "overdense." The underdense trail is found at the higher altitudes for any size meteor. If the meteor is fainter than about 5th magnitude, it will only have an underdense trail. Meteors brighter than this will be overdense at lower altitudes, and underdense at higher altitudes.

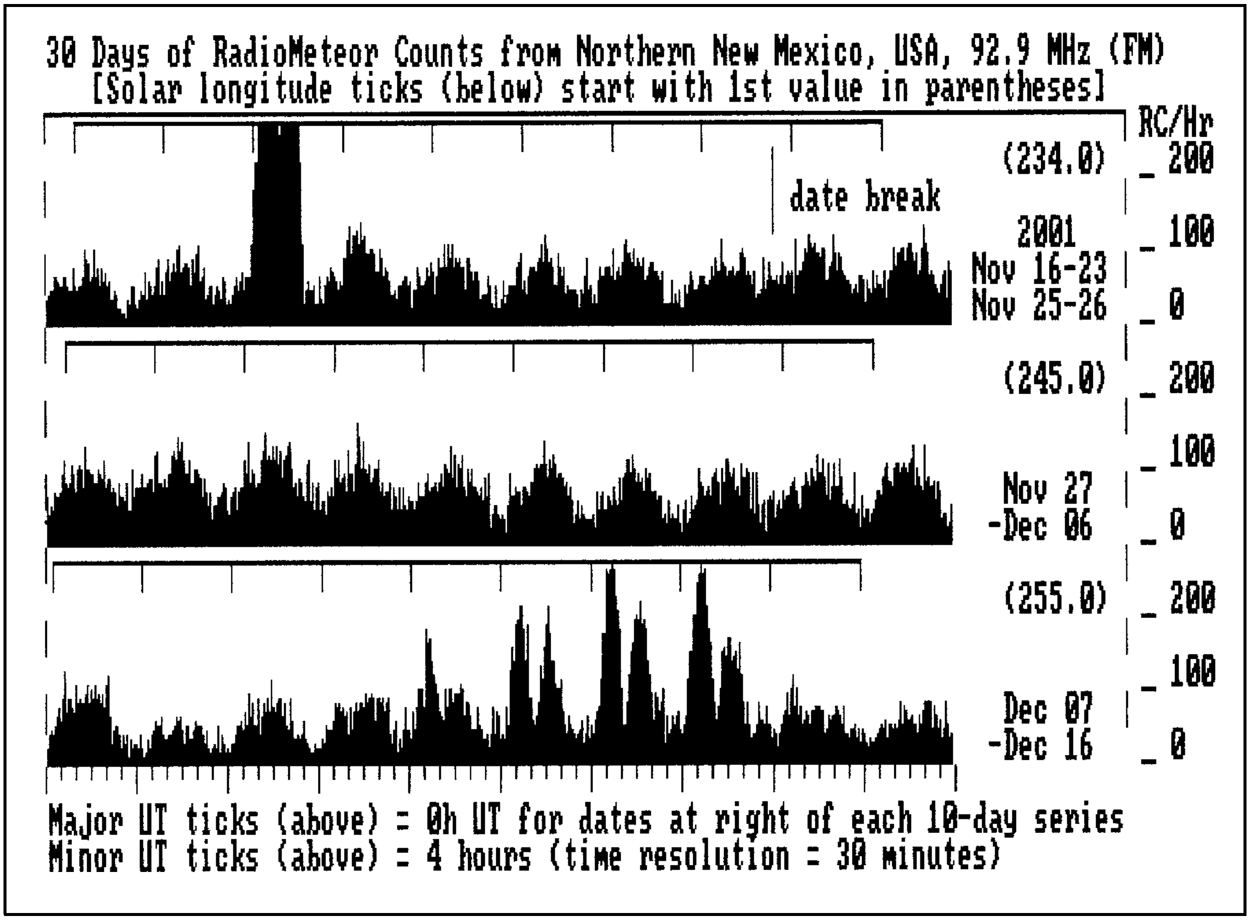


Figure 1. Graph of the 2001 Leonid meteor shower (November 18) and the 2001 Geminid meteor shower (December 11) as recorded by the RMS detailed in this paper.

Radio waves completely penetrate an underdense electron cloud and are scattered in many directions. The polarization of the scattered wave is much the same as the incident wave. The maximum scattering is along the original direction of the wave (forward). Conversely, radio waves barely penetrate an overdense cloud before being reflected in many directions. The maximum reflection is away from the surface as if the surface were a mirror. However, the cloud density is irregular and in motion creating intensity fluctuations in space and with time. The polarization of the reflected wave is usually different from the incident wave. (These cloud irregularities have little consequence for underdense scattering.) Note that scattering favors maximum reception in the original direction of travel of the radio signal, whereas reflection favors maximum reception in opposite directions. Occasional bright meteors can create “glints” and “blobs” observable in all azimuthal directions, but these are rare. RMS counts will be dominated by fainter meteors exhibiting only forward scattering.

Bright meteors also exhibit a “UV head.” A meteor of -5th magnitude is briefly radiating 10^7 watts, and the ultraviolet component ionizes oxygen within a sphere of about 100 meters in radius. Recent videography of bright Leonids reveals a luminous bow shock about 600 meters in diameter [9]. Radar and sensitive radio meteor systems can detect these head phenomena, but I believe this RMS does not.

These electron clouds act upon radio waves until they die away; and this interval is called the “echo duration.” Above 93 km, the primary mechanism is electron diffusion; below this, it is recombination with other ions, atoms, molecules, and atmospheric turbulence. The longest echo durations are found near 93 km. The underdense echo durations range in time from 0.001 to about 0.5 second. The overdense echo durations range from 0.5 second to many hundreds. An excellent graph of echo duration, echo power, and electron density is reference [4] p. 217.

If a meteor’s electron density is too sparse ($<10^{12}$), the echo will be too faint to detect. This density is typical for a 10th magnitude meteor [4] - and is about the maximum density of the atmospheric E and F layers [3] p. 21-10. The optimum altitude for forward scattering is between the onset of overdense conditions (93 km) and a ceiling not too far above this. This top ceiling for detecting a faint signal varies with radio frequency, and for 93 MHz is 103 km [4] p. 206. This limit is called the underdense echo ceiling. At this altitude and above, electron diffusion is so rapid that the echo amplitude and duration approach zero except for fireballs.

Thus, this RMS detects scattered signals from about 103 km to 93 km, a 10 km thick shell extending out from 90 km to a maximum of 800 km along one azimuth.

Quirks

A multitude of variables arise for many reasons - meteor brightness, location in the sky, radiant location, antenna and receiver characteristics; and operator discrimination. Not all of these data average out when large data sets are taken. Here is a list of notable quirks found in radio meteor observations; and numbered for later reference.

- *Q1, Favored meteor distances* – A meteor in line with the transmitter and receiver will produce the best forward scatter signal. If the trail is too close to the observer, it may be below the horizon as viewed from the transmitter; this observer has witnessed and recorded radio meters in the northern sky up to an elevation of 60 degrees. In addition, a high elevation meteor is in a poor location for forward scatter reception. These two effects create an overhead zone where meteors may be missed. A very fortunate observer would have dozens of transmitting stations (all at one frequency) at various distances and azimuths.

- *Q2, Favored meteor azimuths* – On my limited experience and published information, a simple amateur RMS should detect (count) meteors brighter than 5th magnitude along a favorable azimuth (also see [5]). A meteor at an unfavorable azimuth will probably not be detected.

- *Q3, Favored radiant location* – It is strange but true that these current RMS observations of the last three strong meteor showers on six dates show that count levels drop to a minimum when the radiant passes through the zenith or meridian! We'll address this issue later in this paper.

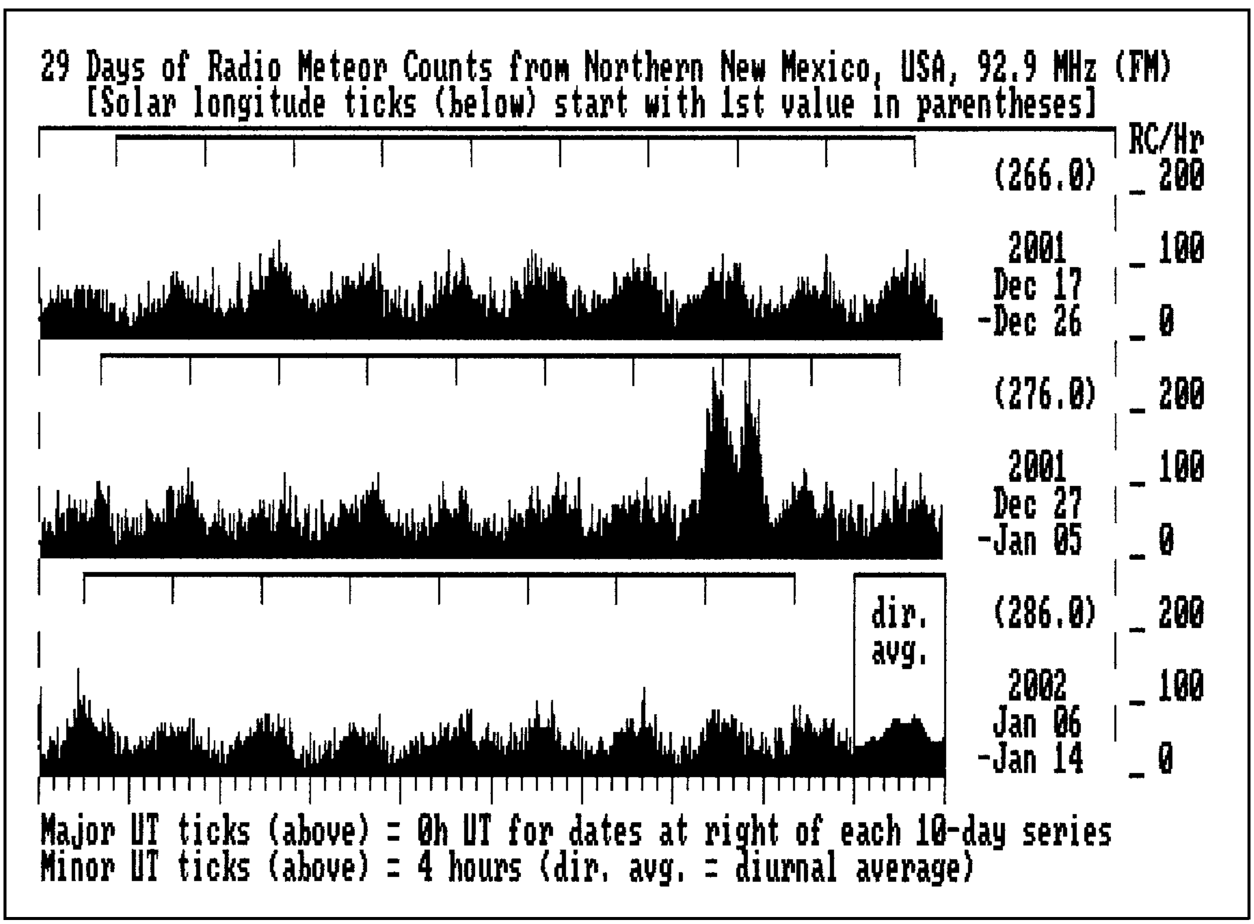


Figure 2. Graph of the 2002 Quadrantid meteor shower (January 3) as recorded by the RMS detailed in this paper.

- *Q4, Favored trail orientations* – Radio transmitters and this RMS antenna all have vertical polarizations. This insures maximum reception distance. Forward scatter leaves the direction of polarization largely unaffected. This means that vertical, oblique, and horizontal trails should all register equally well, but as noted, they do not!

- *Q5, Favored antenna reception* – 1/4 wave ground-plane antenna reception pattern looks like a doughnut lying flat. This pattern has very good 360-degree horizon coverage, but very poor reception towards the zenith. This antenna has best reception at elevations of 10 to 50 degrees. This effect adds to the overhead void.

- *Q6, Count statistics* – RMS records a diurnal average of 40 radio counts/hour near 6 p.m. to 80 rc/hr near 6 a.m. This RMS is not able to detect weak showers with rates of only 10 or less meteors per hour. (Visual plots, photography, and radar are the best methods to study weak showers). These count statistics strongly suggest that this RMS detects only meteors brighter than 4th or 5th magnitude at favored azimuths.

- *Q7, Investigation limits* – This RMS cannot tell the meteor's location or motion in the sky, magnitude, velocity; or orbital parameters.

- *Favored human response* – This will not be dignified with a number, but the majority of amateur astronomical groups favor visual and photographic observations over other means of collecting data. Don't be surprised if your RMS meteor observations go unpublished and ignored. We suggest you follow Dr. Whipple's advice and remember that you only have to please yourself.

FM Radio & Antenna

FM car radios manufactured in the last 5 to 15 years have excellent sensitivity, selectivity, and noise rejection because they use large-scale integrated circuits (IC's). Older models use discrete transistors and will work, but are less suitable. Digital tuning is a must-have feature because analog tuners will drift off-station with temperature change. Car radios run on 12 volts DC and can be powered in the field with batteries, or a one-amp, 12 VDC power supply can be built. The latter is best for a 24/7 RMS.

The antenna is a vertical 1/4 wavelength ground-plane type for reasons previously given. The elements are cut to receive 92.9 MHz (30.2 inches). The four ground-plane radials are spaced every 90 degrees, and droop down at a 45 degree angle. The cut length (L) for the elements (in feet) is L = 234/MHz. The vertical element connects to the center coax wire, and the four radials connect to the coax outer braid. See the *ARRL Antenna Book* [6] for details about coax cable, and building a ground-plane antenna. The impedance of this antenna is 50 ohms, so it matches a few common types of coax cable. FM car radios are also fed with coax to help shield the center wire from noise. The outer coax braid is at electrical ground (-), and the braid connects to the radio chassis. These FM car radios can be found at many thrift stores, and only cost $2 to $5.

A potential problem is identifying the lead-in wires for 12 VDC power (red +, black -), speakers (usually four), ignition switch (power off/on), display lights (high, low, off), and more. If one uses a benchtop power supply with short-circuit protection, locate the power leads, then search for the display lights (sometimes you cannot tell time and frequency without these lights). When it appears to be powered-up correctly and drawing 300 milliamps or so, hook an old speaker up to the remaining lines, taping each one quickly (since it may have 12 VDC on it and not one or two volts of audio). You might also buy a power connector for $5 to $10 at an auto-discount store, if you lack experience and equipment.

Cut the original coax cable just inside the chassis and install a BNC connector – female on the radio, and male on the antenna. If your chassis has a push-in type coax connector, bypass it by opening the chassis and installing a chassis-type female BNC connector. This way, you can disconnect the antenna when it is time to move the radio, store it, or try a different antenna. The mast for a portable receiver can be wood or polyvinyl chloride (PVC) tubing 3 to 6 feet long. The mast for a fixed location RMS should be about 1.5-inch diameter metal tubing which is 10 to 20 feet high and supported by suitable guy wires. Three-foot length brass brazing rod 1/8 inch in diameter is good stock material for antenna elements. Aluminum is preferred by amateur radio operators, but this antenna is fairly small so weight is not a problem (and you can solder to brass). The short mast can slide into a hole in a block of wood or a PVC connector which has been fixed to the top of the chassis. Run the coax line down the mast and fix it in place. Allow for cable aging and temperature contraction by inserting a small u-loop every 3 feet or so.

FM Transmitting Stations

Assuming all has gone well so far, and you have at least one channel (left or right – stereo not needed) of audio; it is time to spend a week listening to every frequency on the dial for stations that are suitable for FM radiometeor reception. If you live in a large city, there may be no suitable stations due to many sources of interference. Start at the high end (107.9 Mhz) and work towards the low end (87.5 Mhz). Listen to each frequency for 30 seconds and then go to the next one working up and down the dial. Rapidly skip-over strong stations (or interference from a strong station) on any frequency. If you hear a brief burst of music or voice then you are receiving an FM station via forward scatter. The best time to listen is 6 a.m., since meteors are most abundant at this time; listening from 6 a.m. to 9 a.m. is convenient. Write down those frequencies that have any bursts, and add the number of bursts and their loudness. The best ones will probably be those that have multiple stations at the same frequency and not just one station. It is important to continue this for at least several days, because you might have a dense fall of meteors and thus pick a poor frequency based on one fall of many meteors. Here is a list of five FM transmitters which I get at 92.9 MHz:

Table 1: Five FM Radio Stations Heard in Northern New Mexico

Call Sign	Location	Type of Music	Range (km)	Bearing (deg.)	Elevation (deg.)	
KTZA	Artesia, NM	Country-western	444	178	9.8	21.6
KSPZ	Colo. Springs, CO	Oldies Rock & Roll	217	352	22.1	39.9
KYBR	Espanola, NM	Contem-porary	180	236	26.3	45.3
KWFM	Tucson, AZ	Easy listening	798	233	3.0	11.2
(unknown)	Juarez, Mexico	Modern Spanish	579	198	6.5	16.4

A meteor 93 km over the given location would have the first elevation calculated in the `elevation' column. A meteor halfway between the receiver and transmitter would have the second elevation. See formulas in [7].

Recorder

A previous FM RMS recorded the date, time, and duration of the audio signal; but this used a lot of computer disk space. It is better to count how many times a meteor burst occurred during a six-minute interval, and write these 10 numbers to a disk file once an hour. An advantage of writing one hour's worth of data as one line in a file is that the sum of these 10 numbers is "radio meteor counts/hr". Any computer is fast enough to do this job. If you don't have an old computer, go to a thrift store and you will probably find a 386 or 486 for $10 or less - this will do just fine! The current RMS 486DX/40 computer can record 100 days worth of data on a single HD (high density) 3-1/2 inch floppy disk. (For practical reasons, one should stop about once a month).

The audio signal must be conditioned in order to feed it into the computer via its mouse port – also called the DB-9 connector, or RS232 serial port. A computer only recognizes and manipulates digital signals (data), and the radio outputs audio or analog signals. What is needed is an analog-to-digital or "A/D" converter. There are several ways to find and use an A/D converter. The simplest is to buy one of the newer digital multimeters (DMM) which have a PC interface feature. These meters take the analog voltage, current, or resistance at the tips of two probes, convert it to a digital string of data, and transfer (upload at regular intervals) along a RS232 line to your computer – what could be simpler? Two suitable and inexpensive DMM's available from Radio Shack are detailed in Table 2.

Table 2: Sample Radio Shack DMM's

Name of Multimeter in Catalog	Catalog No.	Upload Frequency	Retail Price	Sale Price
38-Range LCD Digital Multimeter	22-168A	3 times per second	$100	$80
24-Range Digital Multimeter	22-805	1.5 times per second	$60	$40

Both are suitable for recording events using audio or other signal inputs. The first is used on the 24/7 RMS receiver. The second connects to a 386SX/33 computer, and is used as a live signal feed for testing.

The meter is not connected directly to the audio line of the FM radio. It is necessary to isolate the radio from the meter for electrical safety, system reliability (avoid ground loops), and to stretch the meteor's event duration in time (to enable DMM program logic testing on the signal). This vital bit of circuitry is a "signal conditioner." If the audio line voltage or current was measured, the majority of meteors would not be counted, or they would be counted twice. Most meteor signal reflections usually last from 1/10 seconds to several (one to 10) seconds. The shorter reflection time would not be seen by the meter which “looks” 3 times per second. The ratio of (0.5 / 0.1) or 5 indicates that only one out of five meteors would be measured. The longer reflection time would register as many meteors. Taking five seconds as the average reflection time, and 0.5 as the mean upload frequency (5 / 0.5), this would register as 10 meteors. A fine line exists between missing counts and multiple counts. One solution is to only measure the very strongest change in signal level, and to also avoid doing this twice for the same event.

This is solved fairly well by using a mix of hardware and software. The hardware solution is to connect a green light-emitting diode (LED) to the audio output line and monitor its brightness with a cadmium sulfide (CdS) photoresistive cell. Both can be purchased for a few dollars total. Insert one in each end of a non-reflective black plastic tube and separate the two so that the meter resistance (to the faint LED glow) is about one-half of the highest resistance that can be measured on the DMM. In other words, if this top-scale value is 40 megOhms, set the distance to get 20. Set the tone controls to maximize treble, and adjust the volume control so that the LED just flashes when you hear a meteor-reflected signal.

When the LED briefly flashes from the passage of a meteor, the resistance of the green-sensitive CdS cell will go from a value of many megOhms to a few khoums. The LED may flash for only 1/10 of a second, but the CdS cell will change more slowly taking perhaps 1/5 to 1/2 second to reach its minimum resistance. The DMM software programs (described in the next section) will detect this sudden drop in resistance and count it as a meteor. Meanwhile, the CdS cell is now in darkness or in some light-level between darkness and the initial intensity. Fortunately, the majority of meteor events produce a brighter initial flash than any secondary flashes; and this helps discriminate against multiple counts of 1 event. Also helping to discriminate against this is the fact that a CdS cell has a pronounced “dark memory.” It takes from one to five seconds to return to full resistance, depending on your cell and the initial flash intensity. The net effect of the signal conditioner is to send a signal to the computer that rapidly drops and then recovers more slowly. The user monitors the drop and recovery rates to find the best discrimination level between missed counts and multiple counts.

Software

A short BASIC computer program appears in the owner’s manual for both DMM's. It is only seven lines long, but allows the user to write a simple BASIC computer program to read one value from the DMM. This input is a long string variable, and the measurement must be “parsed” from the string and converted to a numerical value.

R. B. Minton has written two main types of GW-BASIC programs – one for collecting meteor counts, and another for processing, dumping, and plotting meteor counts. “Collecting” means taking data from the DMM and writing to a file. “Processing” means reading the file and optionally reformatting it to use less disk space. “Dumping” means printing the file to look at individual six-minute intervals, one-hour totals, and one-day totals. “Plotting” means creating a screen pixel plot or histogram of two, nine, or 29 days of data. These programs are free (including the BASIC source code) to amateur experimenters (please enclose a SASE). This disk also contains this article, and other useful files. These files are in ASCII (text) format.

- DMM168.BAS – Collects meteor counts using the 168 model DMM.
- DMM805.BAS – Collects meteor counts using the 805 model DMM.
- PDP_30DP.BAS – Process/Dump/Plot 30-days of data - a 30-min. sample-integration pixel-plot.
- PDP_9D_P.BAS – Process/Dump/Plot 9-days of data - a 24-min. sample-integration pixel-plot.
- PDP_2D_P.BAS – Process/Dump/Plot 2-days of data - a 6-min. sample-integration pixel-plot.
- PDP_2D_H.BAS – Process/Dump/Plot 2-days of data - a 1-hr sample-integration histogram.
- SUN2Y.BAS – Create a 2 year calendar of daily solar longitudes at 0 hrs UT.
- DIPOLE.BAS – Plot reception pattern of horizontal 1/2 wave dipole antenna + ground reflector.
- LAYER.BAS – Compute elevation of meteor or scatter layer for any given altitude and range.

Discrimination is the most important function in the “DMM” programs. This discrimination level “lvl” is set to 10 when the program begins running. This means that if the CdS cell resistance drops by more than 10 megOhms from one measurement cycle to the next, it will be counted as a meteor event. It would be hard to drop any further if a second event occurred in the next measurement cycle, because the CdS cell is near its minimum resistance. On the other hand, after one or two seconds it can drop 10 megOhms from a second event. Whether or not this second event is measured as the same meteor (or a second meteor) depends on the discrimination of the operator. The user can press the “+” key to increase “lvl” by one megOhm (per key press), or press the "-" key to decrease it by 1 megOhm (per key press). The program displays the current value of "lvl" in the upper-right corner of the screen.

A great aid in deciding whether the second event is really part of the first event is just listening carefully to the FM signal. If you hear a burst of music followed by a burst of voice, it was probably two events. If you hear a burst of audio (voice or music) followed by oscillations in audio volume, it was most probably one event – the ear becomes trained. It is vital to test your RMS on real meteor events to find the optimum settings before starting 24/7 operation, and once you begin 24/7 operation use the same "lvl," volume, and treble settings to collect data – consistency is very important!

Other Tips

Use a portable FM radio outside when visually observing meteors to indicate the current level of activity. The radio coverage radius is 200 to 800 km, whereas the visual coverage radius is about 200 km. You will probably hear a change in activity before you see a change in activity.

The quantity "meteors/hour" is the most common way of defining the activity or strength of a meteor shower. However, this term originated from visual observations of meteors using standardized methods of observing, and cannot be compared with radio observations. Avoid problems and call your data radio counts/hour or counts/hr.

Record data for a few days and test the software. If all is okay, record data for 30 days, stop the RMS, transfer raw data files to a floppy, check or reset the RMS system time, and restart the software. Schedule start and stop times when meteor activity is low. Start and stop runs at 0 hrs UT to simplify plotting data. If this is not possible, create a copy of the raw data and edit it as required. Make archive copies of all original data as soon as possible. Keep archive copies on an indoor computer, and two sets of floppy disks. Monitor the RMS frequently for proper operation, or use an intercom, or other type of audible alert. Consider using an uninterruptible power supply for critical components.

Results

Two graphs are presented as figures 1 and 2. Note that all dates and times are in Universal Time UT). Each graph shows 29-30 days of data in three rows reading from left to right, and top to bottom. Data are plotted with radio meteor counts per hour (RC/hr) as the Y-axis, and with two units of measurement for the X-axis. The first is time marked once at the bottom of the entire graph, and the second is solar longitude marked above each of the three rows of data. Note the progressive misalignment of the two sets of tick marks as solar longitude increases by nearly (but not exactly) one degree per day. The solar longitude at the start of each 10-day interval is given at the right of each row and is in parentheses. The UT dates are also marked at the right of each row. At the bottom, UT is marked with long ticks for every 0 hrs, and short ticks every 4 hours. Eight data values are plotted in each four-hour interval, thus the smallest time resolution shown is 30 minutes. Each 30-minute data value is the average of five 6-minute count intervals. Each graph was prepared on a dot matrix printer using my BASIC program PDP_30DP.BAS.

Figure 1 shows 30 days of coverage from November 16 through December 16, 2001. Note that no data were recorded for 24 hours starting at 0 hrs November 24, and is marked as a "| date break"'. The sinuous rise and fall in counts is the diurnal variation. In Figure 2, where January 15 might have been shown, the diurnal variations for 26 days were averaged and plotted to show its mean value over a 24-hour period. Figure 1 reveals two major meteor showers – the spectacular 2001 Leonid display on November 18, and the 2001 Geminids on December 11, 12, 13, and 14. Figure 2 reveals one major meteor shower – the 2002 Quadrantids on January 3.

Interpretation

All three major showers displayed double maxima with a central minimum on each of the six dates observed!

The times of these central minima for the Geminids indicate that they occurred when the radiant was near upper culmination. The Geminids had their minima on all four dates when the radiant had a maximum elevation of 86 degrees and was within 12 minutes of zero hour angle (near 09:03 UT). Note that if the radiant is at the zenith, all trails will have a vertical orientation. These data strongly suggest instrumental and radiant aspect effects. These appear to be the combined results of Q3 (favored radiant location), Q4 (favored trail orientations), and Q5 (favored antenna reception).

The Leonids and Quadrantids were one-day events and appear less correlated with hour angle. The Leonids had an elevation of 72 degrees and an hour angle of +0:48 minutes at the central minimum (near 14:03 UT). The Quadrantids had an elevation of 68 degrees and an hour angle of +1:42 at the central minimum (near 17:03 UT). Since these showers lasted one day and passed farther from the zenith, their counts would seem to be more related to meteor density within the shower, and less with radiant position.

The count data for the strong 2001 Leonid display reveal that the counts began to increase near 06:48 UT when the radiant was two degrees below the eastern horizon; yet only nine meteors were recorded during a six-minute interval from 14:00 to 14:06 UT Nov. 18 (radiant altitude 72 degrees, hour angle +48 min.). Interestingly, nine counts per six minutes is nearly the diurnal background level for this time of day. This extreme minimum could have been either a real void in stream density, or the result of RMS quirks. At this hour angle, the former is more likely. Later, near 20:24 UT, when the radiant was in the west 11 degrees from the horizon, the counts returned to typical diurnal levels, and remained so until the radiant set.

The plot resolution for 30 days does not show the times of minima and maxima, and at this scale, they are off-scale. However, the program "dump data" feature prints all times to a resolution of six minutes. The first maximum is at 10:42-48 UT and the second at 16:00-06 UT, with both peaks near 350 radio counts/hour. The first peak was over the North American continent, and the RMS measurement is within minutes of visual reports [8].

The Geminids are evident over four days with a slow increase and rapid decrease. This "skew" in activity has been noted in previous Geminid showers [1] p. 250. In past years, the Geminids have been at their peak for 4 to 6 days near visual magnitude +2.5. This year, visual observers report only a fairly sharp peak on the 14th at a rate of about 90 per hour. They did not see the gradual increase in activity, nor the equally strong activity on the 13th as shown by radio rates over New Mexico.

The Quadrantids are known for being a brief one-to-two-day display. Initial visual observations of this shower from Europe indicate rates of 5 to 10 per hour on January 3 and 4. The radio rates are much higher, suggesting that intense moonlight reduced the visual rates for meteors fainter than 2nd or 3rd magnitude; whereas radio scatter works well in moonlight and down to perhaps 5th magnitude.

The radio Ursids are not shown near December 22. Little or no activity has been reported thus far from visual observers in North America or Europe. One observer in China did report 17 per hour near 17:00 hours UT on Dec. 22.

Concluding Remarks

Additional observations with a 1/2 wave horizontal polarized antenna might explain why horizontal trails record very well and vertical trails very poorly. Scattering theory predicts there should be little difference.

The power of an RMS is in recording times of events - the times of maxima and minima, and the times when counts exceed the diurnal variation. Equally valuable are the ratios of counts — maxima to minima to the diurnal values. These times and ratios reveal the location, width, and relative densities of a meteor shower. One needs radio counts per hour to determine these times and ratios, but "rc/hr" is a not-too meaningful measurement in itself. As stressed before, one should not compare radio counts/hour to visual counts/hour.

The detection of Leonids with the radiant below the horizon indicates that nearly horizontal meteors are easily counted, and that an RMS is an excellent tool to detect this unique situation. Conversely, meteors from a radiant near the zenith can almost escape detection with my current RMS antenna.

Nevertheless, all this is rewarding fun; and illustrates what can be accomplished with a 24/7 RMS made from parts found locally, and costing less than $100.

References

[1] Kronk, Gary W., "Meteor Showers," Enslow Publishers, Inc., 1988.

[2] Rossano, et. al., Leonid MAC `99, http://web99.arc.nasa.gov/~leonid/leonidnews16.html

[3] Danzer, Paul, "The ARRL Handbook for Radio Amateurs," The American Radio Relay League, Inc., 1997.

[4] McKinley, D.W.R., "Meteor Science & Engineering," McGraw-Hill Book Company, Inc., 1961.

[5] McBeath, Alastair, "The Forward Scatter Meteor Year: 2001 Update," WGN, the *Journal of the IMO*, Vol. 29, No. 3, June 2001, pp. 85-92.

[6] Straw, R. Dean, "The ARRL Antenna Book," 18th Ed., The American Radio Relay League, Inc., 1997.

[7] Cantafio Leopold J., "Space-Based Radar Handbook," Artech House, 1985., pp. 215-216.

[8] di Cicco, Dennis, "The 2001 Leonids: A Great Show", *Sky & Telescope* magazine, Vol. 103, No. 3, March 2002, pp. 102-106.

[9] Goldman, Stuart J., "The Leonids' Best Home Videos," *Sky & Telescope* magazine, Vol. 103, No. 4, April 2002, p. 26.

ALPO Feature: Mercury
A Report on the 2001 Apparitions

By Frank J. Melillo, coordinator, ALPO Mercury Section, and Richard Baum, coordinator, ALPO Historical Section

Abstract

Nine observers using a variety of instruments, ranging from 10x50 binoculars to 8-inch telescopes, obtained 62 observations of Mercury during the six apparitions in 2001. These comprised 43 sketches, 14 sets of CCD images, one video image and four photometric readings. Albedo detail was suspected on most occasions, and is especially marked on CCD imagery. This corresponds very well at low resolution with the pattern of the 1971 chart by A. Dollfus and J. B. Murray, now the adopted I.A.U. standard. What differences that do exist can be attributed to personal equation, seeing conditions, and physiological factors. Overall however, it is encouraging to receive work of good quality from so many dedicated observers. This augurs well for our attempt to make further progress in understanding the physical relationship between albedo features and morphology.

Introduction

The report describes the work done during the six elongations that occurred in 2001, i.e., three morning and three evening apparitions. It is thus divided into six sections arranged chronologically. Each section defines the physical circumstances of the apparition, and presents a generalized description of how the planet appeared at differing resolutions in the specified time frame. Incorporated into each account are remarks on the phase anomaly, the so-called Schroeter Effect, that is, the apparent discrepancy between observed and predicted dichotomy first remarked by J. H. Schroeter when he was observing Venus in 1793, but which also applies to Mercury (though in lesser form).

As the planet passes from superior conjunction through greatest eastern elongation to inferior conjunction, there is a corresponding cycle in the apparent angular diameter and phase of the planet. Near inferior conjunction, the planet shows a crescent phase, at superior conjunction, the disk is at full phase. At greatest elongation (east or west) the phase value is intermediate and the planet is half-illuminated, i.e., the terminator is straight. Now in general or popular terms, dichotomy and greatest elongation coincide. However, because the orbit of Mercury is highly eccentric, the coincidence is not exact. Although it is possible to calculate the time of dichotomy with a high degree of accuracy, it so happens the observed and predicted times often disagree in the amount of three or four days. This is the so-called "phase anomaly," a problem that still awaits solution. Various hypotheses have been proposed, though none fully explain the effect.

Table 1: Evening Apparition of Mercury, 25 December 2000 - 13 February 2001

Greatest Elongation: 28 January 2001 at 18°

Perihelion: 1 February 2001

CM Longitude: From 287° to 190°

Observer	No. of Observations	Scope Used
Frasatti, Mario Crescentino, Italy	1 drawing	8-in. SCT
Melillo, Frank J Holtsville, NY	2 CCD images	8-in. SCT

SCT = Schmidt-Cassegrain telescope

Summary of Table 1

Observations

Mercury was observed three times during this evening apparition. CCD images by Melillo on January 28 show a smudge-like shade, identified as possibly Solitudo Abmetei (mid-northern latitude at 50°: longitude - 80°degrees). Unfortunately, only one image was taken and there is nothing to compare with it. Frassati made a beautiful sketch on January 30. At CM longitude 98°, it shows duskiness along the

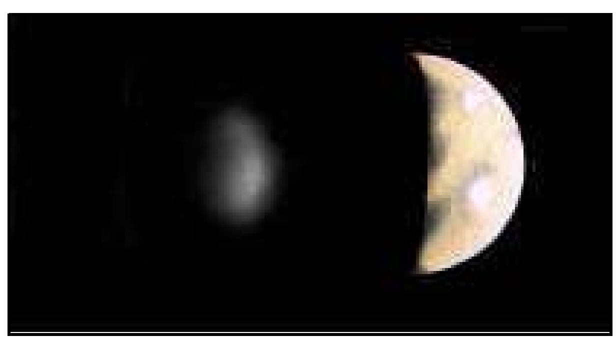


Figure 1 (see Table 1) -- (Left to right) Ccd image by Frank J. Mellilo, 28 January 2001, CM = 80°; sketch by Mario Frasatti, 30 January 2001, CM = 93°.

Figure 2 (see Table 3) -- (Left to right) Ccd images by Frank J. Mellilo, 9 May 2001, CM = 244°, 10 May 2001, CM = 248°; sketch by Mario Frasatti, 11 May 2001, CM = 252°; ccd image by Mellilo, 14 May 2001, CM = 266°; sketches by Frasatti, 18 May 2001, CM = 285°, 22 May 2001, CM = 305°; sketch by Daniel Del Valle, 24 May 2001, CM = 321°; sketch by Frasatti, 29 May 2001, CM = 343°.

terminator, possibly Solitudo Martia, Lycaonis and Admetei; also, two bright areas, of which the northern at approximately 50° - 60° longitude may be Aurora. This is seemingly verified by a CCD image obtained on Jan. 28. Unfortunately, the area was not fully mapped by Mariner 10, though it did register a highly reflective smooth plain area. Finally on February 3, Mercury was imaged as a crescent phase and no markings were seen.

Phase Anomalies

Mercury reached perihelion on February 1. Greatest elongation occurred on January 28. Dichotomy, therefore, ought to have taken place on that date. Instead, the planet showed a very slightly gibbous disk, and on January 30, one a little less than half. It is therefore estimated that dichotomy occurred on January 29, a one-day difference between observed and predicted dichotomy, too small to have any significant value.

Table 2: Morning Apparition of Mercury, 13 February - 23 April 2001

Greatest Elongation: 11 March at 27°		
Aphelion: 17 March		
CM Longitude: From 197° to 174°		
Observer	**No. of Observations**	**Scope Used**
	None	

Table 3: Evening Apparition of Mercury, 23 April - 16 June 2001

Greatest Elongation: 22 May at 22°		
Perihelion: 30 April		
Aphelion: 13 June		
CM Longitude: From 178° to 97°		
Observer	**No. of Observations**	**Scope Used**
Amato, Michael West Haven, CT	4 drawings	90mm REF
Berg, Ray Crown Point, IN	4 drawings	8-in. SCT
Braga, Raffaello Corsico, Italy	2 drawings	4-in. REF
Del Valle, Daniel Aguadilla, PR	1 drawing	8-in. NEWT
Frasatti, Mario Crescentino, Italy	5 drawings	8-in. SCT
Haas, Walter Las Cruces, NM	9 drawings	8-in. NEWT
Melillo, Frank J Holtsville, NY	5 sets CCDs	8-in. SCT
Nunes, Ricardo Lisbon, Portugal	1 video image	8-inch SCT
Schmude, Richard Barnesville, GA (Atlanta)	4 photometric readings	
NEWT = Newtonian reflector REF =Refractor SCT = Schmidt-Cassegrain		

Summary of Table 3

Observations

A favorable evening apparition of which nine observers took advantage, obtaining a total of 25 sketches, five sets of CCD images, one video image and four photometric readings, an unusually large contribution. Much of the region covered at this time was imperfectly mapped by Mariner 10.

Melillo and Michael Amato made the first observations of the apparition on May 8. The former secured CCD images, the latter observed visually but was unable to distinguish anything on the tiny disk. On the other hand, Melillo's images do show possible detail (CM long. 239°). Melillo observed the following day in improved conditions, and again registered distinct markings. As Mercury then had a diurnal rotation of 4°, images obtained on May 10 showed no perceptible change in its general appearance (CM long. 248°). This was visually observed by Mario Frassati on May 11. The dark feature may be Solitudo Criophori. Raffaello Braga's drawing of May 11 showed a similar shading in the equatorial region which seems to be Solitudo Criophori. This feature is more evident on Melillo images of May 14 and 15, CM longitudes 266° and 270° respectively.

Ray Berg charted a dusky area in the north hemisphere on May 17 and 18. This was probably Solitudo Aphrodites. Frassati depicted both this and another feature on May 18 and 19, (CM longitudes 286° and 290°, respectively). Two excellent drawings by the same observer dated May 22 and 29, CM longitudes 305° and 343° respectively, depict a crescent marked by two dusky areas, identified as Solitudo Alarum in the south and Solitudo Aphrodites to the north. A slight terminator shading was evident to Daniel Del Valle and Raffaello Braga on May 24 and 26.

Between May 21 and June 3, Walter Haas made nine drawings, and on six consecutive nights (May 21 - 26), he drew four elongated dusky shadings adjoining the terminator. Some of these correlate with features depicted by Frassati. Haas made a last sketch on June 3. It shows a fine crescent lightly marked by spottiness at the terminator. Ricardo Nunes obtained a video image with a quick cam video recorder on May 22, but "noise" in the data does not allow us to make out any features.

Richard Schmude made four photometric measurements of Mercury. But uncertainties exist due to the low elevation. He used Alpha Canis Majoris (Sirius) on May 14 - 16, and Alpha Bootis (Arcturus) on May 24 as comparisons. His results are as follows:

Table 4: Photometric Data for May 2001

Date (UT)	Measured Magnitude*	Normalized Magnitude V(1,α)**	Phase Angle α (degrees)
May 14.062	-0.25+/-0.10	+1.40	81.0
May 15.068	-0.39+/-0.11	+1.22	84.3
May 16.056	-0.33+/-0.09	+1.24	87.4
May 24.066	+0.60+/-0.17	+1.81	110.5

*All magnitudes have been corrected for extinction and transformation as is done in Hall and Genet, 1988, pp. 196-200.
** Magnitude of Mercury if it was one A.U. from both the Earth and the Sun.

As a result, the normalized magnitude of Mercury comes out as –0.20 which is quite a bit dimmer than the –0.36 value cited in literature.

Phase Anomaly

Mercury reached perihelion on April 30. It then moved away from the Sun as seen from Earth, and due to the eccentricity of its orbit, moved farther out from the Sun. CCD images by Melillo taken in the interval between May 8 -15 reveal a slightly gibbous phase. Ray Berg provided excellent sketches of the half-phase on May 16 and 17. A thick crescent was evident to Frassati and Berg on the 18th.

Greatest elongation occurred on May 22, but on that date, Frassati's drawing and Ricardo Nunes's video image showed a 0.39 phase, observed dichotomy having occurred six days earlier. During this period, Mercury was rapidly approaching aphelion on June 13. It is also possible that albedo markings along the terminator may have some effect on the half-phase. But it was too little to notice and it did not apply to this case.

Binocular Observing

Michael Amato, Ray Berg and Melillo made some observations with binoculars. Amato and Berg using 10x50mm binoculars and Melillo with 10x70mm used the opportunity to compare Mercury's color with that of Jupiter. Both Mercury and Jupiter appeared in the same 5-degree binocular field when the two planets were comparatively close to each other for a short period around May 16. According to Amato, Mercury was somewhat more yellowish than Jupiter. But as Mercury descended towards the horizon, pink hues

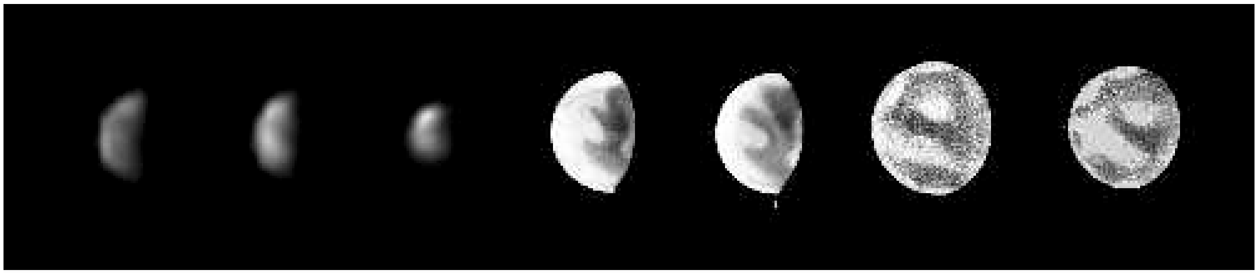


Figure 3 (see Table 5) -- (Left to right) Ccd images by Frank J. Mellilo, 14 July 2001, CM = 263°, 15 July 2001, CM = 268°, 21 July 2001, CM = 295°; sketches by Mario Frasatti, 21 July 2001, CM = 295°, 22 July 2001, CM = 299°, 28 July 2001, CM = 325°, 29 July 2001, CM = 329°.

were detected. Berg described Jupiter as very pale yellow with Mercury definitely yellow with a hint of orange. Melillo agreed. In addition, he saw Mercury higher in the sky through a telescope in daylight hours and found it then more yellowish, not unlike the Moon than any of the other colors mentioned.

Mercury and Jupiter may have the same color when higher in the sky. Jupiter is so much brighter, appears yellow, and does not seem to be materially affected at low altitudes. Since Mercury is dimmer and scintillates due to its small apparent angular diameter, it appears somewhat redder at low altitudes.

Table 5: Morning Apparition of Mercury, 16 June - 5 August 2001

Greatest Elongation: 9 July at 21°

Perihelion: 27 July

CM Longitude: From 97° to 01°

Observer	No. of Observations	Scope Used
Frasatti, Mario Crescentino, Italy	4 sketches	8-in. SCT
Melillo, Frank J Holtsville, NY	3 sets CCDs	

SCT = Schmidt-Cassegrain

Summary of Table 5

Observations

Melillo obtained several CCD images on July 14, 15, and 21. All were taken in broad daylight when Mercury was at least 70° above the southern horizon close to the meridian. A Wratten #25 red filter was used to increase the contrast against the bright background. Unfortunately, there is no Mariner 10 map of this region.

The best CCD image was secured on July 14, the CM longitude being 263°. A dusky marking in mid-northern latitude was most likely Solitudo Aphrodites, and a bright area farther north was probably Apollonia. This compares well with the map produced by Johann Warell of Uppsala University, Sweden, from his observations in the period 1995-1998. Converting Warrell's map to a scale and resolution of an 8-inch telescope, it was found there was complete agreement with Melillo. More CCD images were taken on July 15, the disk having the same general aspect. On July 21, with the CM longitude 295°, Melillo took more CCD images while Frassati made a fine drawing. A dark area was obvious in mid-northern latitudes. This was Solitudo Aphrodites as seen a week earlier. Now though, it had rotated slowly towards the terminator. In addition, a bright area in high northern latitudes was also seen, probably Apollonia. It would seem this region may contain bright crater ejecta. On July 22, Frassati made another sketch which again compares remarkably well with the CCD images and Warrell's map. Frassati made more sketches on July 28 and 29. At CM longitudes 325° and 329° respectively, they showed two bright areas, one north of the equator, the other in the south, Pentas and Pieria respectively. Again, Apollonia, a bright region in high northern latitudes, was also well seen.

Phase Anomaly

Greatest elongation occurred on July 9. Unfortunately, no observations were made until July 14. On that date, an image by Melillo showed a broad crescent, 0.47 illuminated. On July 15, it appeared to be close to half. By July 21, it was gibbous. Observed dichotomy probably occurred on July 15, but no later than the July 16; some six to seven days after greatest elongation. Solitudo Aphrodites adjoined the terminator at this time. It is therefore possible the slight darkening would create the impression of a dent in the terminator, leading the observer to estimate a slight crescentic effect.

Table 6: Evening Apparition of Mercury, 6 August - 14 October 2001

Greatest Elongation: 18 September at 27°

Aphelion: 9 September

CM Longitude: From 2° to 357°

Observer	No. of Observations	Scope Used
Frasatti, Mario Crescentino, Italy	1 drawing	8-in. SCT

SCT = Schmidt-Cassegrain

Summary of Table 6

Mario Frassati made the only observation this apparition. His drawing dated September 5 (CM longitude 136°) shows a prominent white area just north of the equator. Could it perhaps be the rays system Pleias? Mariner 10 imagery discloses some bright crater ejects east of Caloris. But we need to consider differences in viewing geometry before admitting a positive correlation; Mariner 10 viewed the region at a lower angle than Frassati.

Table 7: Morning Apparition of Mercury, 14 October - 4 December 2001

Greatest Elongation: 29 October at 19°

Perihelion: 23 October

CM Longitude: From 357° to 260°

Observer	No. of Observations	Scope Used
Amato, Michael West Haven, CT	2 drawings	6-in. NEWT
Del Valle, Daniel Aguadilla, PR	2 drawings	8-in. SCT
Frasatti, Mario Crescentino, Italy	6 drawings	8-in. SCT
Melillo, Frank J Holtsville, NY	4 sets CCDs	8-in. SCT

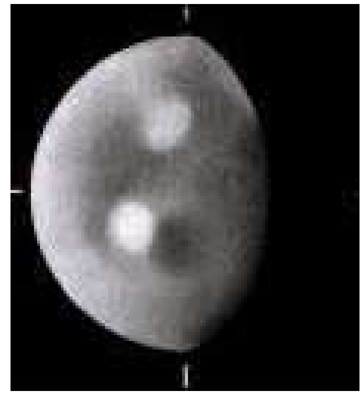
NEWT = Newtonian reflector
SCT = Schmidt-Cassegrain

Summary of Table 7

Observations

This was the most favorable morning apparition of the year. In addition, Mercury was within 2/3 of a degree of Venus from October 27 to November 7,

Figure 4 (see Table 6) -- Drawing by Mario Frasatti, 5 September 2001, CM = 136°.



which made Mercury easy to find in broad daylight. Again, Melillo obtained fine CCD images when the planet was close to the meridian. As the region covered during this apparition was mapped by Mariner 10, correlation of topography with albedo detail is possible, and this will be helpful in identifying the bright spots described by visual observers.

There is good coverage from October 27 to November 4. Melillo made the first observation on October 27 with excellent CCD images. At CM longitude 83°, a dusky feature was seen near the terminator, just south of the equator, extending faintly towards the limb. This was probably Solitudo Martis or Lycaonis. Melillo obtained more images the following day, but conditions on that occasion were very poor. Michael Amato suspected duskiness along the terminator, which may identify with what Melillo recorded. Daniel Del Valle observed on October 28 and described the markings as "suspected" only. Seeing was mediocre to poor.

With CM longitude 98° on October 30, Melillo secured excellent CCD images. These register three dusky features which may be Solitudos Martis, Jovis and Matae just south of equator. In addition to that, there was a very bright area near the mid-northern limb. This may be the Pleias area which includes several bright ray craters. One in particular, Degas, is the brightest of all, and may appear very bright near the limb as seen from Earth. Mario Frasatti's sketches of November 1 and 3 show a very bright area in the same place. Another possibility is the ray system from Amru Al-Qays and the features east of Caloris. But they were too far over the eastern limb. Unfortunately, the Mariner 10 map may not be helpful in this case due to the different geometry. No brightenings were reported near the North Polar Region.

Melillo imaged the planet on November 4, and Amato and Del Valle made sketches of its appearance - the CM longitude was 124°. A bright area was seen in mid-northern latitudes near the center of the disk. Again, it could be the Pleias area. Del Valle also suspected a bright area to the south. The dark streaks noted by Amato and Del Valle may be Solitudos

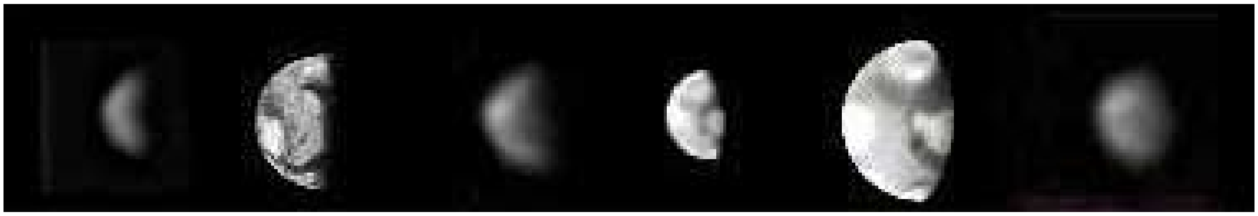


Figure 5 (see Table 7) -- (Left to right) Ccd image by Frank J. Mellilo, 27 October 2001, CM = 83°; drawing by Daniel Del Valle, 28 October 2001, CM = 88°; ccd image by Frank J. Mellilo, 30 October 2001, CM = 99°; sketches by Mario Frasatti, 1 November 2001, CM = 109°, 3 November 2001, CM = 119°; ccd image by Mellilo, 4 November 2001, CM = 124°.

Horarum and Neptuni in the north. Frassati observed on November 15, 16, 18, and 25. On November 15 through to the 18, (CM longitude 175°-189°), a U-shaped marking was seen in the northern hemisphere. This may be two connected features, possibly Solitudos Phoenicis and Neptuni. A dusky area just south of the equator was possibly Solitudo Matae or Solitudo Helii. The east limb appeared bright. Finally, on November 25, with Mercury only 5.6° from the Sun, it displayed a full phase. At CM longitude 221°, the disk was pale with a slight hint of brightening near the center.

Dichotomy

Mercury was at perihelion on October 23, and greatest elongation occurred on October 29. On October 27, CCD images showed a thick crescent. The next day, drawings by Amato and Del Valle disclosed a half phase. On October 30, CCD images show a slightly gibbous phase. Frasatti on November 1 drew a well-developed gibbous phase. While no observations were made on October 29, it seems that sometime between October 28 and 29, Mercury displayed a true half phase.

Conclusion

Mercury was observed on five out of six apparitions during 2001. Nearly every observation showed some albedo features on the disk. With CCD and the great variety of telescope accessories and the help of Mariner 10 imagery, it is possible we may soon have some basic understanding of what the visual observer is able to distinguish on the surface of the planet. Unfortunately, dusky features may not be much help in this respect. But as Hartmann pointed out several years ago, correlation is possible if instead we use the bright spots as control points. Many astronomical books are in error when they state that features cannot be seen on the disk. **This may have to be revised!** With the approaching MESSENGER mission and the Bepsi-Columbo spacecraft, we will very soon have a much clearer understanding of the entire surface of the planet and be in a position to more positively identify what the telescope reveals with actual surface relief.

References

Arnal, O.C (1996), “The Challenge of Observing Mercury: Frustrations and Awards”, *JALPO*, Vol. 39 No. 2 pp. 49-55.

Capen C., Dobbins, T. and Parker, D., (1988) *Introduction to Observing and Photographing the Solar System*, Richmond, VA Willmann-Bell, pg. 31.

Davies, M., Dwornik, S., Gault, D. and Strom, R. (1978), *Atlas of Mercury* NASA

Dobbins, T. and Sheehan, W. “Mesmerized by Mercury”, *Sky & Telescope*, June 2000, Vol. 99, No. 6, pp. 109-114.

Hall, D. and Genet, R., “Photoelectric Photometry of Variable Stars”, 2nd ed., Willmann-Bell Inc., Richmond, VA, 1988.

Price, F W (1994), “The Planet Observer’s Handbook” Cambridge University Press, England, pp 73-98.

Schaaf, F (1991) “Seeing the Solar System” New York, John Wiley & Sons, Inc. pg 49.

Schmude, R.W. (1990), “Observations of Mercury in 1988 – 1989” *JALPO*, Vol.34, No. 3, pp 101-103.

Call for Mercury Observation Reports

Observation data of Mercury are needed by Frank Melillo for the report covering the current evening apparition. Look for Mercury low in the west before dawn.

The ALPO Mercury Section Report Form is available at: http://www.lpl.arizona.edu/~rhill/alpo/mercstuff/mercfrm.jpg

Those without computer should send a SASE to Frank Melillo directly for copies of the observing form.

See the *ALPO Resources* pages of this Journal for more information.

ALPO MERCURY SECTION

NAME____________________________

ADDRESS__________________________

____

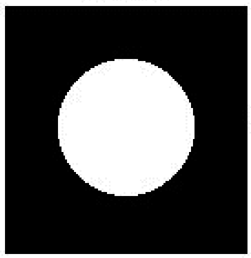
APPARITION:
Morning_____
Eveining_____
ARC SECONDS____"
ELONGATION:
____° from the sun

For Coordinator Only:

Sketch

DATE_________________
TIME (UT)_______________
Telescope____________________________
Magnification________________________
Filter(s)_____________________________
Seeing (10-best/1-worst)_______________
Visual Description:

NORTH



WEST

Central Meridian Longitude______°

Photo or CCD

DATE:_____________
TIME (UT):__________
Image 1

Central Meridian Longitude______°

Telescope:___________________
Camera Type:_________________
Exposure:____________________
f/ratio:_____________________
Filter:_______________________

Comments:

Date:________________
TIME (UT):____________
Image 2

Central Meridian Longitude______°

Telescope_____________________
Camera Type___________________
Exposure______________________
f/ratio_______________________
Filter________________________

Comments:

Send all observations to: Frank J Melillo
ALPO Mercury Coordinator
14 Glen-Hollow Dr., E-#16
Holtsville, NY 11742

E-mail for questions, special observations and alerts: frankj12@aol.com

ALPO Feature: Venus

A Report on the 1998-99 Eastern (Evening) Apparition

By Julius L. Benton, Jr., coordinator, ALPO Venus Section

Abstract

This report is a detailed summary of visual and photographic observations submitted to the Venus Section of the ALPO by observers residing in the United States, Puerto Rico, Canada, Italy, and Germany during the 1998-99 eastern (evening) apparition and lists instruments and data resources used in making those observations. Comparative investigations pertain to observers, instrumentation, and photovisual data. Accompanying this synopsis are illustrations and a statistical analysis of the categories of features reported in the atmosphere of Venus, including cusps, cusp-caps, and cusp-bands, seen or suspected at visual wavelengths, both in integrated light and with color filters, as well as in ultraviolet CCD images. The apparent phase of Venus and terminator irregularities are discussed, as well as results from the continued monitoring of the dark hemisphere of Venus for the Ashen Light.

Introduction

An excellent collection of 200 drawings and CCD images of Venus was contributed to the ALPO Venus Section by observers during the 1998-99 Eastern (Evening) Apparition, and geocentric phenomena in Universal Time (UT) for the observing season are presented in Table 1 (page 24). Figure 1 (page 25) illustrates the distribution of observations by month during the 1998-99 Eastern (Evening) Apparition.

The level of observational coverage of Venus was very good during the 1998-99 Apparition. Individuals began observing two months after Venus emerged from Superior Conjunction, which occurred on 1998 OCT 30, and they continued to follow the planet up to within a day before Inferior Conjunction on 1999 AUG 20. Routine monitoring of Venus for the full duration of any given apparition is always our goal, and observers are encouraged to try to plan their programs accordingly. The "observing season," or observation period, ranged from 1998 DEC 29 to 1999 AUG 19, with over four-fifths of the observations (81.5 percent) submitted for the period from 1999 March through June when Venus was well-placed for viewing (near greatest elongation from the Sun) and approaching greatest brilliancy, which occurred in July.

Twelve persons contributed a total of 200 visual, photographic and CCD observations of Venus during the 1998-99 Apparition, and Table 2 (page 26) gives their names, observing sites, number of observations, and instruments used.

Table 1: Geocentric Phenomena for the 1998-99 Eastern (Evening) Apparition of Venus

Superior Conjunction	1998	Oct 30^d 04^h UT
Initial Observation		Dec 29 14
Dichotomy (predicted)	1999	June 10 22
Greatest Elongation East (45°)		June 11 12
Greatest Brilliancy (mv = -4.5)		July 14 19
Final Observation		Aug 19 19
Inferior Conjunction		Aug 20 12

Apparent Diameter (observed range):
10".21 (1998 Dec 29) - 57".96 (1999 Aug 19)
Phase Coefficient, k (observed range):
0.969 (1998 Dec 29) - 0.011 (1999 Aug 19)

Figure 2 (page 25) depicts the distribution of observers and submitted observations by observer's nation of origin for the 1998-99 Eastern (Evening) Apparition. Slightly over half of the individuals contributing to the ALPO Venus Section (58.3 percent) were located in the United States, accounting for over two-thirds (69.0 percent) of the total observations received. As in several recent previous apparitions, international participation in our programs continued in response to our efforts to foster increased cooperation among lunar and planetary observers worldwide.

The types of telescopes employed to perform observations of Venus in 1998-99 are shown graphically in Figure 3 (page 27). Nearly three-fourths (74.0 percent) of the observations in 1998-99 were made with telescopes of 15.2-cm (6.0-in.) aperture or greater. Instruments of classical design (i.e., refractors and Newtonians) were used to make over half (57.5 percent) of the observations, while Schmidt-Cassegrains and Maksutovs (nonclassical designs) were used to complete the remaining Venus reports (37.5 percent and 5.0 percent, respectively). During 1998-99, about three-fourths of the observations (74.4 per-

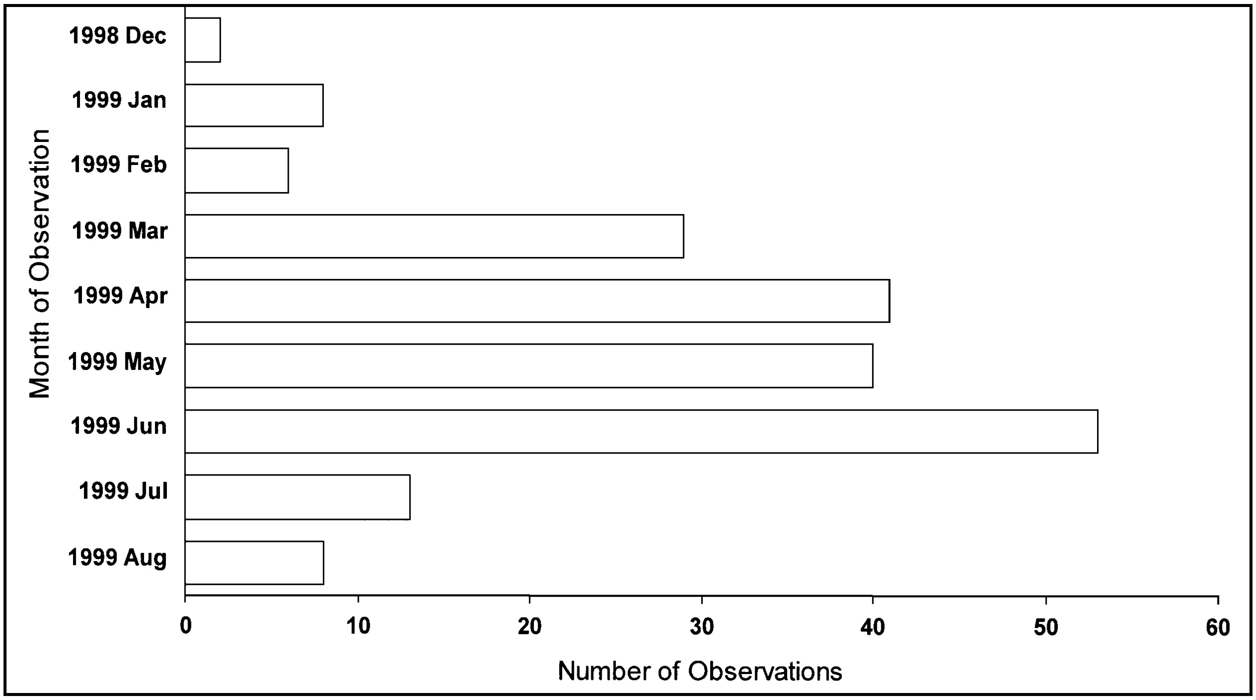


Figure 1. Number of Observations by Month, 1998-99 Eastern (Evening) Apparition of Venus.

cent) were conducted under dark-sky conditions, although several observers attempted observations in twilight to reduce spurious atmospheric effects near the horizon.

The ALPO Venus Section Coordinator wishes to thank the twelve individuals mentioned in this report for their careful and meaningful photo-visual observations of the planet during 1998-99. Readers wishing to find out more about observing the planet

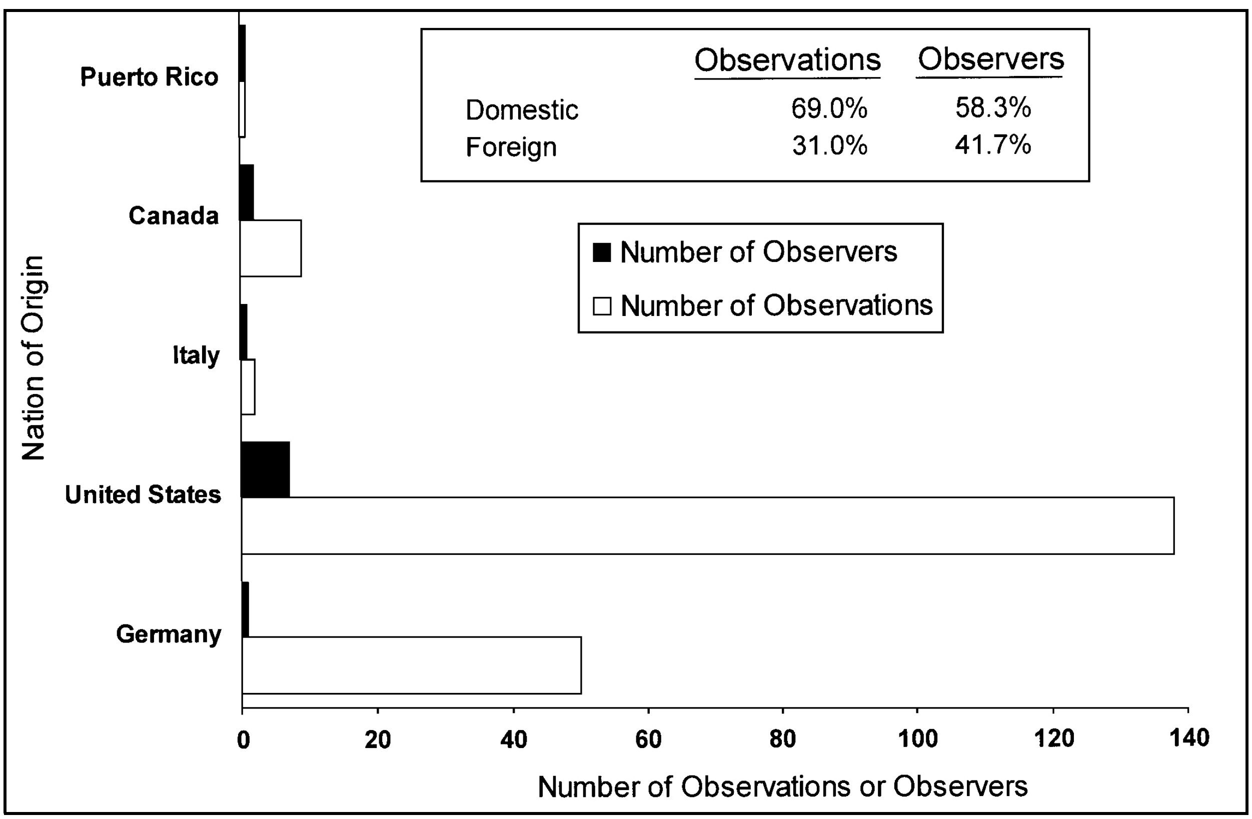


Figure 2. Number of Observations and Observers by Nationality, 1998-99 Eastern (Evening) Apparition of Venus.

Table 2: ALPO Venus Observers During the 1998-99 Eastern (Evening) Apparition

Observer and Observing Site	No. of Observations	Telescope(s) Used*
Benton, Julius L., Jr.; Wilmington Island, GA	44	15.2-cm (6.0-in) REF
Boisclair, Norman J.; South Glens Falls, NY	6	8.9-cm (3.5-in) MAK
	1	50.8-cm (20.0-in) NEW
Boschat, Michael; Halifax, Nova Scotia, Canada	1	20.3-cm (8.0-in) SCT
Bradbury, Mark; Indianapolis, IN	16	8.0-cm (3.1-in) REF
del Valle, Daniel; Aquadilla, Puerto Rico	1	8.9-cm (3.5-in) MAK
Dymond, Garry; St. Johns, Newfoundland, Canada	8	20.3-cm (8.0-in) SCT
Frassati, Mario; Crescentino, Italy	2	20.3-cm (8.0-in) SCT
Haas, Walter H.; Las Cruces, NM	20	20.3-cm (8.0-in) NEW
	4	31.8-cm (12.5-in) NEW
	1	35.6-cm (14.0-in) CAS
Melillo, Frank J.; Holtsville, NY	40	20.3-cm (8.0-in) SCT
Niechoy, Detlev; Göttingen, Germany	1	6.0-cm (2.4-in) REF
	1	8.9-cm (3.5-in) REF
	24	10.2-cm (4.0-in) REF
	24	20.3-cm (8.0-in) SCT
Schmude, Richard W.; Barnesville, GA	3	8.9-cm (3.5-in) MAK
	1	25.4-cm (10.0-in) NEW
	1	50.8-cm (20.0-in) NEW
Wasiuta, Myron E.; Dale City, VA	1	15.5-cm (6.1-in) REF
Total Number of Observers	12	
Total Number of Observations	200	

* CAS = Cassegrain, MAK = Maksutov, NEW = Newtonian, REF = Refractor, SCT = Schmidt-Cassegrain.

Venus are cordially invited to join the ALPO and become regular participants in our research programs in the future.

Observations of Venusian Atmospheric Details

Standardized procedures and techniques for conducting visual studies of the notoriously elusive “markings” in the atmosphere of Venus are described in detail in The Venus Handbook (Benton 1987). Readers who have access to earlier issues of this Journal may want to consult previous apparition reports for a historical perspective on photo-visual studies of the planet by ALPO observers (e.g., Benton, 1998, 1999, 2000).

Most of the observations used for this analysis were made at visual wavelengths, and some examples of these observations in the form of drawings appear in this report to aid the reader in interpreting the phenomena reported in the atmosphere of Venus in 1998-99 (see figures 6, 9, 10 and 15, pp. 30, 31 and 33). Frank Melillo continued to expand on his valu-

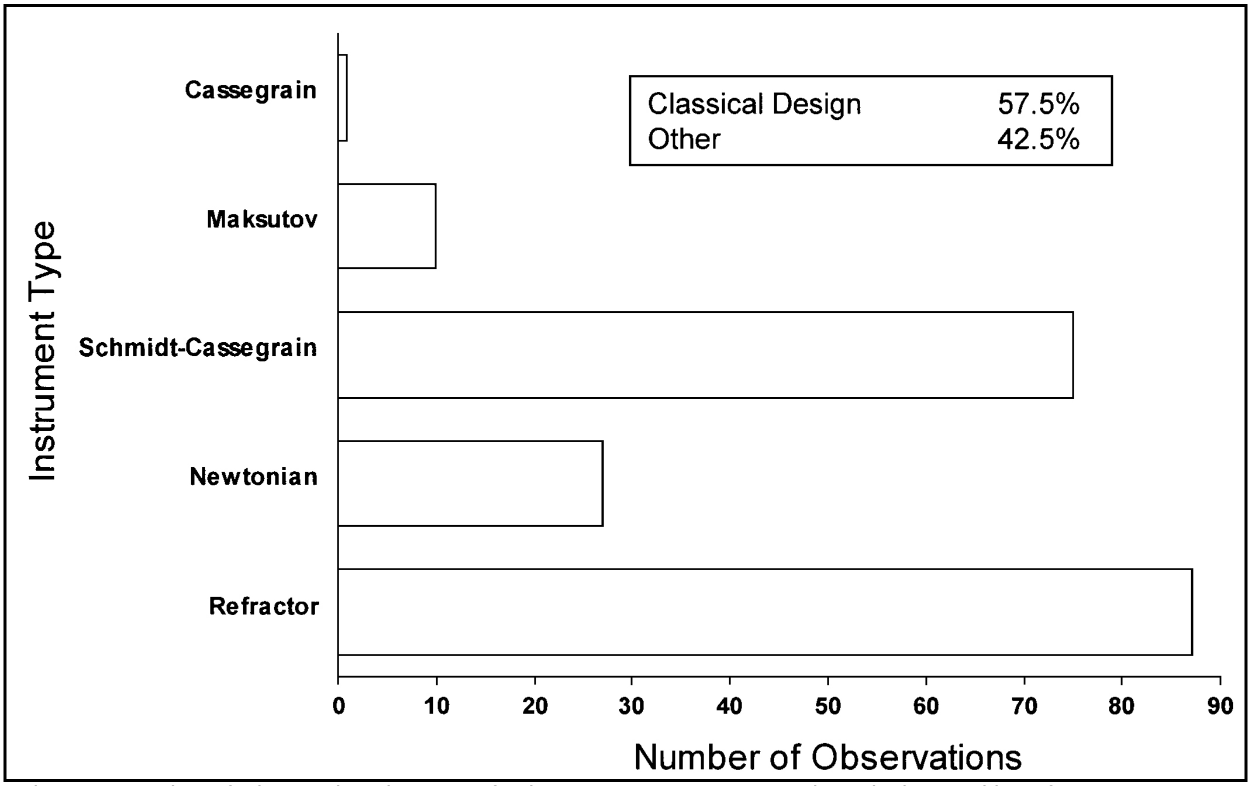


Figure 3. Number of Observations by Type of Telescope, 1998-99 Eastern (Evening) Apparition of Venus.

able and painstaking efforts to obtain CCD images of Venus at ultraviolet wavelengths, and some of his images accompany this report (see figures 7, 8, 11-14, 16 and 17, pp. 30, 31, 32, 33, and 34).

The visual and CCD data for the 1998-99 Apparition represented all of the traditional categories of dusky and bright markings in Venus' atmosphere, as described in the literature referenced previously in the report. Figure 4 (page 28) illustrates the frequency at which the specific forms of markings were seen or suspected. Most observations referred to more than a single category of marking or feature, and thus totals exceeding 100 percent are possible. Although our conclusions based on the submitted data appear reasonable, readers should understand that considerable subjectivity occurs when observers try to describe the vague and ill-defined atmospheric markings on Venus visually. This factor undoubtedly affected the data in Figure 4, and everyone is strongly encouraged to conduct simultaneous observations whenever possible to confirm phenomena and thus produce greater confidence in our results. "Simultaneous observations" occur when two or more individuals, using similar equipment and methods, work independently (by prior arrangement) and observe Venus at the same time and on the same date.

Dusky markings in the atmosphere of Venus are notoriously troublesome to detect visually, and this is a characteristic of the planet that is usually independent of the experience of the observer. Color filters and variable-density polarizers help improve the visibility of any subtle cloud phenomena that may be present on Venus at visual wavelengths. The ALPO Venus Section also continues to encourage observers to try ultraviolet (UV) photography or imaging, since the morphology of features revealed at UV wavelengths is usually quite different from what is seen in visual regions of the spectrum, particularly with the radial dusky patterns.

Figure 4 shows that nearly half (41.6 percent) of the observations of Venus in 1998-99 described a brilliant disc with no markings visible whatsoever, an impression similar to that in past evening apparitions of the planet. When dusky features were seen or suspected, most fell in the categories of "Amorphous Dusky Markings" (62.8 percent), "Banded Dusky Markings" (48.7 percent), and "Irregular Dusky Markings" (23.0 percent). Sightings of "Radial Dusky Markings" during the 1998-99 Eastern (Evening) Apparition occurred for 15.0 percent of the observations. The highest incidence of Radial Dusky Markings occurred, not surprisingly, on images in the near UV taken by Frank Melillo. In several of his images, vague banded dusky features reported by visual observers are also apparent.

Terminator shading was apparent during much of the 1998-99 observing season, reported in 37.8 percent of the observations, as shown in Figure 4. When seen, the terminator shading typically extended from one cusp region to the other, and the shading appeared to lighten (i.e., take on a higher intensity, as measured on the ALPO relative intensity scale, which extends from 0.0 for black to 10.0 for the brightest possible features) as one progressed from the region of the terminator toward the bright limb of the planet. This gradual variance in brightness ended in the Bright Limb Band in most accounts. In many of Melillo's images in 1998-99, terminator shading appears obvious.

The mean relative intensity for all of the dusky features on Venus in 1998-99 ranged from 7.5 to 8.5. The ALPO Scale of Conspicuousness (which runs sequentially from 0.0 for "definitely not seen" up to 10.0 for "certainly seen") was also used regularly during 1998-99. On this scale, the dusky markings in Figure 4 had a mean conspicuousness of about 3.0 during the apparition, which suggests that these features fell within the range from very indistinct impressions to fairly good indications of their actual presence on Venus.

Figure 4 also shows that "Bright Spots or Regions," exclusive of the cusp areas, were seen or suspected in only 4.4 percent of the total submitted observations, and these areas had a derived mean relative intensity of 9.5 to 9.9. In drawings made at visual wavelengths, observers called attention to these bright areas by sketching in dotted lines around such features, and although these features were completely absent on photographs in integrated light, some of Melillo's near-ultraviolet images appeared to show these bright regions.

Observers routinely used color-filter techniques during the 1998-99 Eastern (Evening) Apparition, and when results were compared with studies in Integrated Light, it was clear that variable-density polarizers and color filters enhanced the appearance of dusky atmospheric phenomena on Venus.

The Bright Limb Band

Figure 4 shows that a "Bright Limb Band" on the illuminated hemisphere of Venus was apparent in about 31 percent of the submitted observations in 1998-99. When the Bright Limb Band was seen or suspected, it appeared as a continuous, brilliant arc extending from cusp to cusp 85.4 percent of the time, and interrupted or only partially visible along the limb of Venus in 14.6 percent of the positive reports. The mean numerical intensity of the Bright Limb Band was 9.9 and the feature was definitely more conspicuous when color filters or variable-density polarizers were utilized. Although visual observers referred to the dazzling brightness of this feature in 1998-99, it was not readily apparent on any photographs or CCD images of Venus that were submitted.

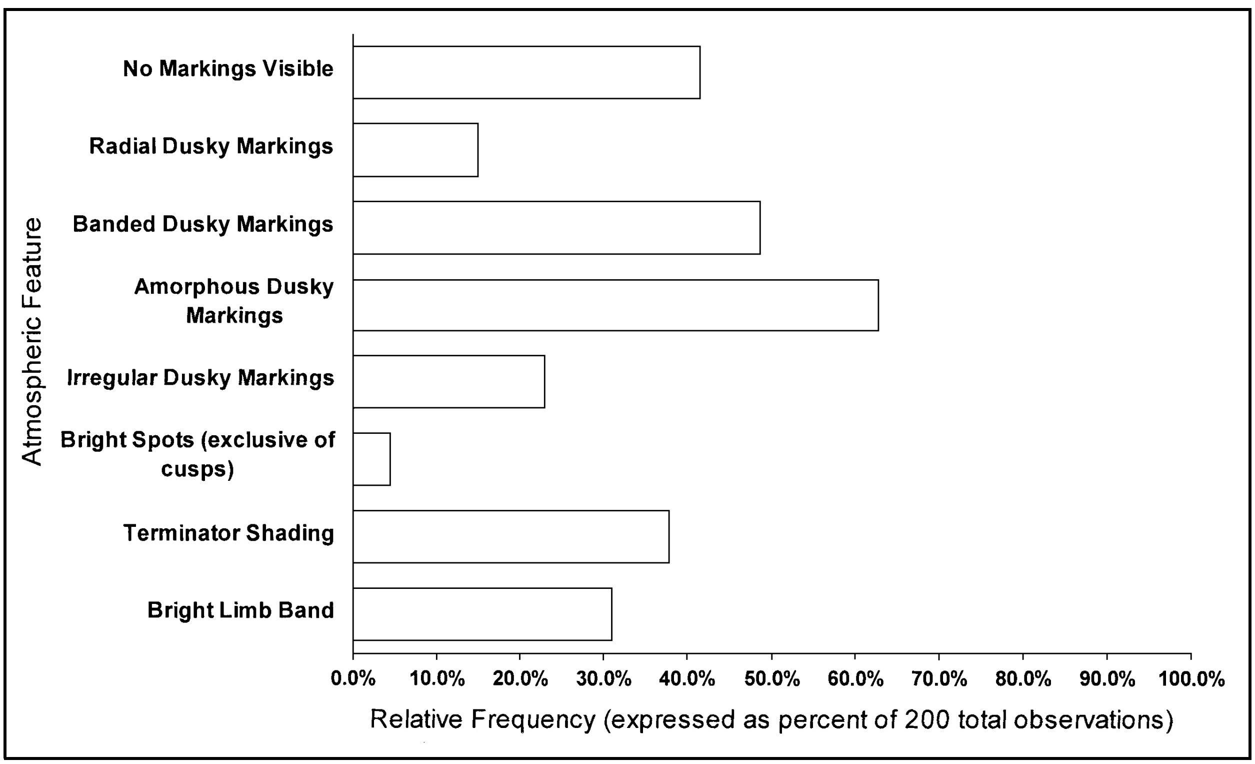


Figure 4. Relative Frequency of Specific Forms of Atmospheric Markings, 1998-99 Eastern (Evening) Apparition of Venus.

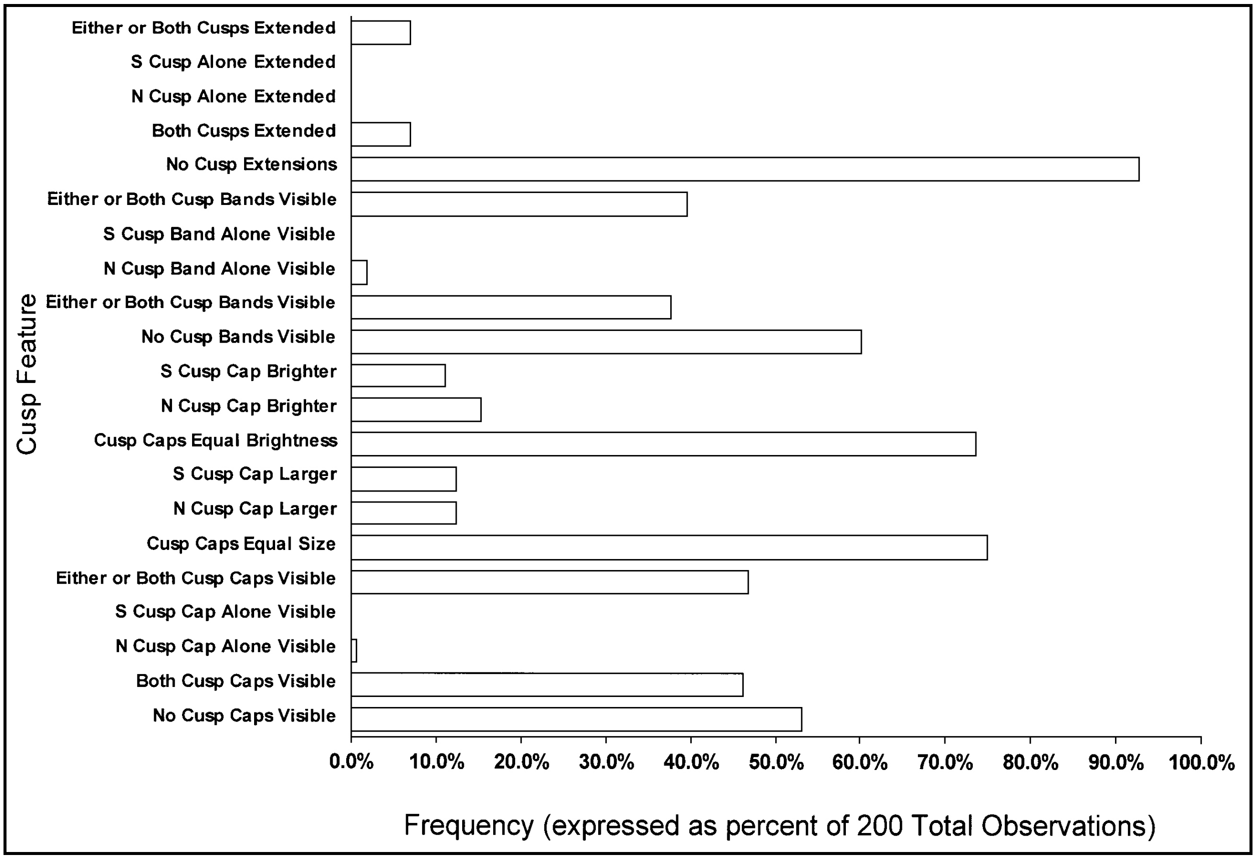


Figure 5. Relative Frequency of Observations of Specific Cusp Features, 1998-99 Eastern (Evening) Apparition of Venus.

Terminator Irregularities

The terminator is the geometric curve that divides the sunlit and dark hemispheres of Venus. Observers described a deformed or asymmetric terminator in somewhat less than one-quarter (23.9 percent) of the observations in 1998-99. Amorphous, banded, and irregular dusky atmospheric markings appeared to blend with the dusky shading along the terminator, perhaps contributing to any reported irregularities. Filter techniques helped improve the visibility of terminator irregularities and adjacent dusky atmospheric features during the 1998-99 Apparition. Due to irradiation, bright features close to the terminator sometimes appear as bulges, and dark features may take on the appearance of dusky hollows.

Cusps, Cusp-Caps, and Cusp-Bands

In general, when the phase coefficient, k, which is the fraction of the disc that is sunlit, lies between 0.1 and 0.8, features on Venus having the most contrast and prominence are repeatedly sighted at or near the planet's cusps. These cusp-caps are sometimes bordered by what are described as dark, usually diffuse, cusp-bands. Figure 5 (page 29) shows the visibility statistics for Venusian cusp features in 1998-99.

Figure 5 illustrates that, when the northern and southern cusp-caps of Venus were seen in 1998-99, these features were equal in size and brightness in roughly three-quarters of the observations. There were a very few instances when either the northern or southern cusp-cap was the larger, the brighter, or both, although in slightly more than half of the observations submitted (53.2 percent), neither cusp-cap was visible. The mean relative intensity of the cusp-caps was about 9.9 during the 1998-99 Apparition. Shaded cusp-bands bordering the brighter cusp-caps were absent in 60.3 percent of the observations when cusp-caps were visible, and the cusp-bands displayed a mean relative intensity of about 6.6 (see Figure 5).

Cusp Extensions

As can be noticed by referring to Figure 5, there were no cusp extensions reported beyond the 180° expected from simple geometry in 92.9 percent of the observations (in Integrated Light and with color filters). Later in the apparition, as Venus progressed through increasingly crescentic phases approaching inferior conjunction, several observers recorded cusp extensions that ranged from 2° to 50°. Just before inferior conjunction, a few observers reported the extended cusps as joining, forming a spectacular thin, bright halo encircling the entire dark hemisphere of

Venus (views were enhanced when using a W47 dark blue filter). Cusp extensions were depicted on several drawings, and although their visual appearance was improved by filter techniques, none were photographed successfully in Integrated Light or visual wavelengths. Failure to capture cusp extensions on film is not surprising, however, because the sunlit regions of Venus are so much brighter than the faint extensions.

We encourage observers to try their hand at recording cusp extensions using CCDs, video cameras, or both in future apparitions.

Estimates of Dichotomy

The discrepancy between the predicted and the observed dates of dichotomy (half-phase), known as the "Schroeter Effect" on Venus, was reported by only two observers during the 1998-99 Eastern (Evening) Apparition. The predicted half-phase occurs when **k** = 0.500, and the phase angle, i, between the Sun and the Earth as seen from Venus, equals 90°. The observed-minus-predicted discrepancies for 1998-99 are given in Table 3 (page 30).

Table 3: Observed versus Predicted Dichotomy of Venus: 1998-99 Eastern (Evening) Apparition

Observers:	J. Benton	W. Haas*
	a. UT Dates (1999)	
Observed (O)	JUN 06.10	JUN 07.11
Predicted (P)	JUN 10.92	JUN 10.92
Difference (O-P)	-04.82^{d}	-03.81^{d}
	b. Phase (k)	
Observed (O)	0.526	0.521
Predicted (P)	0.500	0.500
Difference (O-P)	+0.026	+0.021
	c. Phase Angle (i, degrees)	
Observed (O)	87.0	87.6
Predicted (P)	90.0	90.0
Difference (O-P)	-3.0	-2.4

* Estimated probability of straight terminator was approximately 80 percent.

Note: The drawings and CCD images that follow as figures 6 through 17 are all oriented with celestial south at the top and celestial west at the left, which is the normal inverted view when observing objects near the meridian with an astronomical telescope in the Earth's Northern Hemisphere. (North was originally at the top in the CCD images, which have been reoriented.) Seeing was reported as, or has been converted to, the standard ALPO scale, ranging from 0.0 for the worst possible condition to 10.0 for perfect seeing. Transparency is on the ALPO Scale, ranging from 0 for worst to 5 for perfect.

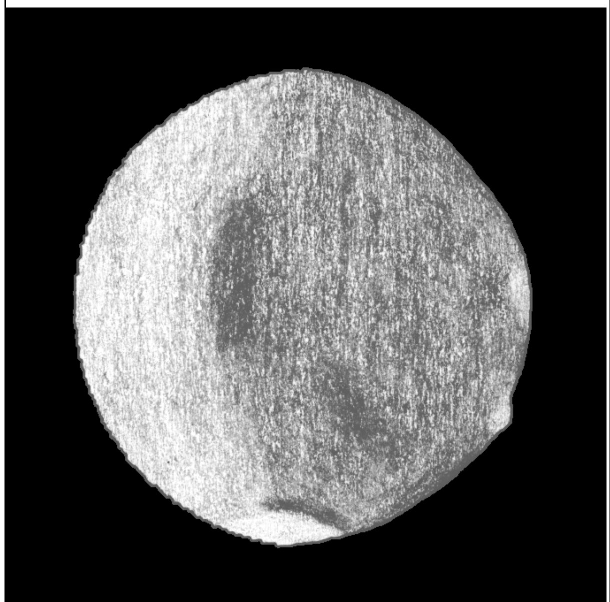


Figure 6. 1999 JAN 16, 22:35-22:47 UT. Drawing by Richard W. Schmude, Villa Rica, GA. 50.8-cm (20.0-in) Newtonian, 380X, Integrated Light and W80A (blue) Filter. Seeing 3.5, Transparency 5.0. Phase (k) = 0.948, Diameter = 10".5.

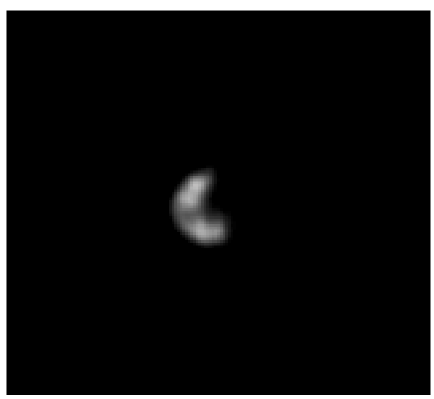


Figure 7. 1999 MAR 13, 23:30 UT. CCD image by Frank J. Melillo, Holtsville, NY. 20.3-cm (8.0-in) Schmidt-Cassegrain, StarLite Xpress MX-5 camera, Schott UG-I UV Filter with IR-blocking filter, 3-sec exposure at f/25. Seeing 7.0. Phase (k) = 0.845, Diameter = 12".4.

Figure 8. 1999 MAR 26, 23:30-23:46 UT. CCD images by Frank J. Melillo, Holtsville, NY. 20.3-cm (8.0-in) Schmidt-Cassegrain, StarLite Xpress MX-5 camera, Schott UG-I UV Filter with IR-blocking filter. Seeing 8.0. Phase (k) = 0.810, Diameter = 13".2.

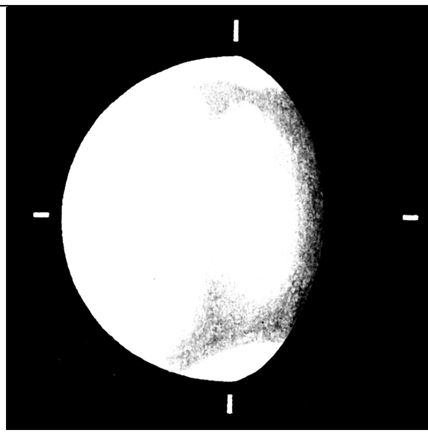


Figure 9. 1999 MAR 28, 18:07 UT. Drawing by Mario Frassati, Crescentino, Italy. 20.3-cm (8.0-in) Schmidt-Cassegrain, 250X, Integrated Light. Seeing 6.0 (interpolated). Phase (k) = 0.805, Diameter = 13".3.

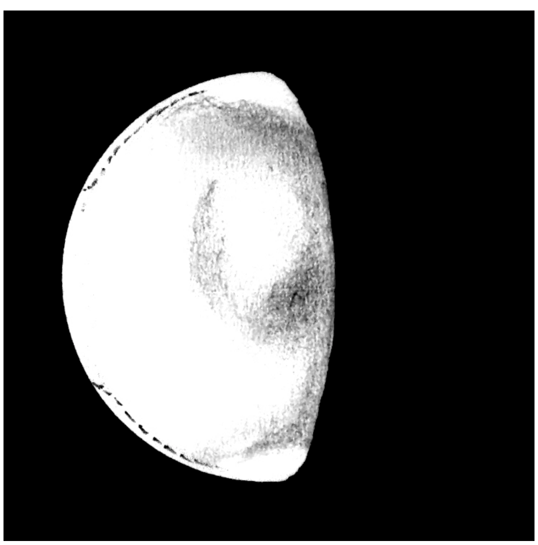


Figure 10. 1999 APR 20, 00:30-00:48 UT. Drawing by Julius L. Benton, Jr., Wilmington Island, GA. 15.2-cm (6.0-in) Zeiss refractor, 230X, Integrated Light and W80A (blue) Filter. Seeing 6.5, Transparency 5.0. Phase (k) = 0.733, Diameter = 15".0.

Dark-Hemisphere Phenomena and Ashen-Light Observations

The Ashen Light, first reported by G. Riccioli in 1643, refers to an extremely elusive, faint illumination of Venus's dark hemisphere. Although its origin is clearly not the same, the Ashen Light bears a resemblance to Earthshine on the dark portion of the Moon. Like the lunar earthshine, it would appear that the Ashen Light would be most likely seen when viewed against a dark sky, although such circumstances occur only when the planet is very low in the sky where adverse terrestrial atmospheric conditions contribute to bad seeing. Also, substantial glare in contrast with the surrounding dark sky influences such observations. Despite these problems, most observers throughout the years concur that Venus must be viewed against a totally dark sky for any hope of seeing the Ashen Light. Nevertheless, the ALPO Venus Section continues to hear from observers who claim they have seen the Ashen Light when Venus was observed during twilight or even in the daytime.

During 1998-99, there were virtually no instances (1.3 percent of the observations) when the Ashen Light was suspected in Integrated Light, color filters, or variable-density polarizers. On 1999 AUG 16 and 17, Walter Haas described "diffuse mottlings" on the dark hemisphere of Venus in Integrated Light (no filter) and in red (W25) and blue (W80A) filters, but no other individuals confirmed his impressions. No other observers reported suspicions of dark hemisphere illumination during the 1998-99 observing season.

There was only one instance in the 1998-99 Eastern (Evening) Apparition when an observer (Detlev Niechoy) thought he could possibly detect the dark hemisphere of Venus as appearing darker than the surrounding sky. This phenomenon is almost certainly an effect of contrast.

Figure 11. 1999 APR 24, 23:06-23:21 UT. CCD images by Frank J. Melillo, Holtsville, NY. 20.3-cm (8.0-in) Schmidt-Cassegrain, StarLite Xpress MX-5 camera, Schott UG-I UV Filter with IR-blocking filter. Seeing 7.0. Phase (k) = 0.715, Diameter = 15”.5.

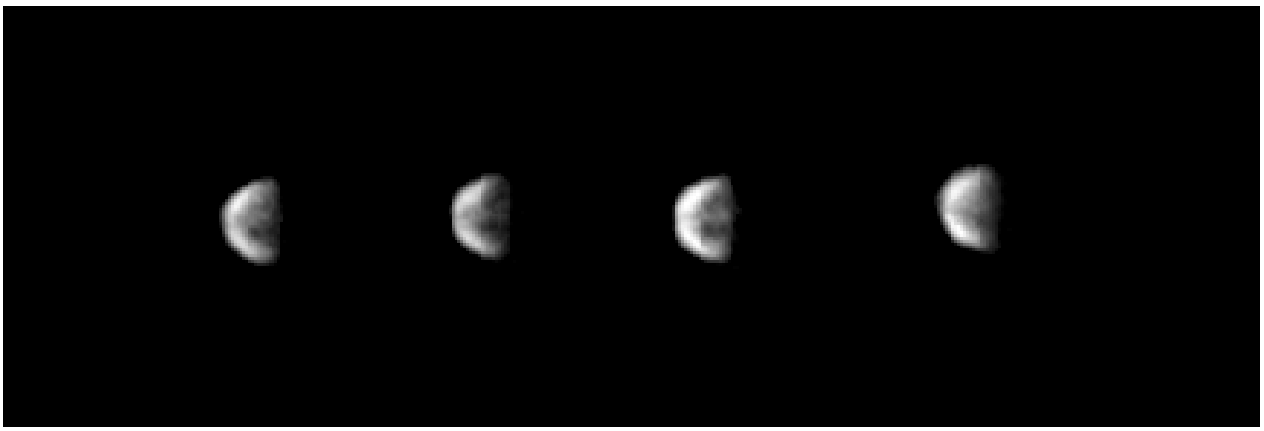


Figure 12. 1999 MAY 11, 23:l5-23:35 UT. CCD images by Frank J. Melillo, Holtsville, NY. 20.3-cm (8.0-in) Schmidt-Cassegrain, StarLite Xpress MX-5 camera, Schott UG-I UV Filter with IR-blocking filter. Seeing 8.0. Phase (k) = 0.647, Diameter = 17”.5.

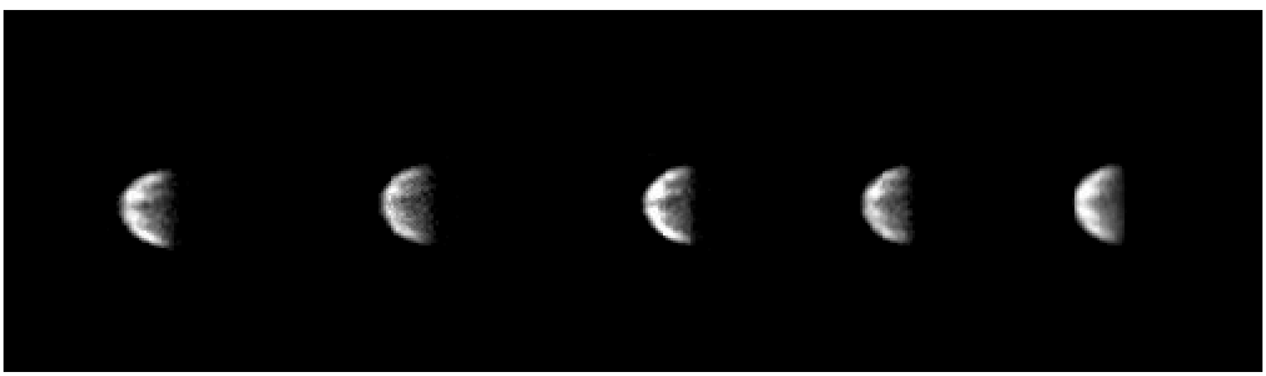


Figure 13. 1999 MAY 20, 23:20-23:45 UT. CCD images by Frank J. Melillo, Holtsville, NY. 20.3-cm (8.0-in) Schmidt-Cassegrain, StarLite Xpress MX-5 camera, Schott UG-I UV Filter with IR-blocking filter. Seeing 9.0. Phase (k) = 0.607, Diameter = 18”.9.

Conclusions

The results of our investigation of visual, photographic and CCD observations submitted to the ALPO Venus Section during the 1998-99 Eastern (Evening) Apparition suggested limited activity in the atmosphere of Venus. In particular, virtually all of the near-UV photographs contributed by Frank Melillo consistently showed atmospheric features on Venus, chiefly in the categories of Radial and Banded Dusky Markings. It would have been of considerable interest if some of Melillo’s UV images had matching simulta-

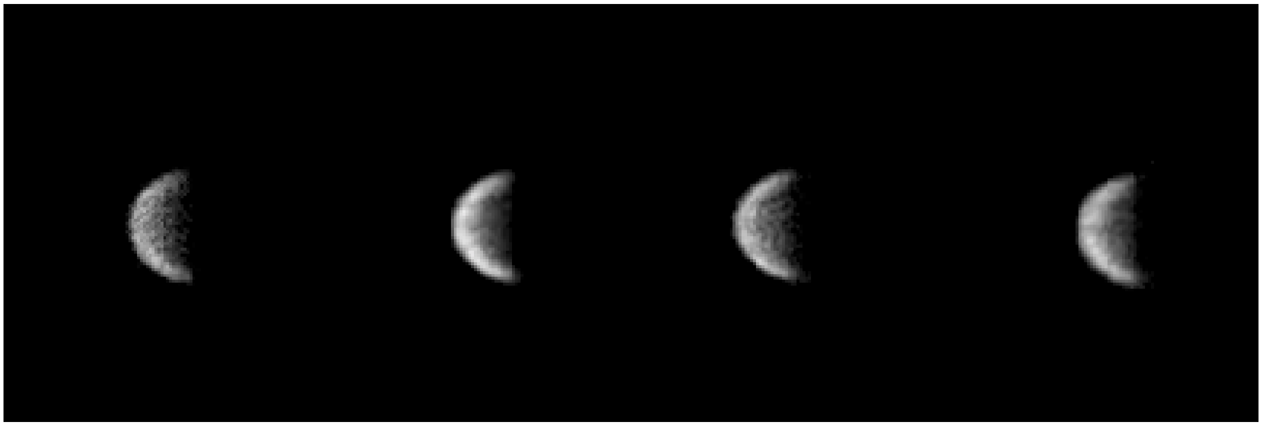


Figure 14. 1999 JUN 08, 23:25-23:45 UT. CCD images by Frank J. Melillo, Holtsville, NY. 20.3-cm (8.0-in) Schmidt-Cassegrain, StarLite Xpress MX-5 camera, Schott UG-I UV Filter with IR-blocking filter. Seeing 7.0. Phase (k) = 0.511, Diameter = 22".9.

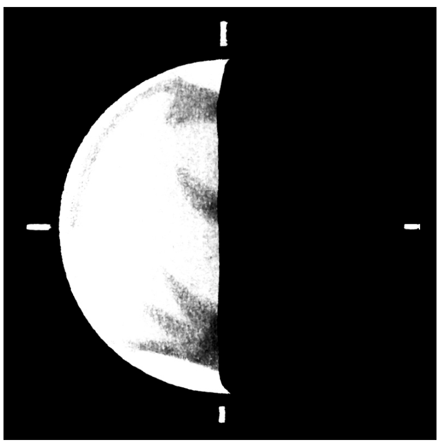


Figure 15. 1999 JUN 09, 18:45 UT. Drawing by Mario Frassati, Crescentino, Italy. 20.3-cm (8.0-in) Schmidt-Cassegrain, 250X Integrated Light and W8 (yellow) Filter. Seeing 4.0 (interpolated). Phase (k) = 0.507, Diameter = 23".1.

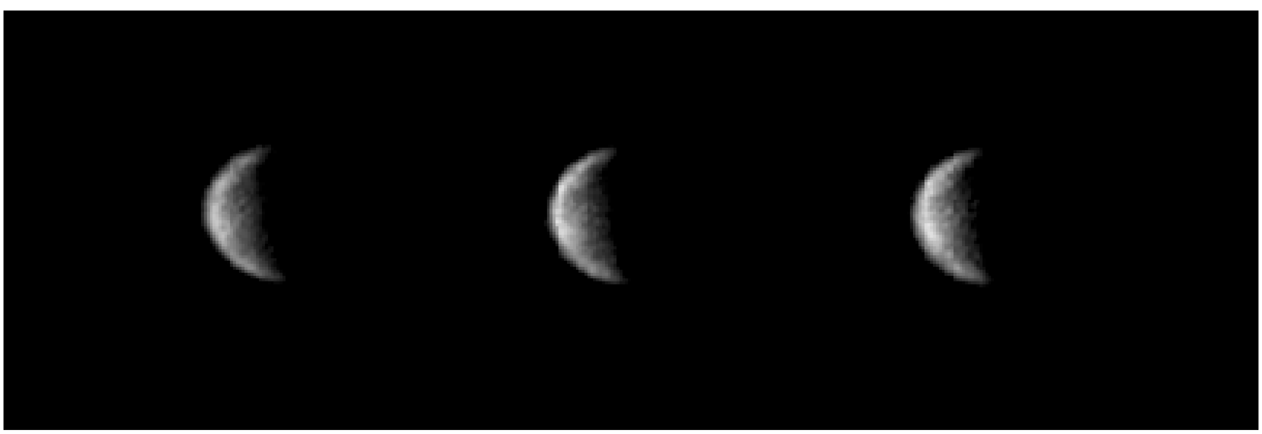


Figure 16. 1999 JUN 24, 23:45-23:55 UT. CCD images by Frank J. Melillo, Holtsville, NY. 20.3-cm (8.0-in) Schmidt-Cassegrain, StarLite Xpress MX-5 camera, Schott UG-I UV Filter with IR-blocking filter. Seeing 8.0. Phase (k) = 0.414, Diameter = 27".9.

neous visual observations from other observers for comparative analysis. It has already been mentioned earlier in this report that it is very difficult to differentiate between what are thought to be real atmospheric phenomena and what is merely illusory on Venus at visual wavelengths, and more confidence in our results will occur as the number of observers and incidence of simultaneous observations increase. The ALPO Venus Section will continue its effort to organize and implement a simultaneous observation schedule among observers willing to adopt such a plan during future apparitions. Perhaps observers in relative proximity to one another can work out their own schedule for watching Venus at the same time.

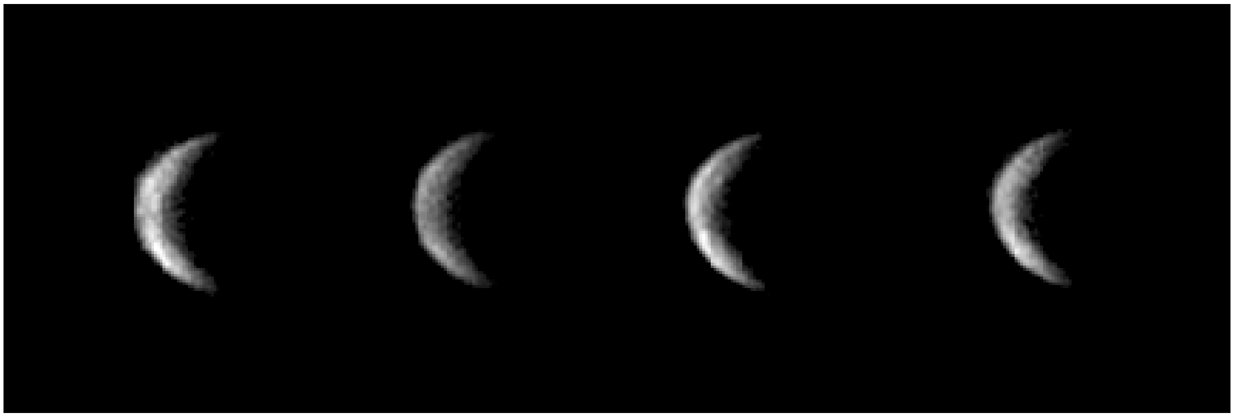


Figure 17. 1999 JUL 06, 23:30-23:50 UT. CCD images by Frank J. Melillo, Holtsville, NY. 20.3-cm (8.0-in) Schmidt-Cassegrain, StarLite Xpress MX-5 camera, Schott UG-I UV Filter with IR-blocking filter. Seeing 7.0. Phase (k) = 0.329, Diameter = 33".0.

Indeed, the example set by Melillo in recent years by doing fairly routine imaging in the near UV will perhaps encourage a few others to try ultraviolet imaging of the planet.

ALPO studies of the Ashen Light, which peaked during the Pioneer Venus Orbiter Project, are continuing every apparition. Constant monitoring of the planet for the presence of this phenomenon by a large number of observers, ideally participating in a simultaneous observing program, remains vital as a means of improving our chances of capturing confirmed dark-hemisphere events. Although the probability of success is perhaps low, capturing the Ashen Light on images of Venus would be an excellent objective.

Active international cooperation by individuals making regular systematic, simultaneous observations of Venus continues to be our prime objective, and the ALPO Venus Section invites interested readers to join us in our projects and challenges ahead.

References

Benton, Julius L., Jr. (1973). *An Introduction to Observing Venus*. Savannah, GA: Review Publishing Co.

________. (1987). *Visual Observations of Venus: Theory and Methods* (The A.L.P.O. Venus Handbook). Savannah, GA: Review Publishing Co.

________. (1998). "The A.L.P.O. Observations of Venus: The 1994 Eastern (Evening) Apparition." JALPO, 40, No. 2 (Apr.): 54-61.

________. (1999). '"A.L.P.O. Observations of Venus During the 1995-96 Eastern (Evening) Apparition." JALPO, 41, No. 2 (Apr.): 57-65.

________. (2000), '"A.L.P.O. Observations of Venus During the 1997-98 Eastern (Evening) Apparition. " JALPO, 42, No. 4 (Oct.): 149-157.

Hunten, D.M., et al., eds. (1983). Venus. Tucson: University of Arizona Press.

United States Naval Observatory. The Astronomical Almanac. Washington: U.S. Government Printing Office. (Annual publication; the 1998 and 1999 editions, which were published in 1997 and 1998, respectively, were used for this report.)

Call for Venus Observation Reports

Observation data of Venus are needed by Julius Benton for the report covering the current apparition. Look for Venus in the east before dawn.

The ALPO Venus Section Report Form is available in pdf format at: http://www.lpl.arizona.edu/~rhill/alpo/venustuff/venus1.pdf

Those without computer should contact Julius Benton directly for either the *ALPO Venus Observing Kit* or the *Observing Forms Packet*. *The Venus Observing Kit* includes introductory description of ALPO Venus observing programs for beginners, a full set of observing forms, and a copy of *The Venus Handbook*. The *Observing Forms Packet* includes observing forms to replace those provided in the observing kit described above. Specify Venus Forms.

Observers who wish to make copies of the observing forms may instead send 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 ALPO Venus, Saturn, or lunar SAP sections. Observers should make copies using high-quality paper.

See the *ALPO Resources* pages of this Journal

ALPO Feature: The Moon

Crater Alphonsus

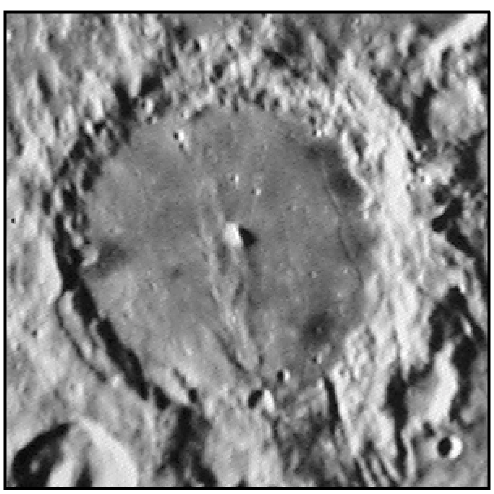
By Eric Douglass
ALPO Journal staff writer

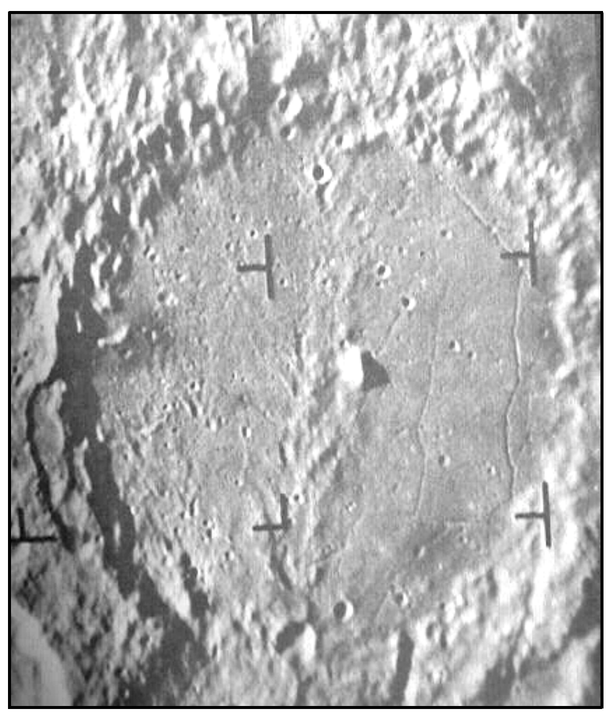
Alphonsus is the middle crater in the prominent verticle row of three (Ptolemaeus, Alphonsus, and Arzachel) near the center of the Moon. At first glance, it appears as an ordinary crater, but close examination reveals its interesting history.

Alphonsus was created by an impact during the Moon's Nectarian Period, 3.85 to 3.92 billion years ago. Initially, it was a typical, complex crater, with central peaks, steep inner walls, and a sharp rim surrounded by ejecta. Its concave bottom was filled with a layer of impact melt and impact debris that fell back onto the crater floor, forming a lens-shaped slab. In its final stage of formation, unstable rim material slid down to the floor, and slumping of the inner walls resulted in terracing.

A few tens of millions of years later, the enormous Imbrium impact occurred to the north. Its outrushing ejecta deeply gouged the walls of Alphonsus and left a thick layer of material over both the ejecta of Alphonsus and its floor. The

Figure 1: Fissure and craters in Alphonsus smoothed by lava beads as described in text. (Ranger IX Photographs of the Moon; Cameras A, B, and P; NASA SP-112; Washington: USGPO, 1966; B 67.)





Figures 2 (left) and 3: Views of Alphonsus from Earth (left) and from Ranger 9 (right). Note dark-haloed craters from lava-fountaining. (Fig. 2: *Consolidated Lunar Atlas*; G. Kuiper, E. Whitaker, R. Strom, J. Dountain, S. Larson; digital ed. E. Douglass; USAF: 1967; plate E13. Fig. 3: Ranger IX Photographs of the Moon; Cameras A, B, and P; NASA SP-112; Washington: USGPO, 1966; A 32) event sent faults deep into the crust of the Moon throughout this region.

Over the next few hundred million years, the radioactive decay of elements such as thorium, potassium, and uranium heated the Moon's mantle and melted sections of it. These melts were of low density, and therefore oozed up the faults created by the Imbrium impact.

Most of these lavas erupted from fissures in the Imbrium Basin itself, but some tracked up under Alphonsus and collected under the lens of material on its floor. This expanding pool of lava stretched the surface of Alphonsus, causing the lens to break along planes of weakness. At such breaks, the sudden release of pressure allowed the gasses dissolved in the lava to expand explosively upward, entraining some lava with them. On Earth, this kind of eruption is called "lava fountaining." The lava in these fountains fragmented into small beads which, by rapid radiative cooling, solidified before falling to the surface.

The beads are glass, containing few crystals, and since they are dark in color, they darken the lunar surface around the vent. In the image of Alphonsus taken by Ranger 9 (Figure 1), one can see the smoothing effect of the lava beads where they soften and cover the fissure and all the craters under their rain.

From this history, we can associate the visible features of Alphonsus with selenological processes (see Figure 2 for an Earth-based view, and Figure 3 for a view from the Ranger 9 spacecraft). The deep valleys that cross the rim of the crater were created by the ejecta from the Imbrium impact.

The dark areas on the crater floor are around vents where lava fountaining occurred, and are called "dark-haloed craters". The rille-like fissures connecting these vents are the fractures produced by the intrusion of lava beneath the surface. On nights of exceptional seeing, all these features are visible, and they remind us of the violent events that occurred in our Moon's distant past.

For further reading:

Gordon MacDonald; *Volcanoes*; Englewood Cliffs: Prentice-Hall, Inc., 1972; esp. see pages 213-216.

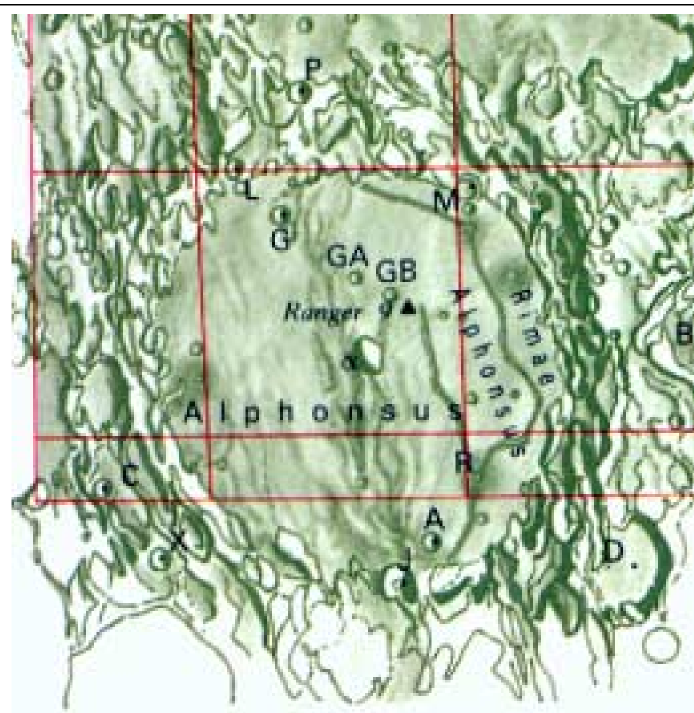
Grant Heiken, David Vaniman, and Bevan French; *Lunar Sourcebook*; Cambridge: Cambridge University Press, 1991; esp. see pages 101-102, 111.

Paul Weissman, Luce-Ann Fadden, and Torrence Johnson; *Encyclopedia of the Solar System*; London: Academic Press, 1999; esp. see pages 895-896.

Haraldur Sigurdsson; *Encyclopedia of Volcanoes*; San Diego: Academic Press, 2000; esp. see pages 703-704.

Don Wilhelms; *The Geologic History of the Moon*; USGS Professional Paper1348; Washington: USGPO, 1987; esp. see pages 113, 89.

This scanned image of a portion of map 44 from Antonin Rükl's *Atlas of the Moon* shows crater Alphonsus, located at 13.4° S, 2.8°W, plus Rimae Alphonsus as well as the impact site of the Ranger 9 satellite.
The crater was named for Alfonso X "El Sabio" (The Wise), King of Castile and astronomer who lived from 1221-1284 AD.
He authored the Alphonsine Tables, a compilation of astronomical data tabulating the positions and movements of the planets. It was completed about 1252 and printed in Venice in 1483. They were a revision and improvement of the Ptolemaic tables and were compiled at Toledo, Spain, by about 50 astronomers assembled for the purpose by Alfonso X. (*Sources: "Atlas of the Moon" by A. Rükl, and http://www.slider.com/enc/2000/Alfonsine_tables.htm. Image used with permission.*)



ALPO Feature:The Moon - Plato’s Hook, Part III

On the Curvature of the Gamma Peak's Shadow on Plato's Floor

By Raffaello Lena, Giorgio Di Iorio, Alessandro Bares, Cristian Fattinnanzi (Geologic Lunar Research group) and Giancarlo Favero (Osservatorio "G. Ruggieri", Padova, Italy)

Introduction

Two papers that recently appeared in this Journal proposed that the hook-like shadow on the floor of the lunar crater Plato drawn by Wilkins and Moore on April 3, 1952, is projected by a complex and elongated hill lying on Plato's floor (Favero, Lena, et al, 2000; Favero, Lena, et al, 2001). The authors reported that the shadow cast by Plato's Gamma Peak never displays significant curvature when the solar elevation (H) is between 3° and 8°.

In response to this, Braga and Ferri argued in a letter to JALPO that the “hook” is the Gamma Peak's shadow, which in some instances appears slightly curved at low Sun (Braga and Ferri, 2002). They included a fuzzy video image by Sorrentino in which the shadow cast by Plato Gamma shows curvature (image taken with an f/10 SCT of F = 200 mm, on February 13, 2000, at H = 4.14 ° and colongitude (C) = 16.7°).

We think that this fuzzy image of Plato is insufficient evidence to prove that the Gamma Peak's shadow may display any curvature. To show that the curvature is not due to chance (for example, deformation by the seeing), an independent and contemporaneous image by at least one other observer should have been obtained.

Recently, Sorrentino proposed two computed dates (March 22, 2002, at 19:46 UT and May 20, 2002, at 20:11 UT) when the solar illumination would reproduce conditions suitable for detecting Plato Gamma's shadow curvature (Sorrentino, 2002). To study the possible causes of the aspect of the Gamma Peak's shadow described by Braga and Ferri, we imaged Plato and its surroundings at exactly the two times computed by Sorrentino, using web-cams and CCD cameras fitted to different telescopes.

Table 1: Contributing Observers, Instruments, and Observing Times.

Observer	Telescope, A, f/	Type	No.	Date and Time
Bares A.	Newt, 250 mm, f/12	CCD	1 (b)	(b) 19:56-21:00
Basso S.	SC, 200 mm, f/10	Web-cam	1 (b)	(b) 20:20-20:28
Di Iorio G.	SC, 200 mm, f/10	CCD	1 (b)	(b) 20:02-21:35
Fattinnanzi C.	Newt, 200 mm, f/6	Web-cam	1 (b)	(b) 19:31-20:14
Fazzo M.	SC, 275 mm, f/10	Web-cam	1 (b)	(b) 19:50-21:14
Lena R.	Refract, 100 mm, f/15	Visual	2 (a&b)	(a) 19:40-19:50,
Martina S. & Ferrero G.	SC, 200 mm, f/10	Web-cam	1 (a)	(a) 19:46
Mengoli G.	SC, 250 mm, f/10	CCD	1 (a)	(a) 18:10-18:50
Moroni P.	SC, 200 mm, f/10	Web-cam	2 (a&b)	(a) 19.38-19:44,
Padulosi F.	Mak, 90 mm, f/14	Web-cam	1 (b)	(b) 20:03-20:28
Porta R.	SC, 250 mm, f/6	Visual	1 (b)	(b) 19:50-20:25

NOTES:
Under Telescope: A = aperture in mm; f/ = focal ratio; Newt = Newtonian reflector; SC = Schmidt-Cassegrain; Refract = refractor; Mak = Maksutov
Under Type: CCD = charge-coupled device; web-cam = cam-corder
Under No. and Date and Time: (a) = March 22, 2002; (b) = May 20, 2002; all times are Universal Time (UT)

Instruments and Measures

This report is based on an analysis of a number of visual observations and images taken on the computed dates and sent to us. We strongly encouraged observers to participate in organized, simultaneous observations. This effort by observers significantly reinforces the level

Table 2: Distribution of Gamma Peak Shadow's Curvature

Straight	Northward	Southward
74%	18%	8%

of confidence we have in our data for each date. A synchronized time signal was used in order to assure accurate timing of the observations. For each observation, we calculated the solar altitude, azimuth (A), and colongitude as seen from Plato, using the *Lunar Observer's Tool Kit* software by Harry Jamieson.

Figure 1. Image taken by S. Martina and G. Ferrero on March 22, 2002, at 19:46 UT (H = 3.46°, A = 96.82°, C = 16.80°) with a webcam (Philips ToUcam) fitted to a Schmidt-Cassegrain, 200 mm f/10. It is the sum of 20 frames, using Astrostack software, taken from 2 records of 15 seconds. Seeing IV-V Antoniadi scale.

Figure 2. Image taken by P. Moroni on March 22, 2002, at 19: 38-19:44 UT (H = 3.45°, A = 96.81°, C = 16.78°), with a webcam (Vesta Pro Philips) fitted to a Schmidt-Cassegrain, 200 mm f/10, equipped with a 2X Barlow lens and IR-blocking filter. It is the sum of 400 frames, using Iris 3.6 software. Seeing III Antoniadi scale.

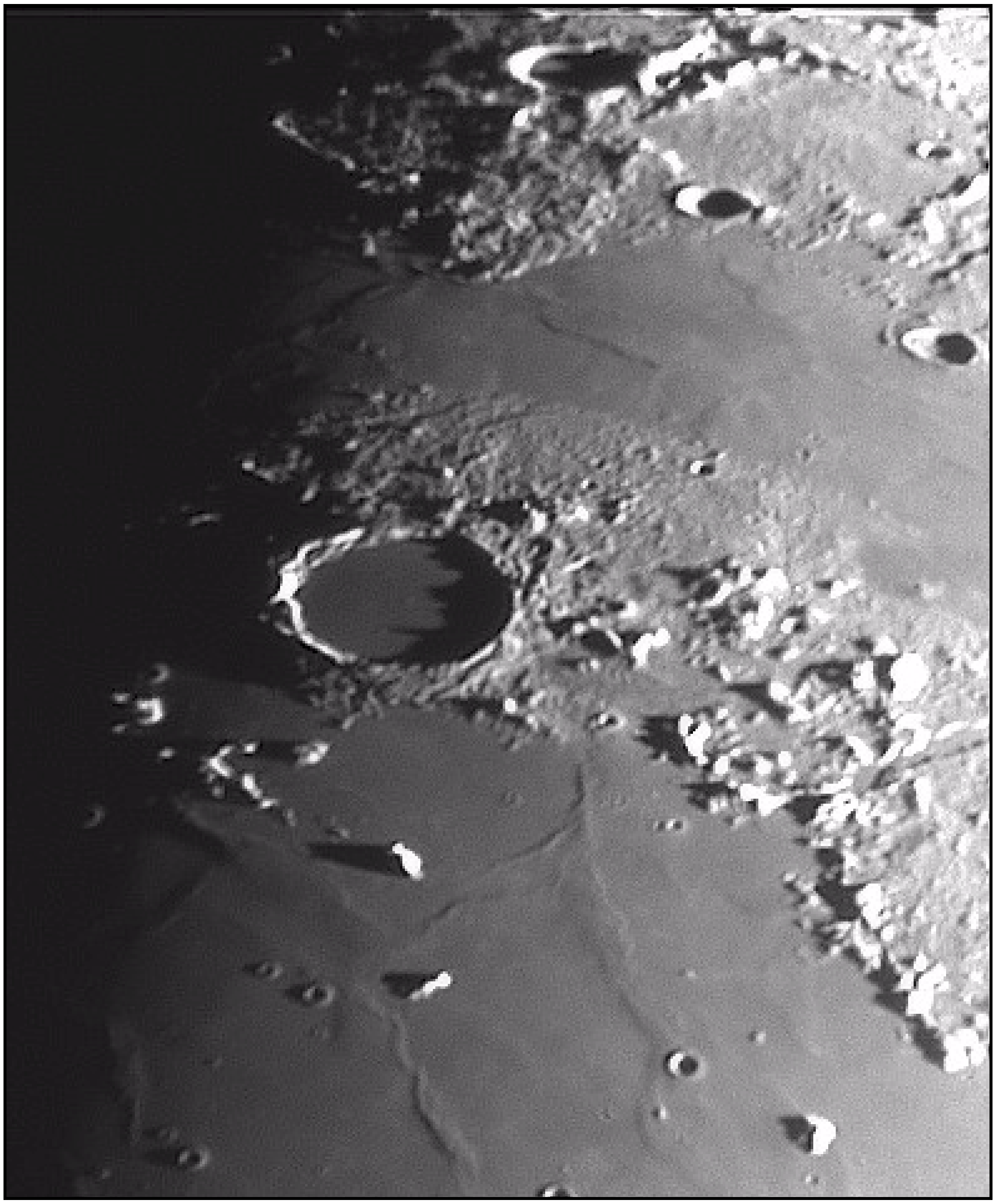


Figure 3. Image taken by G. Mengoli on March 22, 2002, at 18:40 UT (H = 3.12°, A = 96.38°, C = 16.24°), with an HX516 integrating CCD camera fitted to a Schmidt-Cassegrain, 250 mm f/10, equipped with a 1.83X Barlow lens.

Table 1 lists the 12 observers, their instruments, and the dates and times of the 13 observations they supplied.

Results

On both dates, the visual observers found no curvature in the shadow of Gamma Peak.

We received March 22 images from three observers, and May 20 images from seven observers (Table 1). Because of the plentiful simultaneous observations on the latter date, we analyzed the curvature of the Gamma Peak's shadow on each of the approximately 200 images taken on that date. We report the results in Table 2. In every instance when curvature was detected, as enumerated in Table 2, there was no confirmation of the curvature by a simultaneous observation by an independent observer.

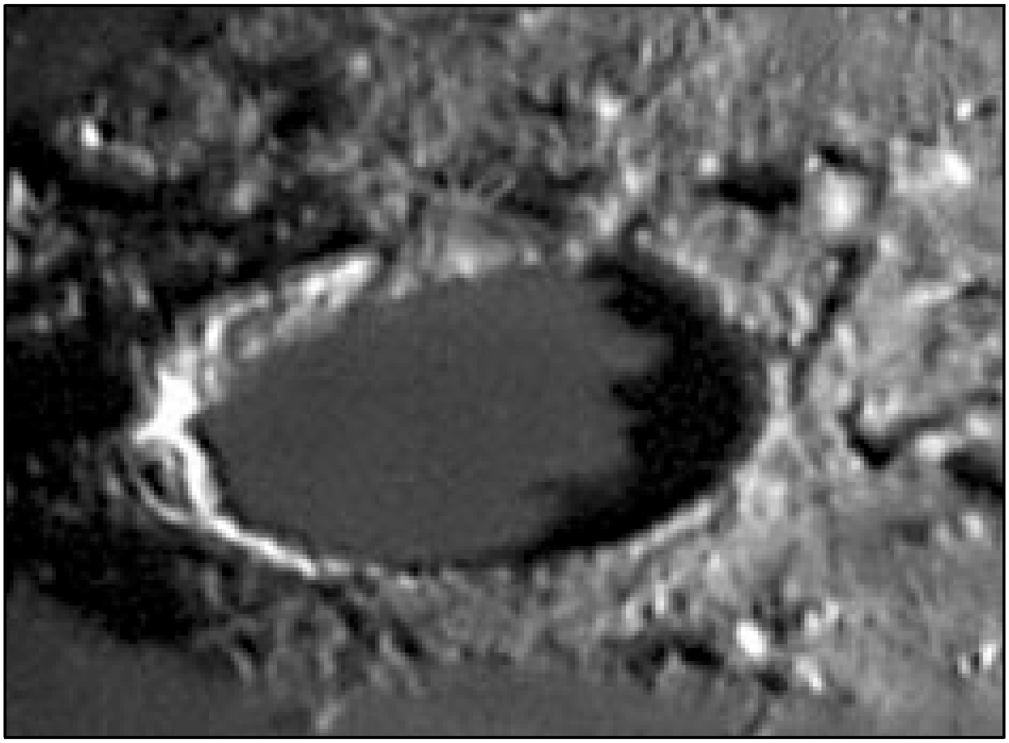
Examples of images

Figures 1 through 7 are oriented with north at the top and IAU west at the left. Figures 8 and 9 are oriented with north at the right and west at the top. Seeing is reported using the Antoniadi Scale.

Images of March 22, 2002

Figure 1 displays the Gamma Peak's shadow slightly curved. This is one of the many images obtained under poor seeing conditions. Figure 2 is a contemporaneous image made in better see-

Figure 4. Image taken by A. Bares on May 20, 2002, at 20:11 UT (H = 4.24°, A = 96.21°, C = 16.79°), with an HX516 integrating CCD camera fitted to a Takahashi Mewlon, 250 mm f/12. Seeing IV Antoniadi scale.



ing conditions with nearly identical instrumentation by summing 20 times as many frames. In it, the Gamma Peak's shadow doesn't display any significant curvature. Figure 3 was taken about an hour before figures 1 and 2, and it shows no curvature.

Images of May 20, 2002

Figure 4 shows curvature in the shadow of the Gamma Peak. Figure 5 is one of several images taken by several other observers at the same time as Figure 4, but under better seeing conditions, and it shows no curvature. Figure 6 displays slight curvature of the Gamma Peak's

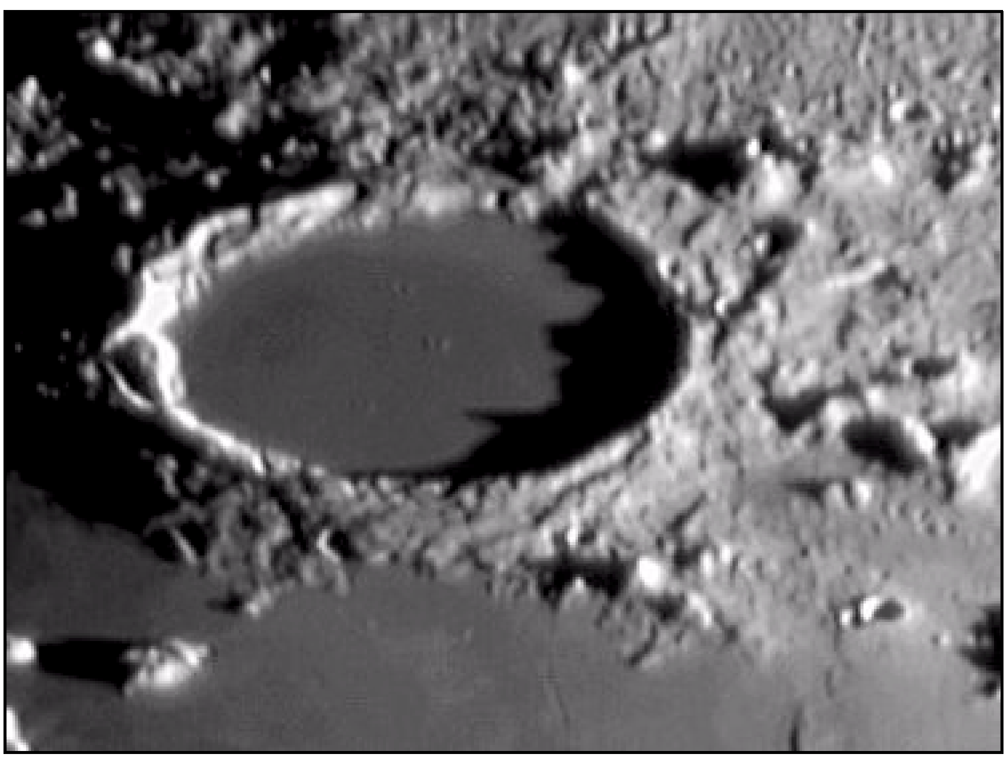


Figure 5. Image taken by C. Fattinnanzi on May 20, 2002, at 20:11 UT (H = 4.24°, A = 96.21°, C = 16.79°), with a Vesta Pro webcam fitted to a Newtonian, 200 mm f/6. Seeing III Antoniadi scale.

Figure 6. Image taken by M. Fazzo on May 20, 2002, at 20:09 UT (H = 4.23°, A = 96.19°, C = 16.78°), with a webcam Vesta Pro fitted to a Schmidt-Cassegrain, 275 mm f/10. Seeing III Antoniadi scale.

shadow. Figure 7 is one of many images contemporaneous with Figure 6, but obtained under better seeing conditions, that show no curvature.

Two excellent sequences were taken on May 20 with a CCD camera, and are presented here as figures 8 and 9. Most of the images in these sequences show no curvature, but in a few of the images a slight curvature is seen. The concavity was sometimes toward the south (Figure 8, image at 19:57:07) and sometimes toward the north (Figure 8, image at 19:57:41). Figure 9 shows one image per second. The shadow of the Gamma Peak can be seen to vary slightly in form from image to image. In particular, images with crisper detail show a straighter shadow.

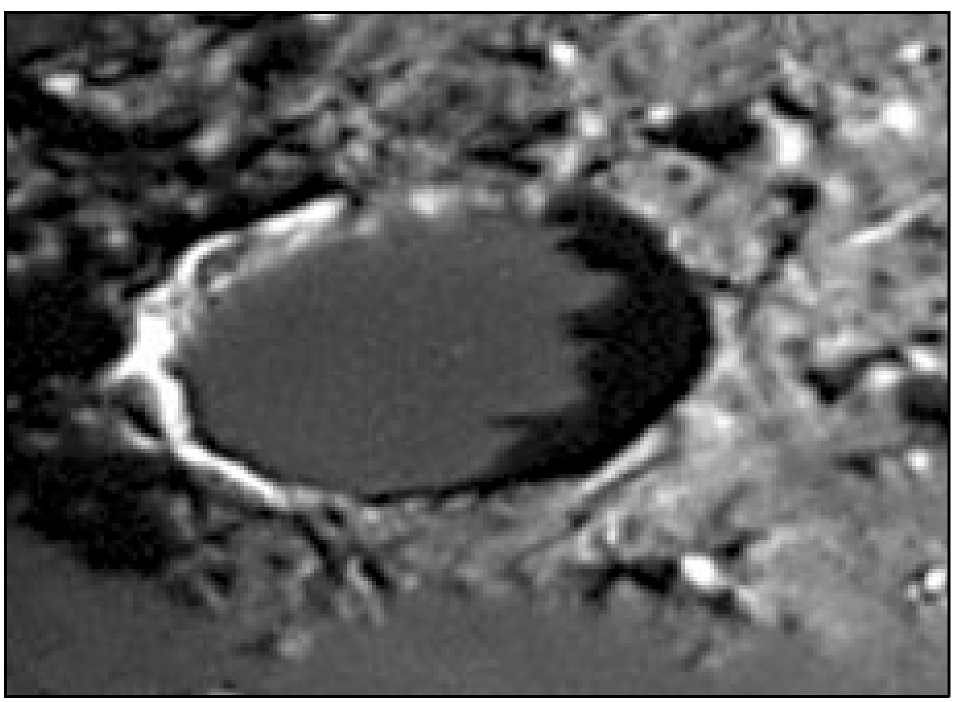


Figure 7. Image taken by A. Bares on May 20, 2002, at 20:09 UT (H = 4.23°, A = 96.19°, C = 16.78°), with an HX516 integrating CCD camera fitted to a Takahashi Mewlon, 250 mm f/12. Seeing II Antoniadi scale.

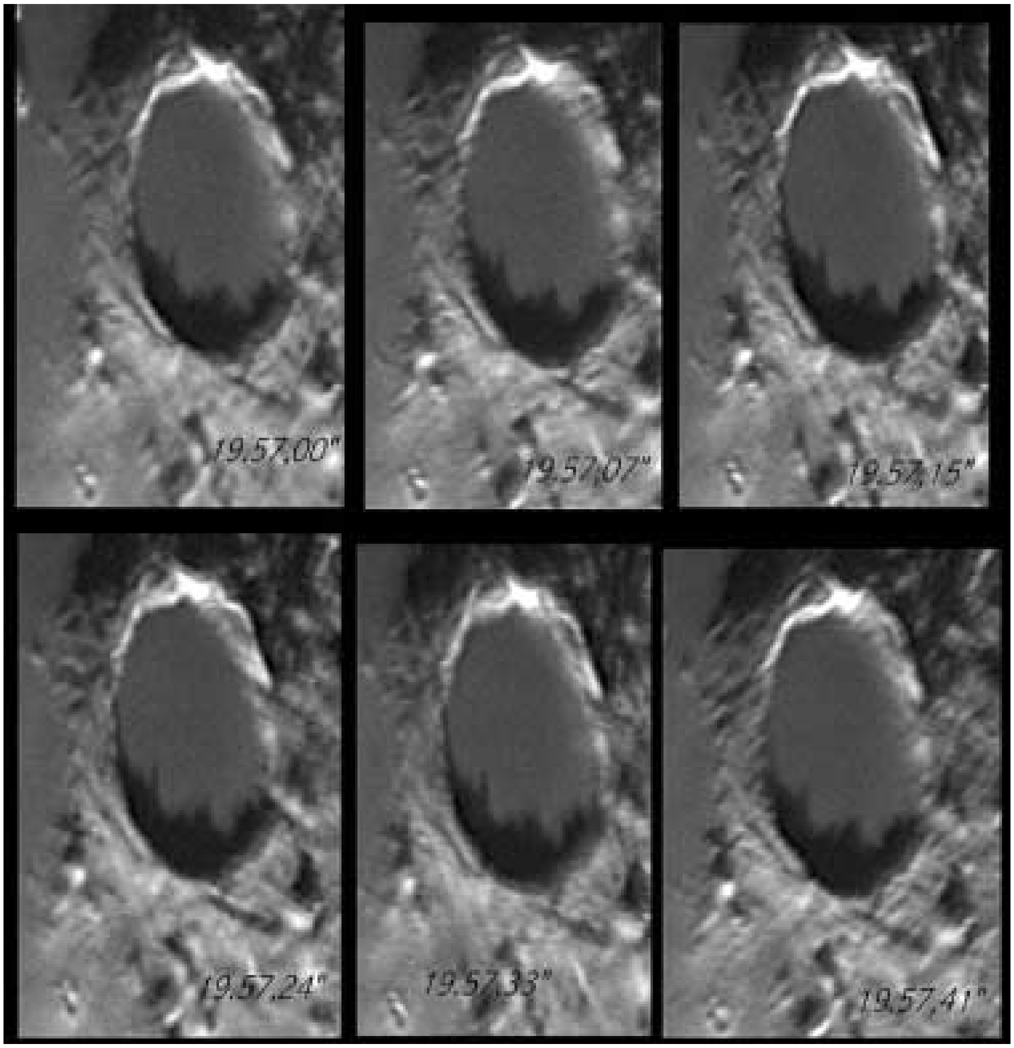


Figure 8. Images taken by A. Bares on May 20, 2002, at 19:57,00 to 19:57,41 UT (H = 4.17°, A = 96.12°, C = 16.68°), with an HX516 integrating CCD camera fitted to a Takahashi Mewlon, 250 mm f/12. Seeing II-IV Antoniadi scale.

Discussion

Observing Plato at the times when a curved appearance should have been detectable (Sorrentino, 2002), we were unable to demonstrate any curvature in the Gamma Peak's shadow. All our results confirm that any curvature detectable in our images lasts only small intervals of time and is related to seeing-induced defocusing and deformations. Because of these fluctuations, curvature in any of the images must be considered to be spurious.

This interpretation of the shadow's curvature should be applied to any images obtained at comparable H and A, such as the Gamma Peak's shadow's curvature seen in the fuzzy image included in the article by Braga and Ferri.

It is significant that visual observations carried out on the two dates by two observers (Table 1) confirmed that brief seeing-related curvature of the shadow as seen in the images does not produce the subjective visual impression of curvature. This suggests that there is no relation of the hook as seen by Wilkins and Moore to any curvature that shows up on images taken during moments of poor seeing. These two expert visual observers could have easily taken into account the effects of seeing during their observation, and would have reported this information in their drawings or comments. They recorded no such caveat. By implication, then, the shadow of the Gamma Peak is not the "hook."

Our results show that imaging techniques are more susceptible to the recording of seeing-related artifacts than is visual observing. This has broad implications for amateur astronomers in an age when imaging is considered to yield definitive data.

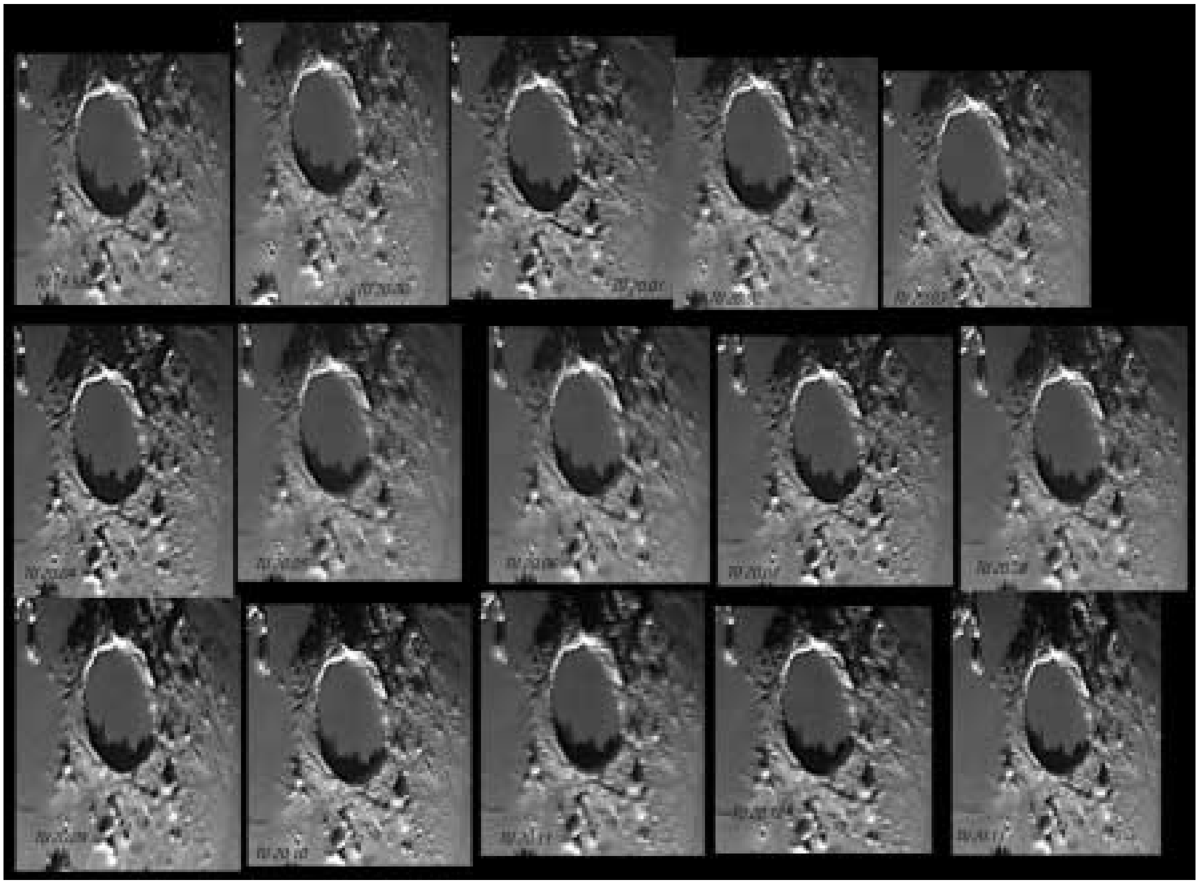


Figure 9. Images taken by A. Bares on May 20, 2002, at 19:58 to 20:13 UT (H = 4.17°-4.25°, A = 96.12°-96.22°, C = 16.68°-16.81°), with an HX516 integrating CCD camera fitted to a Takahashi Mewlon, 250 mm f/12. Seeing II-IV Antoniadi scale.

Acknowledgement

The authors are grateful to the 12 observers whose interest, cooperation, and skill made this study possible.

References

Braga R., Ferri F. (2002) "Plato's Hook: Still an Open Problem." *JALPO*, 44(1): 12-14.

Favero G., Lena R., Lottero F., Fiaschi M. (2001) "The Nature of the Hook-Like Shadow on Plato's Floor Observed by Wilkins and Moore in 1952 - Part II. Simulations with a computer and a plasticine model." *JALPO*, 43(3): 24-29.

Favero G., Lena R., Mengoli G., Cipolat A., Gualdoni P. (2000) "The Nature of the Hook-Like Shadow Observed by Wilkins and Moore on Plato's floor in 1952." *JALPO*, 42(3): 126-132.

Sorrentino G. (2002) "L'uncino di Plato." Coelum, 50: 24-25.

So, What do YOU Think?

Have you seen "Plato's Hook"? If so, do you agree with any of the views expressed on these pages over the past year or so? Or do you have your own theory?

Please let us know. We welcome your comments and will publish thoughtful and appropriate material on this subject here.

ALPO Feature: Mars

The Opposition Cycle of Mars

By Jeffrey D. Beish, assistant coordinator, ALPO Mars Section

(Editor's Note: A full-length paper by Jeff Beish on the Mars apparition described here will be published in the next Joural of the ALPO.)

Abstract

Mars will approach closer to Earth during the next apparition than at any other time in over 57,000 years! A prelude to the 2003 pre-apparition report this article will discuss the historical significance of the next perihelic apparition of Mars as it relates to apparent size and relationship of the orbit of Mars and Earth.

Introduction

There is a rule of thumb we use to determine when Mars is at certain cardinal point in its orbit relative to the orbit of Earth. When Mars is in ***conjunction***, the Sun is between Mars and Earth. Therefore, Mars will not be visible in the morning sky until approximately 54 days later. From the time it becomes visible, it takes nearly 300 more days to begin retrogression, or begin retrograde motion, against the background stars. In other words, Mars appears to be backing up toward the west during retrogression for a brief period during an apparition.

Opposition, or when the Mars is on the opposite side of the Earth from the Sun, will occur 390 days after conjunction. At opposition, the Earth and Mars will be nearly in a straight line from the Sun and shortly after that, in about 37 days, retrogression will end. Also near the time of opposition, both planets will become closest to each other at some point that is not necessarily coincident with opposition time and varies as much as a week or two.

Mars will be visible for another 300 days after opposition and will hide in the glare of the Sun once again as it will then again reach conjunction. The cycle is complete in 780 Earth days.

Here is another general rule for predicting oppositions of Mars; Mars has average 15.8-year seasonal opposition cycle, which consists of three or four ***aphelic*** oppositions and three consecutive ***perihelic*** oppositions [Capen, 1984, Capen, 1984]. We sometimes refer to this as the seven Martian ***synodic periods***. This cycle repeats after every 79 years, with an error of several days (4 to 5 days), and if one lives long enough, he or she may see this cycle nearly replicate in 284 years (See table).

Notice in the last paragraph the wording "nearly replicate in 284 years." If one is mathematically inclined, he or she may very well find that these cycles vary slightly from one complete opposition cycle to the other. We have found that over very long periods of time, Mars will vary its distance at closest approach to Earth by a fair amount. Therefore, we should have a brief discussion on how close Mars comes to Earth.

A Truly Closest Approach

During a conversation with syndicated television personality and astronomer Jack Horkheimer, he asked the ALPO Mars Section to compute the date when Mars last came as close to Earth as it is predicted to approach Earth during the 2003 perihelic apparition [Horkheimer, 2001]. He posed an interesting question and one with an answer not readily available. Since our computer programs are written to calculate the physical ephemerides of Mars for more or less "current" observers, there was no practical reason to compute the orbits and other aspects of Earth and Mars for more than a hundred years or so.

Table of Past, Current Future Apparitions of Mars;
(apparent diameter over 25 seconds of arc)

Date	Years Since /Until	Size (seconds of arc)	Distance from Earth		
			A.U.	Miles	Kilometers
Aug 25,1719	-284	25.03	0.37401	34,770,446	55,951,099
Aug 13,1766	-237	25.08	0.37326	34,700,721	55,838,901
Aug 18,1845	-158	25.09	0.37302	34,678,409	55,802,997
Aug 22,1924	-79	25.10	0.37284	34,661,675	55,776,070
Aug 27,2003	0	25.11	0.37271	34,649,589	55,756,622
Aug 30, 2082	79	25.06	0.37356	34,724,502	55,883,780
Aug 19, 2129	126	25.08	0.37327	34,697,545	55,840,397
Aug 24, 2208	205	25.11	0.37278	34,651,996	55,767,094
Aug 28, 2287	284	25.15	0.37224	34,601,800	55,686,311

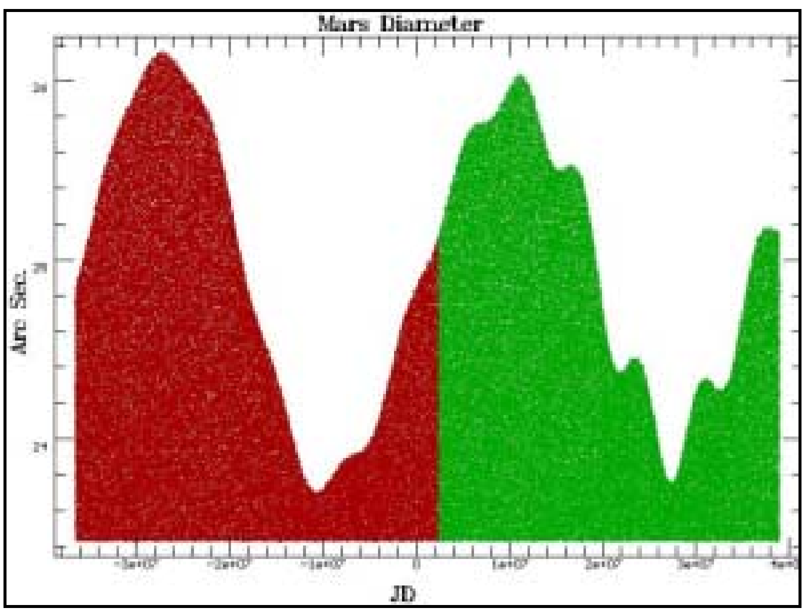
Using this author's 450-MHz PC, several computer runs were made and it soon became clear that this problem was too much for a home computer to solve in a timely manner. So, we enlisted the aid of Mr. James DeYoung, an employee of the U.S. Naval Observatory Time Service and a former coworker of this author, for his expert help to answer this most intriguing question. The problem was posed to Mr. DeYoung: when was Mars as close or closer to Earth as it will be during the 2003 apparition? At that time, Mars will be at a distance of 0.37271 A.U. or 34,649,589 miles (55,756,622 km) from Earth at closest approach. [Note: one (1) A.U. equals 92,955,621 miles or 149,597,870 km]. Also, Mars will subtend an apparent diameter of 25.11 seconds of arc.

Jim is a mathematician and computer specialist by trade and is interested in astronomical calculations. This was just the problem for Jim to help us solve. He prepared a computer program using the integration method used was the Burlirsch-Stoer method to calculate the orbits of and perturbations of all nine-planets. This included the major perturbations and effects of the Moon and the four major asteroids to plot the results. During Jim's off duty hours, he ran the program constantly until a plot of each time Mars was near opposition at the closest approach to Earth. We arbitrarily chose a limit of +/- 100,000 years starting with this author's last birthday on October 17, 2001 (JD 2452200.5).

Amazingly, we found that Mars will be closer during the 2003 apparition than at any other time since the year -57,537! At that time, Mars was 0.372631 AU (apparent diameter of 25.14 seconds of arc). Note that the slight difference from the 25.11 in 2003 is due to circumstances of the dates for opposition and closest approaches.

Additional results were gleaned from this experiment, and we include some interesting points: First, during the year -79,241 Mars and Earth were only 0.358104 AU apart and Mars subtended an apparent diameter of 26.16 seconds of arc! The next highest maximum in this series will be during the year +25,695 when Mars will come within 0.359818 AU from Earth (will subtend an apparent diameter of 26.04 arc sec). So, scientific publicists will meet the 2003 apparition of Mars with great excitement – and also a host of amateur astronomers.

It should be noted that these values are Earth-Moon barycenter to Mars distances where slightly different values can result from using the methods used for predicting the Solar System Ephemerides in the short run — say 100 years or so. A plot established several interesting points when Mars was as close to or closer to Earth than it will be during 2003. The integration output was printed with @1d steps to maintain the 1x10-15 accuracy. The integration should have maintained 5 to 6 digits of precision over this number of steps, mostly round off error accumulation and a smaller amount from truncation errors (See figure on this page).



A plot from numerical integration for the orbits of Earth and Mars during the points of closest approach for a period of +/- 100,000 years from JD 2452200.5. Left, or the red points, indicate pre-2001 and right, or green points, are after 2001. The abscissa ordinate axis indicates the Julian day in millions of days and the ordinate axes shows the apparent diameter of Mars as seen from Earth during a particular closest approach.

Discussion

While it is of interest to observers to know how close Mars will approach Earth during any particular apparition, we pay little attention to exact details of the apparition characteristics. To many it would be only of passing interest to know that Mars will reach some historic distance from Earth or be higher in the sky, etc. But to relate to orbital elements is not very exciting to most Mars watchers. In other words, most of us like to just look at Mars without all the mathematical fuss.

At those times when Mars approaches very close to the Earth, we know observers will likely want to get out their telescopes and record what they see of the Red Planet, and we in the ALPO Mars Section are more than happy to encourage them to do so. One way is to make the upcoming apparition sound exciting and to interest observers to participate in our observing programs.

However, in 2003 Mars will come closer to Earth than at any other time since we can remember, or at least for anyone alive today. While we usually do not take the time to compute the orbit of Mars so far in the past or future it was nevertheless a fun project for our friend Jack Horkheimer and his TV audience. However, it also show us the unusual nature of the orbital relationship of Mars and Earth and hopefully to help us realize how erratic our Solar System really is. The Solar System is always in a state of change!

References

Capen, C.F., “A Guide to Observing Mars - I”, JALPO, Vol. 30, Nos. 7-8, April 1984, pp. 172 -176.

Capen, C.F., “A Guide to Observing Mars - II”, JALPO, Vol 30, Nos. 9-10, August 1984, pp. 186-190.

Horkheimer, Jack, “Star Gazer Celebrates its 25th Anniversary! The Leonid Meteor Shower May Turn Into A Meteor Storm And An Announcement About Mars You Won't Believe!” STAR GAZER Episode # 01-45, 1,248th Show, Aired: Monday, November 5, 2001 through Sunday, November 11, 2001

ALPO Feature: Jupiter

An Observational History of Jupiter's Changing Red Spot

By Phillip W. Budine
Jupiter Section

Abbreviations Used in this Paper

RS = Red Spot
STB = South Temperate Belt
SEB = South Equatorial Belt
STrD = South Tropical Disturbance
RSH = Red Spot Hollow
STrZ = South Tropical Zone
STB = South Temperate Belt
In tables 2, 3 and 4, the "Intensity" scale is 0 (satellite shadows) to 10 (most brilliant features).
Also, "Rotation" is given in minutes, hours and seconds.

Abstract

Jupiter's Great Red Spot has changed in appearance, color, size, intensity and rotation period over many years. This paper deals with the changing Great Red Spot from 1951 to 2002, and is based upon the personal research and observations by this writer whose visual observations were made with a variety of telescopes over this 51-year period. A summary and emphasis are placed on the following periods of observations:

- The LONG Red Spot years
- The **dark** Red Spot years
- The "changing" Red Spot years
- The faint Red Spot years

This paper will also include the various aspects that the Great Red Spot has presented over the many years. Also, covered will be the interaction the Red Spot has had with other Jovian features such as the STB White Ovals, the South Tropical Zone disturbances, the South Tropical Zone Streaks, and the South Equatorial Belt Disturbances.

Introduction

Back in 1948, I first started observing Jupiter with a 1.6-inch Unitron refractor and a 2.4 inch Bushnell refractor. By the 1951-52 and 1952-53 apparitions, I had employed a 3.5-inch SkyScope reflector, a 3-inch Unitron refractor and a 4-inch Unitron refractor. During the 1960's, I was observing with a 10-inch Cave reflector, the 4-inch Unitron and a 3.5-inch Questar. By the 1990's, I was observing with a 6-inch Meade APO refractor. Now in the 2000 era, I have primarily used a 4-inch Celestron refractor, a 5-inch Meade APO refractor and a 5-inch Maksutov-Cassegrain catadioptric reflector. All together, I have owned and employed 20 telescopes over the period 1948-2002.

I still use six telescopes, including my 4-inch Unitron. I have studied the Great Red Spot during the period 1952-2002 — a period of 50 years. Therefore, it is my 50th anniversary of observing Jupiter's Great Red Spot! It is also the 50th anniversary with my 4-inch Unitron refractor. And next year will be my 50th anniversary with the ALPO!

Observations of the Great Red Spot include notes, disc drawings, strip or sectional sketches, color estimates, intensity estimates, longitudinal length measurements, Red Spot type classifications and transit observations providing rotation periods.

This report is based primarily upon my own observations with my own telescopes. In some cases, I have used observations by other experienced Jupiter observers to compare or confirm some observational periods. I have taken the observations, data, statistics and drawings and have classified the reports by observing periods as follows

- Long Red Spot - Early Years
- Red Spot Hollow

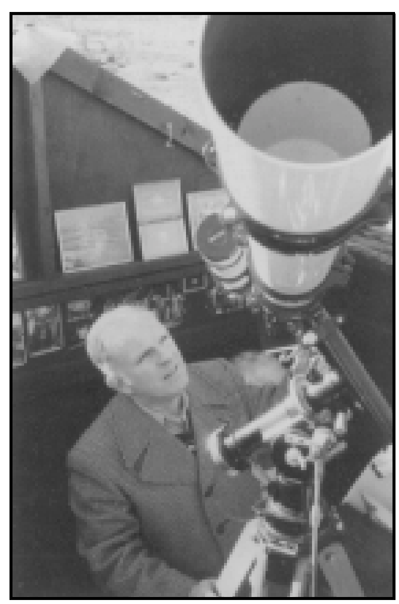


Figure 1: Photo of the author with his "vintage" 1952 4-inch Unitron refractor in "tip-off roof" observatory.

- Dark Red Spot
- Faint Red Spot

In each period I have indicated the years, prominent color (s) of the Great Red Spot, intensity, mean length, classification type and mean rotation period for the Great Red Spot. Notes concerning aspects, comments and interactions of Jupiter's Great Red Spot then follow. I have tried to include interesting comments where appropriate.

In the following tables, the classification type for the Great Red Spot for each period is also included. The table below lists the classification number for each Great Red Spot::

Table 1: Aspects (Types) of Great Red Spot

Aspect (Type)	Description
1	Red Spot Hollow
2	Red Spot Hollow with Red Spot
3	Dusky Red Spot
4	Red spot with border, pointed ends, tails and/or spots
5	Dusky Red Spot with dark border
6	Faint Red Spot
7	Dark Red Spot; sometimes with dark spots at ends and tails
8	Very dark Red Spot

Long Red Spot - The Early Years:

The early Red Spot became very prominent from 1878 - 1882 and again from 1886- l910. Very dark and long in 1878-79, when its rotation period lengthened. Peek had 9:55:38, when the period shortened in 1909-10. The length in 1878-79 was 38-43 degrees, and by 1936,the period was 9:55:39. The Red Spot was accelerated rapidly from 9:55:39 to 9:55:41 in 1936. It was usually darkest when shortest in length. The mean length in 1879-1882 was 34 degrees. In 1927-28, it had a length of 30 degrees. In 1935-36, its length was 26 degrees. In 1942-43, the length was 21 degrees, which is closer to more recent estimates.

As for color, during the period April 9, 1886 - June 18, 1910, the color of the Red Spot was often called “blood red” or “brick red.” When the Red Spot was darkest, the South Equatorial Belt (SEB) was faintest. The Red Spot was very dark before SEB eruptions. Up to 1937, periods between eruptions were nine years, and after this, three years.

The SEB was dark and wide prior to 1919. The first recorded SEB Disturbance was in 1919 and the South Tropical Disturbance (STrD) of 1901-40 interacted with the Red Spot from 1902-1920. The Red Spot was near conjunction with the STrD from 1909-10 and 1919-20.

The first STrD was observed on February 28, 1901 with a rotation period of 9:55:20. The STrD in 1901 took the following periods of time to transit the Red Spot: 6 weeks, 3 months, and a few days.

The periods for following years were: 1904 - instant (where the STrD passed over/around the Red Spot either instantly or in less than a day), 1906 - 14 days, 1907 - 12 days and in 1914 - 6 weeks. The maximum length of the STrD was 230 degrees.

Table 2: Red Spot Hollow

Time Period	Color	Intensity	Length (degrees)	RS Type	Rotation Period
1952-54	Y-W	5.2	23	1	9:55:43
1955-60	Or-W	5.5	29	1&2	9:55:41
1984-85	Or-YW	4.2	19	1	9:55:39
1993-94	Y-W	5.2	19	1 & 2	9:55:40

1952-54 — Red Spot Hollow (RSH) is prominent.

1955-60 — RSH is still prominent.

1984 — South Temperate Belt (STB) Fade from BC to DE. Following Oval DE a South Tropical Disturbance (STrD) was emerging from the p-end of the dusky Red Spot and Red Spot Hollow (RSH). DE passing RS may have created it. Following end of STrD seen in August, 1984. RS length is 24 degrees. STB Fade is past RS by July 31, 1984. STrD disappeared in September, 1984. STrD was not seen preceding the Red Spot.

1985 — FA is preceding the RS. From FA to RS a South Tropical Belt (STrB) is formed. South Tropical Dislocation (STrDis) No. 4 begins. By September 12, 1985 a dark STrD is preceding the RS area.

1993-94 — RSH is prominent

Table 3: Dark Red Spot

Time Period	Color	Intensity	Length (degrees)	RS Type	Rotation Period
1954-58	R-Or	3.9	26	7	9:55:40
1960-63	Or	3.2	24	8	9:55:41
1964-75	R-Or, R	3.3	22	8 & 4	9:55:42
1975-76	Or-R	5.2	24	5	9:55:43
1981-83	Or	4.5	22	3	9:55:40
1989-90	Or	4.8	20	7	9:55:41
1992-93	Or	4.5	20	7	9:55:42
1995-96	Or	4.6	19	7 & 2	9:55:41

1956 — Red spot is dark “blood red" in April, 1956. The SEB is observed crossing RS.

1960 — Early March, RS is prominent and dark. March 19, 1960 interior is shaded and structured.

196l — RS is darkest in a century. Dark spots bordering RS. RS is accelerated -4 degrees in longitude from 25 degrees to 21 degrees (II). Mean length is 22 degrees to 25 degrees. RS observed oscillating in longitude in a period of 90 days. Dark streaks developing from RS preceding end moving at -1.3 degrees per day south across STrZ formed belt on N. edge STB.

1962-63 — RS has dark pointed ends. After SEB eruption and full development of the 1962-63 South Equatorial Belt Disturbance, RS expected to change to the "hollow" aspect. It does not occur! Usually very red. Contrast striking against STrZ. Retrograding SEBs dark spots reached the RS by October, 1962. Red Spot not affected by the dark spots rounding the RS. RSH did not form afterwards. Thin dark belt in RS. Deceleration of RS from August to October, 1962. From 9:55:41 to 9:55:45 after October 7, 1962. RS period later from 9:55:44 - 9:55:41.

1964 — Oval DE is in conjunction with Red Spot on January 23, 1964. RS color is from orange to pink. RS belt (SEBs) observed. RS period is 9:55:41.

1964-65 — RS is still dark since 1960! SEB Disturbance is weak.

1965-66 — Dark spots moving around RS in 9 days. Observed from November 24, 1965 - January 6, 1966. Also, from January 7 at the following end of the RS until January 11 when the spots were at the preceding end of the RS. Walter Haas recorded a dark spot near south preceding end of the RS on January 11, 1966. Spots were recorded until January 25, 1966.

1966-67 — RS color is pink in early 1966. A rose color by mid-1966. An orange by the end of the period. Called the "pink fish" by Elmer J. Reese during the early part of the apparition. Red Spot is long and narrow with dark pointed ends. Streaks are in the interior. From mid-April to early May a "dark streak" was observed in the STrZ.

1967-68 — Red Spot has a dark border. RS is observed oscillating in longitude.

1968-69 — RS is still oscillating.

1969-70 — RS is dark. RS was decelerated on December 23, 1970. It was involved with the South Tropical Disturbance (STrD) of 1969. Preceding end of the STrD reached the following end of the RS on December 23, 1970. Rotation period of the RS was increased by 3.2 seconds. STrD had the following periods: Preceding end: 9:55:24 and following end: 9:55:32.

Table 3: Dark Red Spot (table repeated, text continued)

Time Period	Color	Intensity	Length (degrees)	RS Type	Rotation Period
1954-58	R-Or	3.9	26	7	9:55:40
1960-63	Or	3.2	24	8	9:55:41
1964-75	R-Or, R	3.3	22	8 & 4	9:55:42
1975-76	Or-R	5.2	24	5	9:55:43
1981-83	Or	4.5	22	3	9:55:40
1989-90	Or	4.8	20	7	9:55:41
1992-93	Or	4.5	20	7	9:55:42
1995-96	Or	4.6	19	7 & 2	9:55:41

1971 — Red Spot is sti11 dark. RS did not fade after the 1971 South Equatorial Belt Disturbances. The first disturbance began on June 21, 1971. The second disturbance started on July 18, 1971. The first retrograding SEBs dark spots reached the Red Spot preceding end around August 24, 1971. Most SEB Disturbances since 1958 have followed the 3 year period between events. The RS was again oscillating in 90 days. The mean length of the RS was 24 degrees.

1972 — Red Spot is still dark after 10 years.

1973 — RS still dark; no sign of fading.; even after 1971 SEB Disturbances.

1973-74 — RS still prominent after 11 apparitions! Mean length of RS is 22 degrees. Red Spot has a rotation period of 9:55:41. RS is accelerated -3 degrees when DE passes it from May 6-20, 1973. DE was in conjunction with the RS on May 6, 1973. FA was in conjunction on February 2, 1974.

1974-75 — Red Spot is still quite dark.

1975 — Retrograding SEBs dark spots from the 1975 SEB Disturbance meet the RS in two groups in the early part of September and the middle of September, 1975. By October 12, 1975 they are very close to the Red Spot. The RS started to fade by mid-September. SEBs belt was observed crossing the Red Spot. STB Fade passed the RS. STrZ Dislocation (STrDis) #1 begins. 1975-76: Red Spot is dark and prominent early in the apparition. A blood red color at times. By December 5, 1975 the RS has faded. By January 15, 1976 RSH was developing and becoming prominent.

1982 — FA passed the Red Spot. STrZDis # 3 is formed. A South Tropical Belt (STrB) appears between FA and the RS. 1983: BC is passing the Red Spot.

1986-87 — Red Spot is orange. FA is in conjunction with the RS on October 11, 1986. Rotation period of RS is 9:55:41.

1987-88 — Red Spot is dark in southern portion in December, 1987. STB Oval BC is in conjunction with RS on January 6, 1988. FA in conjunction with RS on February 16, 1988. RS is fainter.

1989-90 — There were no conjunctions of the STB Ovals with the Red Spot this apparition. STB Fade seen from FA to BC. RS length is 20 degrees. South Equatorial Belt began to fade in May, 1989. Retrograding motion of the RS from November, 1988 to July, 1989. Increasing in longitude. The white spot activity usually following the RS became inactive. The SEB white spot activity had been continually observed for 10 years!

1992-93 — STB Ovals BC and DE were very difficult to observe in the STB Fade. Dark STB segment following FA. Some observers called it the "False Red Spot". BC was in conjunction with the RS on November 29, 1992. DE was in conjunction with the RS on January 10, 1993. The passing and conjunctions of the STB Ovals with the Red Spot are probably the greatest factors as the causes of the events relating to the STB Fade, the STrDis and the STrD which have developed since 1975. RS is rotating at 9:55:42. RS rotation period slows to 9:55:43. RS length is 20 degrees. I predicted the 1993 South Equatorial Belt Disturbance would erupt in the early months of 1993. It erupted April 6- 7,1993 (Schmude). Similar to the 1958 event. RS was R-Or in color. I observed SEBs retrograding spots passing the RS on May 8, 1993. By May 17, 1993 the RS had faded considerably. The 1993 SEB Disturbance was a "classical" type. The Bright Streak SEB Disturbances of 1985 and 1986 were intermediate types and lacked the dark SEBZ spots and retrograding SEBs dark spots! The Red Spot decelerated in a (+) direction from October 31, 1992 - July 7, 1993; a total of 9 degrees. RS had a rotation period of 9:55:42. STB Oval FA was in conjunction with the RS on July 24,1993.

Table 4: Faint Red Spot

Time Period	Color	Intensity	Length (degrees)	RS Type	Rotation Period
1954-55	Tan	4.3	22	3	9:55:44
1974-83	R-Or	4.9	19	6 & 4	9:55:42
1986-88	Or-Pink	4.0	25	6	9:55:42
1988-89	Or	4.8	22	5	9:55:41
1990-92	Or	5.0	20	5	9:55:41
1996-97	R-Or	4.5	21	6	9:55:40
1997-98	Or	5.0	17	6	9:55:41
1998-99	Or	4.8	20	6	9:55:41
1999-00	R-Or	5.2	16	5	9:55:41
2000-01	Or	5.0	18	5	9:55:41
2001-02	Or	5.2	19	5	9:55:41

1976-77 — Red spot has faded.

1977-78 — The RS has returned to predisturbance era; until 1990 when it faded and and disappeared prior to the 1990 SEB Disturbance. Later in 1978 Red Spot seen in southern part of RSH. Dark border around RS.

1978-79 — STB Fade passes STrDis #*2.* STrD develops. Events persisted to 1981.

1986-87 — Red spot is orange. FA is in conjunction with RS on October 11, 1986. RS has a rotation period of 9:55:41. FA passing the RS induced a STrB. South Tropical Belt extended from DE to BC. STrDis #5 is started. Rotation period of RS is 9:55:40.

1987-88 — Red Spot is darker in southern portion in December, 1987. Oval BC is in conjunction with Red Spot on January 6,1988. STB Oval FA is in conjunction with RS on February 16, 1988. Red Spot is faint. STB Fade is present from FA to BC. STrDis #6 has begun.

1988-89 — Red Spot moved in System II from 17 degrees to 21 degrees (+4) in November, 1988. DE is preceding on July 2, 1988. STB Oval FA is in conjunction with the RS on March 13, 1989. RS length is 23 degrees. Late in the apparition it becomes 27 degrees. RS is decelerating from November 12 - 14, 1988 (+4 degrees).

1990-91 — Red Spot is fainter. RS moved in decreasing (-) longitude. BC and DE are difficult in the STB Fade. DE passes RS on October 28, 1990. By May, 1991 the RS is rounder with belts across its interior. FA passes the RS on June 30, 1991. STrDis #8 has begun. STrB has a length of 240 degrees. Tail is observed at the following end of the RS. Red Spot is dusky.

1996-97 — Red Spot has a dark border Color is usually R-Or. DE is in conjunction with RS on September 14, 1997.

1998-99 — STB Ovals BC and DE merge into one; they become BE around May 7, 1998. Mid-SEB Disturbance erupts on May 7, 1998. Red Spot is “short” – 16 degrees in length. RS is usually orange. RS faded and sometimes recorded tan.

2000 — BE and FA merge into one to become BA near March 1, 2000.

2000-01 — Red Spot is visible in southern part of RSH on July 18, 2000. Also, STrB is developing from the RS preceding end on the same date.

2001-02 — STrBelt is gone. STBn appears. Red Spot is increasing in longitude. Looking for possible future fading of the South Equatorial Belt.

2002 — STB Oval BA is in conjunction with the Red Spot around February 27, 2002. BA loses its border when in conjunction with the RS. Sometimes BA is seen overlapping the southern Red Spot; at other times it has no contact with the southern edge of the Red Spot.

Conclusion

Over the past 50 years, it has been a "joy" to observe Jupiter's Great Red Spot and its behavior and different aspects. If you were to ask me what period was the most interesting and exciting for observing the Red Spot, I would have to answer the 1960's and early 70's. During those years, the Red Spot was very dark and yet later went through changes as it had interactions with other phenomena in the 70's. In any case, each observer should keep "looking up" at Jupiter's Red Spot, because one thing is for sure, the Great Red Spot will "change" again!!

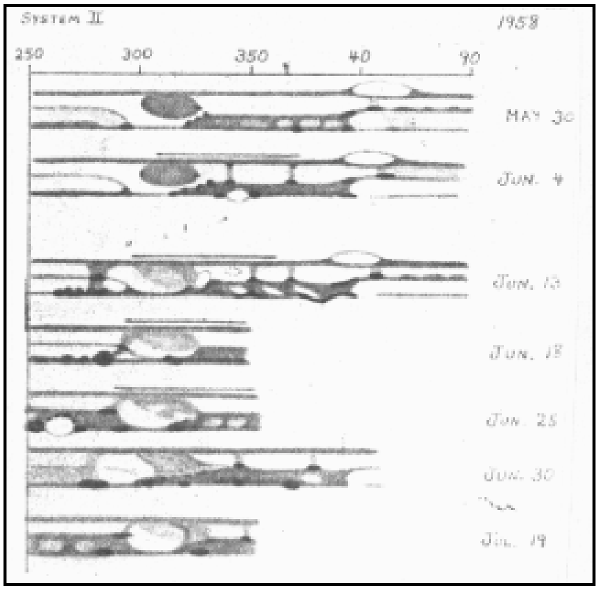


Figure 2: Strip sketches by Elmer J. Reese, May 30 - July 19, 1958. South Equatorial Belt Disturbance illustrating the Dark Red Spot, developing SEB Disturbance and the changing Red Spot. Note that retrograding dark spots in SEB have reached the leading end of the RS by June 13-18. Note also change of the RSH aspect. Also shown is STeZ oval DE. RS began as Type 7, ended as Type 2. CM2 = 250 – 90 degrees. Equipment = 6-inch reflector; other data not provided. Image quality limited to condition of hard copy scanned for this publication.

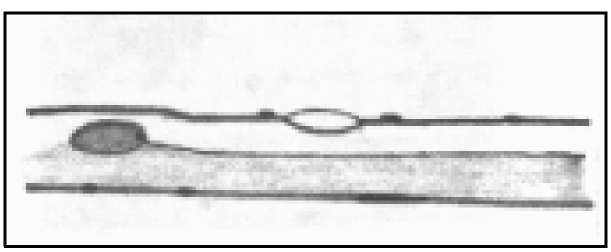


Figure 3: Sketch by author, July 8, 1962. Note Dark Red Spot with dark spot and tail at trailing end; also shown is BC. RS = Type 7. CM2 = 50 degrees. Equipment = 4-inch Unitron refractor. Other data not provided. Image quality limited to condition of hard copy scanned for this publication.

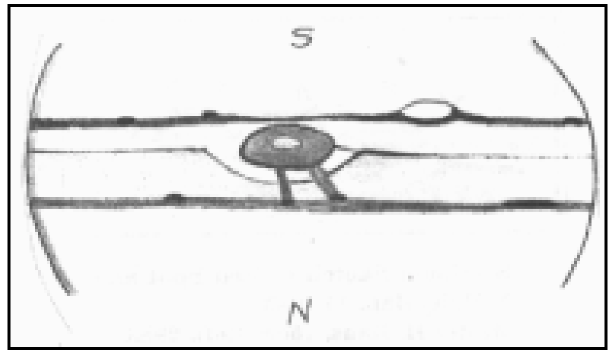


Figure 4: Sketch by author, October 20, 1962. Note Dark Red Spot with bright interior spot; tail at trailing end of RS; also shown is STeZ Oval FA. RS = Type 8. CM2 = 25 degrees. Equipment = 4-inch Unitron refractor. Other data not provided. Image quality limited to condition of hard copy scanned for this publication.

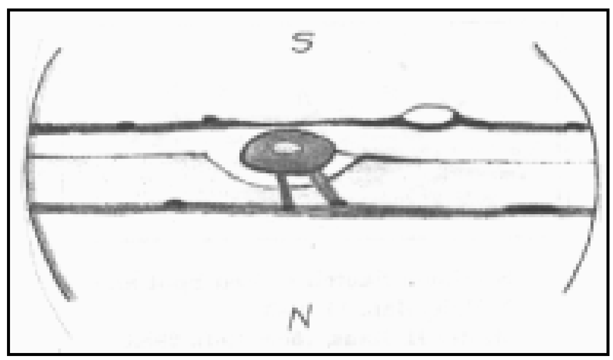


Figure 5: Sketch by author, February 27, 1967. Note RS interior spots and dark spots on RS border; also visible are STrB as well as fine detail of the SEB; also shown is STeZ Oval DE. RS = Type 2. CM2 = 329 - 22 degrees. Equipment = 10-inch Cave reflector. Other data not provided. Image quality limited to condition of hard copy scanned for this publication.

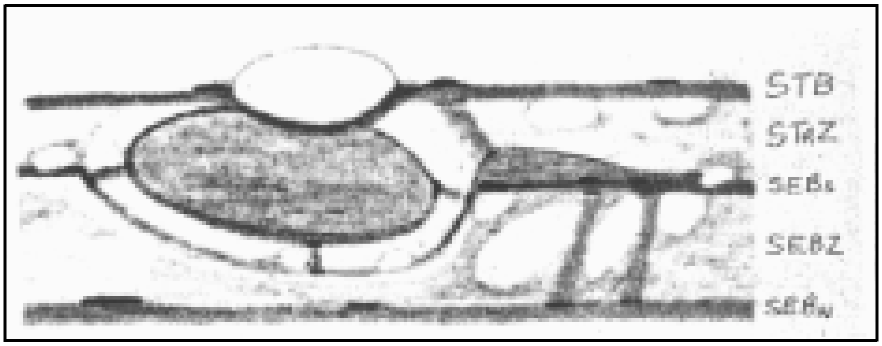
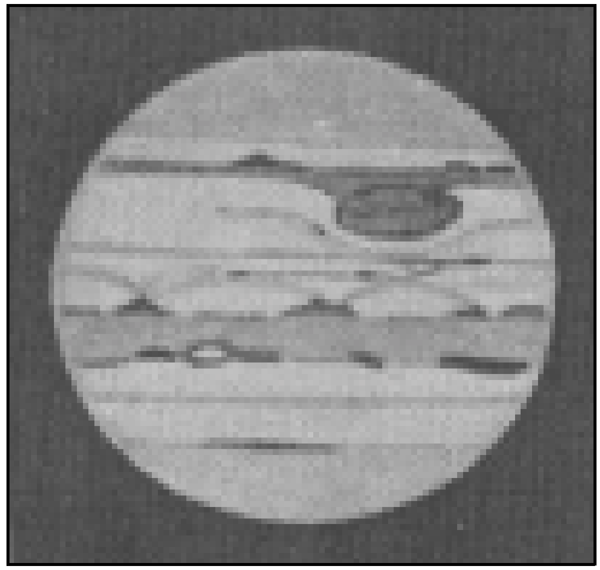


Figure 6: Sketch by author, April 7, 1968. Dark RS in conjunction with FA; also note tilt of RS. RS = Type 8. CM2 = 24 degrees. Equipment = 10-inch Cave reflector. Other data not provided. Image quality limited to condition of hard copy scanned for this publication.

Figure 7: Sketch by author, June 29, 1970. Note Dark RS with interior detail. RS = Type 8. CM2 = 8 degrees. Equipment = 4-inch Unitron refractor. Other data not provided. Image quality limited to condition of hard copy scanned for this publication.



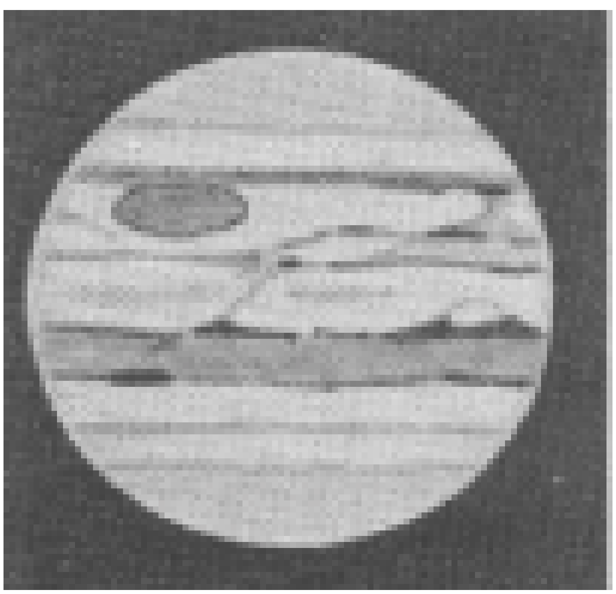


Figure 8: Sketch by author, August 26, 1970. Note Dark RS; leading end of STrD is near following limb. RS = Type 8. CM1 = 350 degrees, CM2 = 44 degrees. Equipment = 4-inch Unitron refractor. Other data not provided. Image quality limited to condition of hard copy scanned for this publication.

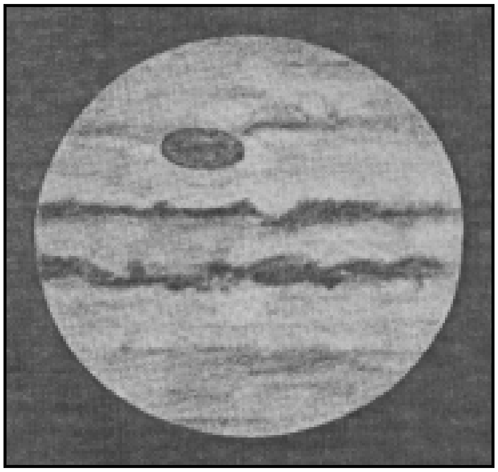
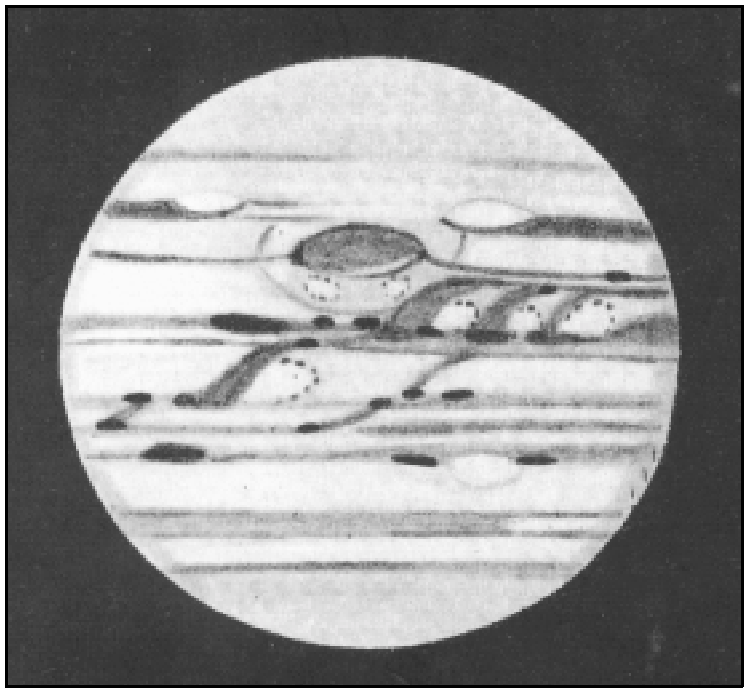


Figure 9: Sketch by Ron E. Doel, July 12, 1973. Note Dark RS; RS = Type 8. CM1 = 65 degrees, CM2 = 18 degrees. Note interior structure. Equipment = 8-inch reflector. Other data not provided. Image quality limited to condition of hard copy scanned for this publication.

Figure 10: Sketch by author, September 14, 1975. Note Dark RS; narrow with pointed ends, dark spots and tails. Early development of SEB Disturbance; also shown are STB Ovals BC and DE. RS = Type 4. CM1 = 25 degrees, CM2 = 41 degrees. Equipment = 4-inch Unitron refractor. Other data not provided. Image quality limited to condition of hard copy scanned for this publication.



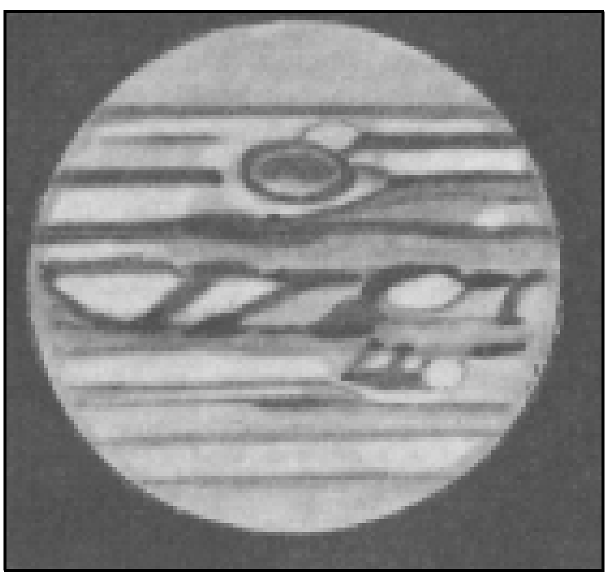


Figure 11: Sketch by author, October 23, 1975. Note RS with internal detail; RS has a darker border and a following tail; Oval DE is nearing conjunction with the RS. RS = Type 5. CM1 = 325 degrees, CM2 = 43 degrees. Equipment = 4-inch Unitron refractor. Other data not provided. Image quality limited to condition of hard copy scanned for this publication.

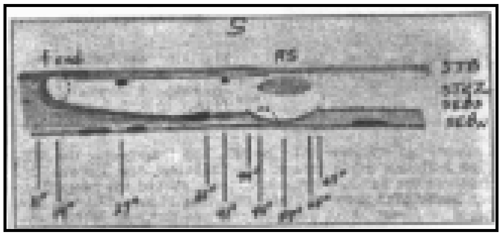


Figure 12: Sketch by author, December 31, 1979. Note how dusky STrD following end precedes the RS. RS = Type 6. CM2 = 067 degrees. Equipment = 4-inch Unitron refractor. Other data not provided. Image quality limited to condition of hard copy scanned for this publication.

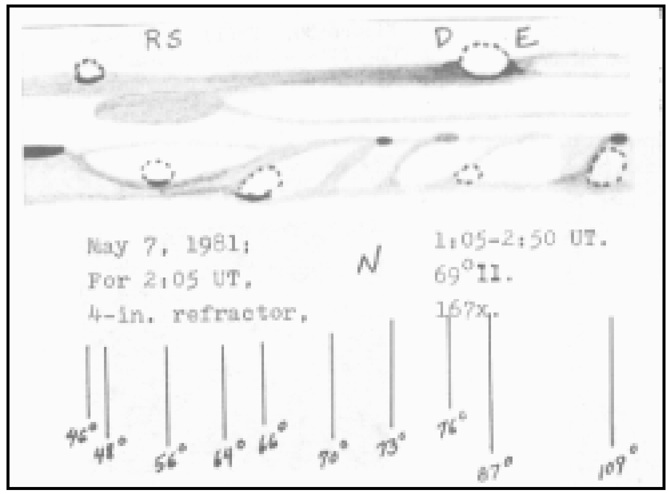


Figure 13: Sketch by author, May 7, 1981. Note narrow dusky RS with trailing tail; also shown are SEB detail and Oval DE. RS = Type 6. CM2 = 46 - 109 degrees. Equipment = 4-inch Unitron refractor. Other data not provided. Image quality limited to condition of hard copy scanned for this publication.

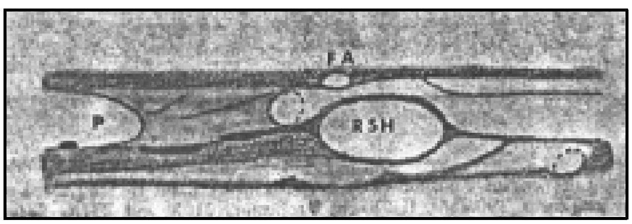


Figure 14: Sketch by author, July 24, 1984. Note RSH, STrD with leading and trailing ends shown preceding the RSH; STB Oval FA has just passed conjunction with the RSH. RS = Type 1. CM2 = 35 degrees. Equipment = 4-inch Questar catadioptric. Other data not provided. Image quality limited to condition of hard copy scanned for this publication.

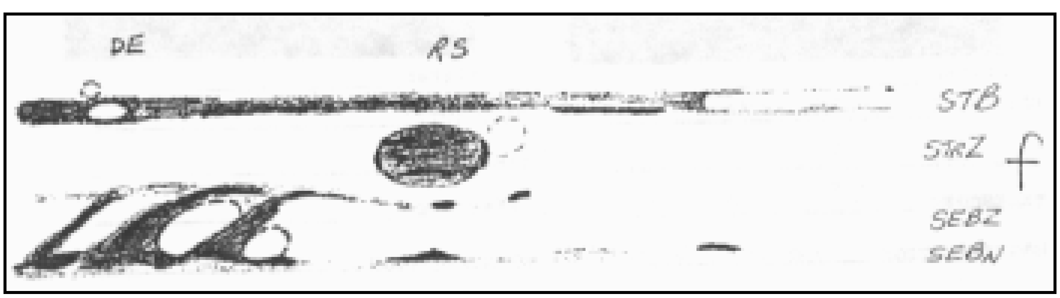


Figure 15: Sketch by author, April 29, 1993. Note Dark Red Spot; early stage of development of 1993 SEB Disturbance; Oval DE precedes the RS. RS = Type 8. CM2 = 355 - 55 degrees. Equipment = 3.5-inch Questar catadioptric. Other data not provided. Image quality limited to condition of hard copy scanned for this publication.

Figure 16 Sketch by author, March 24, 1994. Note RSH with dark border and interior shading; RSH = 23 degrees. RS = Type 2. CM1 - 143 degrees, CM2 = 23 degrees. Equipment = 6-inch Meade APO refractor. Other data not provided. Image quality limited to condition of hard copy scanned for this publication.

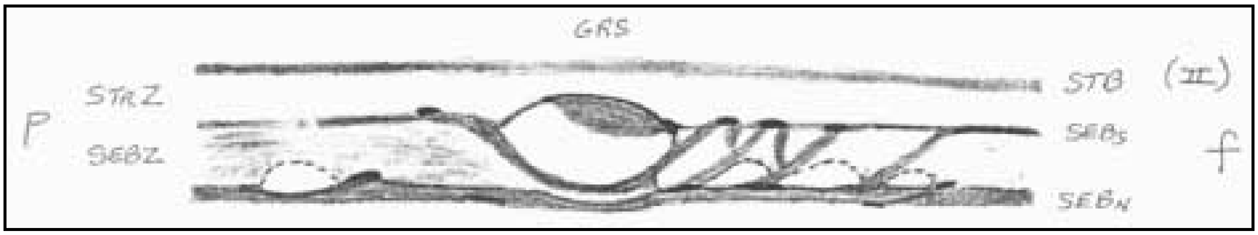


Figure 17 Sketch by author, May 23, 1996. Note RSH and RS; notice SEB details following the RS area. RS = Type 2. CM2 = 55 - 86 degrees. Equipment = 6-inch Meade APO refractor. Other data not provided. Image quality limited to condition of hard copy scanned for this publication.

ALPO Resources

People, publications, etc. to help our members

Board of Directors

- Executive Director (Chair); Donald C. Parker, 12911 Lerida Street, Coral Gables, FL 33156
- Associate Director; Richard W. Schmude, Jr., Gordon College, Division of Mathematics & Natural Sciences, 419 College Drive, Barnesville, GA 30204
- Founder/Director Emeritus; Walter H. Haas, 2225 Thomas Drive, Las Cruces, NM 88001
- Member of the Board; Julius L. Benton, Jr., Associates in Astronomy, 305 Surrey Road, Savannah, GA 31410
- Member of the Board; Richard Hill, Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721
- Member of the Board; Ken Poshedly, 1741 Bruckner Ct., Snellville, GA 30078-2784
- Member of the Board, Secretary; Elizabeth W. Westfall, P.O. Box 2447, Antioch, CA 94531-2447
- Member of the Board; John E. Westfall, P.O. Box 2447, Antioch, CA 94531-2447
- Membership Secretary/Treasurer; Matthew Will, P.O. Box 13456, Springfield, IL 62791-3456

Publications Staff

- Acting Publisher; Ken Poshedly. Send ALL papers and articles to 1741 Bruckner Ct, Snellville, GA 30078-2784; e-mail poshedly@bellsouth.net

Science Editors

- Dr. Klaus R Brasch, Executive Director, Office of Technology Transfer & Professor of Biology, California State University, San Bernardino, 5500 University Parkway, San Bernardino, CA 92407
- Acting Editor; Dr. Richard K Ulrich, Professor, Dept. Of Chemical Engineering, 3202 Bell Engineering Center, University of Arkansas, Fayetteville, AR 72701
- John E Westfall, P.O. Box 2447 Antioch, CA 94531-2447

General Editors

- Acting Editor (General Materials); Robert A Garfinkle, F.R.A.S., 32924 Monrovia St., Union City, CA 94587-5433
- Magazine Markup and Assembly; Ken Poshedly, 1741 Bruckner Ct, Snellville, GA 30078-2784
- Acting Editor (General Materials); Roger J Venable, MD, 3405 Woodstone Pl., Augusta, GA 30909-1844

Book Review Editor

- Jose Olivarez, 4705 SE 14th St., Ocala, FL 34471

Graphics (Acting)

- John Sanford, P.O. Box 1000, Springville, CA 93265-1000

Staff Writers (Acting)

- Eric Douglass, 10326 Tarieton Dr., Mechanicsville, VA 23116-5835
- James S Lamm, 9211 13th Avenue Circle NW, Bradenton, FL 34209
- Richard J Wessling, 5429 Overlook Dr., Milford, OH 45150-9651

Translators (Acting)

- French Language Submissions; Richard J McKim, Cherry Tree Cottage, 16 Upper Main Street, Upper Benefield, Peterborough Pe8 5an, United Kingdom
- Spanish Language Submissions; Guido E Santacana, Nuevo Laredo 1678, Venus Gardens, Rio Piedras, PR 00926

Lunar and Planetary Training Program

- Coordinator; Timothy J. Robertson, 2010 Hillgate Way #L, Simi Valley, CA 93065

Solar Section

- Coordinator, *Website, SolNet, Rotation Report,* handbook; Richard Hill, Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721
- Assistant Coordinator, Correspondence and New Observers; Gordon W. Garcia, 340 Illinois Boulevard, Hoffman Estates, IL 60194-3319
- Assistant Coordinator; Brad Timerson (use e-mail for correspondence, see Internet directory)

Mercury Section

- Acting Coordinator; Frank J. Melillo, 14 Glen-Hollow Dr., E-#16, Holtsville, NY 11742

Venus Section

- Coordinator: Julius L. Benton, Jr., Associates in Astronomy, 305 Surrey Road, Savannah, GA 31410

Mercury/Venus Transit Section

- Coordinator; John E. Westfall, P.O. Box 2447, Antioch, CA 94531-2447

Lunar Section

- Coordinator, *Selected Areas Program;* Julius L. Benton, Jr., Associates in Astronomy, 305 Surrey Road, Savannah, GA 31410
- Coordinator, *Lunar Meteoritic Impacts Search*; Brian Cudnik, 11851 Leaf Oak Drive, Houston, TX 77065
- Acting Coordinator, *Lunar Transient Phenomena*; Anthony Cook, School of Computer Science and Information Technology, University of Nottingham, Jubilee Campus, Wollaton Rd., Nottingham NG8 1BB, United Kingdom

ALPO Resources (continued)

- Assistant Coordinator, *Lunar Transient Phenomena*; David O. Darling, 416 West Wilson St., Sun Prairie, WI 53590-2114
- Coordinator, *Lunar Topographical Studies*; Marvin W. Huddleston, 2621 Spiceberry Lane, Mesquite, TX 75149

Mars Section

- Coordinator, *all observations, U.S. correspondence;* Daniel M. Troiani, 629 Verona Court, Schaumburg, IL 60193
- Assistant Coordinator; CCD Imaging, "Mars Project"; Donald C. Parker, 12911 Lerida Street, Coral Gables, FL 33156
- Assistant Coordinator; Daniel Joyce, 6203 N. Keeler Avenue, Chicago, IL 60648-5109
- Assistant Coordinator; Jeff D. Beish, 842 Virginia Ave., Lake Placid, FL 33852

Minor Planets Section

- Coordinator; Frederick Pilcher, Illinois College, Jacksonville, IL 62650.
- Assistant Coordinator; Lawrence S. Garrett, 206 River Road, Fairfax, VT 05454
- Assistant Coordinator; Richard Kowalski, 7630 Conrad Street, 761 Zephyrhills, FL 33544-2729
- Scientific Advisor; Steve Larson, Lunar & Planetary Lab, University of Arizona, Tuscon, AZ 85721

Jupiter Section

- Coordinator, Richard W. Schmude Jr., Gordon College, Division of Mathematics & Natural Sciences, 419 College Drive, Barnesville, GA 30204
- Assistant Coordinator, Scientific Advisor; Sanjay Limaye, University of Wisconsin, Space Science and Engineering Center, Atmospheric Oceanic and Space Science Bldg. 1017, 1225 W. Dayton St., Madison, WI 53706
- Assistant Coordinator, Transit Timings; John McAnally, 2124 Wooded Acres, Waco, TX 76710
- Assistant Coordinator, Newsletter; Craig MacDougal, 821 Settlers Road, Tampa, FL 33613
- Assistant Coordinator, Galilean Satellites; John E. Westfall, P.O. Box 2447, Antioch, CA 94531-2447
- Acting Assistant Coordinator; Ed Grafton, 15411 Greenleaf Lane, Houston, TX 77062
- Acting Assistant Coordinator; Dr. P. Clay Sherrod, Arkansas Sky Observatory, Conway Offices, 794 Drake Drive, Conway, AR 72034

Saturn Section

- Coordinator, Julius L. Benton, Jr., Associates in Astronomy, 305 Surrey Road, Savannah, GA 31410

Remote Planets Section

- Coordinator; Richard W. Schmude, Jr., Gordon College, Division of Mathematics & Natural Sciences, 419 College Drive, Barnesville, GA 30204

Comets Section

- Acting Coordinator; Gary Kronk, 1117 Troy-O'Fallon Rd., Troy, IL 62294

Meteors Section

- Coordinator; Robert D. Lunsford, 161 Vance Street, Chula Vista, CA 91910
- Acting Assistant Coordinator; Robin Gray, P.O. Box 547, Winnemuca, NV 89446

Meteorites Section

- Coordinator; Dolores Hill, Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721

Computing Section

- Coordinator; Mike W. McClure, 170 Prestwick Ct., Bowling Green, KY 42103

Youth Section

- Acting Coordinator; Timothy J. Robertson, 2010 Hillgate Way #L, Simi Valley, CA 93065

Historical Section

- Coordinator; Richard Baum, 25 Whitchurch Rd., Chester, CH3 5QA, United Kingdom
- Acting Assistant Coordinator; Thomas A. Dobbins, 305 Northern Spy Circle, Howard, OH 43028

Instruments Section

- Coordinator; R.B. Minton, 568 N. 1st St., Raton, NM 87740
- Assistant Coordinator; Richard J Wessling, 5429 Overlook Dr., Milford, OH 45150-9651

Website

- Coordinator; Richard Hill, Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721
- Assistant Coordinator; Jonathan D. Slaton, 1025 George, Alton, IL 62002-2561

Eclipse Section

- Coordinator; Michael D. Reynolds, Chabot Observatory and Science Center, 10902 Skyline Boulevard, Oakland, CA 94619

ALPO Publications:

The Monograph Series

ALPO monographs are publications that we believe will appeal to our members, but which are too lengthy for publication in *The Strolling Astronomer*. They should be ordered from *The Strolling Astronomer* science editor (P.O. Box 2447, Antioch, CA 94531-2447 U.S.A.) for the

ALPO Resources (continued)

ALPO Staff E-mail Directory

Beish, J.D. .... jeffbeish@htn.net
Benton. J.L. (routine e-mail + observations & images) .... jlbaina@msn.com
Benton, J.L. (back-up e-mail + observations & images) .... jlbalpo@netscape.net
Brasch, K.R. .... kbrasch@csusb.edu
Baum, R. .... richardbaum@julianbaum.co.uk
Cook, A .... acc@css.nott.ac.uk
Cudnik, B. .... xflare@earthlink.net
Darling, D.O. .... DOD121252@aol.com
Dobbins, Tom .... kmdobbins@coshocton.com
Douglass, E. .... ejdftd@mindspring.com
Garcia, G.W. .... gordg@megsinet.net
Garfinkle, R.A. .... ragarf@earthlink.net
Garrett, L.S. .... lgasteroid@earthlink.net
Grafton, E. .... egrafton@ghg.net
Haas, W.H. .... haasw@zianet.com
Hill, D .... dhill@lpl.arizona.edu
Hill, R. .... rhill@lpl.arizona.edu
Huddleston, M.W .... Kc51e:@hotmail.com
Joyce, D. .... djoyce@triton.cc.il.us
Kowalski, R. .... bitnik@bitnik.com
Kronk, G .... kronk@amsmeteors.org
Lamm, J.S. .... jlspacerox@aol.com
Limaye, S. .... sanjayl@ssec.wisc.edu
Lunsford, R.D. .... lunro.imo.usa@cox.net
MacDougal, C. .... macdouc@prodigy.net
McAnally, J. .... CPAJohnM@aol.com
McClure, M.W. .... mike.mcclure@kctcs.net
McKim, R.J. .... rmckim5374@aol.com
Melillo, F. .... FrankJ12@aol.com
Olivarez, J. .... olivarezhsd@earthlink.net
Parker, D.C. .... park3232@bellsouth.net
Pilcher, F. .... pilcher@hilltop.ic.edu
Poshedly, K. .... poshedly@bellsouth.net
Reynolds, M. .... MReynolds@ChabotSpace.org
Robertson, T.J. .... cometman@cometman.net
Sanford, J. .... starhome@springvillewireless.com
Santacana, G.E. .... laffitte@prtc.net
Schmude, R.W. .... schmude@gdn.edu
Sherrod, C. .... drclay@arksky.org
Slaton, J.D. .... jd@justfurfun.org
Timerson, B. .... bwtimer@eznet.net
Troiani, D.M. .... dantroiani@earthlink.net
Ulrich, R.K. .... rulrich@uark.edu
Venable, R.J. .... rjvmd@knology.net
Wessling, R.J. .... pinesop@aol.com
Westfall, E.W. .... ewestfall5@attbi.com
Westfall, J.E. .... 73737.1102@compuserve.com
Will, M. .... will008@attglobal.net

prices indicated, which include postage. Checks should be in U.S. funds, payable to "ALPO".

- **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 for the United States, Canada, and Mexico; $16 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 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 for the United States, Canada, and Mexico; $40 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 for the United States, Canada, and Mexico; $26 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 for the United States, Canada, and Mexico; $15 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 for the United States, Canada, and Mexico; $4 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 for the United States, Canada, and Mexico; $16 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 for the United States, Canada, and Mexico; $26 elsewhere.
- **Monograph Number 9**. *Does Anything Ever Happen on the Moon?* By Walter H. Haas. Reprint of 1942 article. 54 pages. Price: $6 for the United States, Canada, and Mexico; $8 elsewhere.
- **Monograph Number 10.** *Observing and Understanding Uranus, Neptune and Pluto*. By Richard W. Schmude, Jr. 31 pages. Price: $4 for the United States, Canada, and Mexico; $5 elsewhere.

ALPO Observing Section Publications

Order the following directly from the appropriate ALPO section coordinators; use the address in the listings pages which appeared earlier in this booklet unless another address is given.

ALPO Resources (continued)

- **Lunar and Planetary Training Program (Robertson):** *The Novice Observers Handbook* $15. 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 check or money order payable to "Timothy J. Robertson."
- **Lunar (Benton):** (1) *The ALPO Lunar Section's Selected Areas Program (*$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. Includes observing forms to replace those provided in the observing kit described above. Specify *Lunar Form*s. (See note for Venus.)
- **Lunar (Jamieson):** *Lunar Observer's Tool Kit*, price $50, is a computer program designed to aid lunar observers at all levels to plan, make, and record their observations. This popular program was first written in 1985 for the Commodore 64 and ported to DOS around 1990. Those familiar with the old DOS version will find most of the same tools in this new Windows version, plus many new ones. A complete list of these tools includes Dome Table View and Maintenance, Dome Observation Scheduling, Archiving Your Dome Observations, Lunar Feature Table View and Maintenance, Schedule General Lunar Observations, Lunar Heights and Depths, Solar Altitude and Azimuth, Lunar Ephemeris, Lunar Longitude and Latitude to Xi and Eta, Lunar Xi and Eta to Longitude and Latitude, Lunar Atlas Referencing, JALPO and Selenology Bibliography, Minimum System Requirements, Lunar and Planetary Links, and Lunar Observer's ToolKit Help and Library. Some of the program's options include predicting when a lunar feature will be illuminated in a certain way, what features from a collection of features will be under a given range of illumination, physical ephemeris information, mountain height computation, coordinate conversion, and browsing of the software's included database of over 6,000 lunar features. Contact hjamieson@telocity.com; web site at http://members.telocity.com/hjamieson/TKWebPage.htm#Jamieson's
- **Venus (Benton):** (1) *The ALPO Venus Observing Kit,* $17.50. Includes introductory description of ALPO Venus observing programs for beginners, a full set of observing forms, and a copy of *The Venus Handbook.* (2) *Observing Forms Packet,* $10. Includes observing forms to replace those provided in the observing kit described above. Specify *Venus Forms.* To order either numbers (1) or (2), send a check or money order payable to "Julius L. Benton, Jr." All foreign orders should include $5 additional for postage and handling; p/h included in price for domestic orders. Shipment will be made in two to three weeks under normal circumstances. NOTE: Observers who wish to make copies of the observing forms may instead send 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 ALPO Venus, Saturn, or lunar SAP sections. Observers should make copies using high-quality paper.
- **Mars (Troiani):** (1) *Martian Chronicle;* published approximately monthly during each apparition; send 8 to 10 SASEs; (2) *Observing Forms;* send SASE to obtain one form for you to copy; otherwise send $3.60 to obtain 25 copies (make checks payable to “Dan Troiani").
- **Mars:** *ALPO Mars Observers Handbook,* send check or money order for $10 per book (postage and handling included) to Astronomical League Book Service, c/o Paul Castle, 2535 45th St., Rock Island, IL 61201.
- **Jupiter:** (1) *Jupiter Observer’s Startup Ki*t, $3 from the Jupiter Section Coordinator. (2) *Jupite*r, ALPO section newsletter, available online via the ALPO website or via snail-mail; send SASE to the Jupiter Section Coordinator; (3) To join the ALPO Jupiter Section e-mail network, *J-Ne*t, send an e-mail message to the Jupiter Section Coordinator. (4) *Timing the Eclipses of Jupiter’s Galilean Satellites* observing kit and report form; send SASE with 55 cents in postage stamps to John Westfall.
- **Saturn (Benton):** (1) The *ALPO Saturn Observing Ki*t, $20; includes introductory description of Saturn observing programs for beginners, a full set of observing forms, and a copy of *The Saturn Handboo*k. (2) *Saturn Observing Forms Packe*t, $10; includes observing forms to replace those provided in the observing kit described above. Specify *Saturn Forms.* To order, see note for *Venus Forms*.
- **Meteors:** (1) Pamphlet, *The ALPO Guide to Watching Meteors,* send check or money order for $4 per book (postage and handling included) to Astronomical League Book Service, c/o Paul Castle, 2535 45th St., Rock Island, IL 61201. (2) *The ALPO Meteors Section Newslette*r, free (except postage), published quarterly (March, June, September, and December). Send check or money order for first class postage to cover desired number of issues to Robert D. Lunsford, 161 Vance St., Chula Vista, CA 91910.
- **Minor Planets (Derald D. Nye):** *The Minor Planet Bulleti*n, published quarterly $14 per year in the U.S., Mexico and Canada, $19 per year elsewhere (air mail only). Send check or money order payable to “Minor Planet Bulletin” to 10385 East Observatory Dr., Corona de Tucson, AZ 8564I-2309.
- **Computing Section (McClure):** Online newsletter, *The Digital Lens,* available via the World Wide Web and e-mail. To subscribe or make contributions, contact Mike McClure

Other ALPO Publications

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

ALPO Resources (continued)

- ***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: ALPO Membership Secretary.
- *ALPO* ***Membership Directory.*** $5 in North America; $6 elsewhere. Latest updated list of members on 3.5-in. MS-DOS diskette; either DBASE or ASCII format. Make payment to "ALPO" Also available via e-mail as portable document format (pdf) file to requester's e-mail address. Provided at the discretion of the Membership Secretary. Order from Matthew Will, ALPO membership secretary/treasurer.
- **Back issues** of *The* ***Strolling Astronomer (JALPO).*** 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 for each back issue; the current issue, the last one published, is $5. We are always glad to be able to furnish old issues to interested persons and can arrange discounts on orders of more than $30. Order directly from and make payment to "Walter H. Haas"(see address earlier in this section)

  $4 each:
  Vol. 7 (1953); 3 and 10
  Vol. 8 (1954); 7-8
  Vol. 11 (1957); 11-12
  Vol. 21 (1968-69); 3-4 and 7-8
  Vol. 23 (1971-72); 7-8 and 9-10
  Vol. 24 (1972-74); 7 and 8
  Vol. 25 (1974-76); 1-2, 3-4, and 11-12
  Vol. 26 (1976.77); 3-4 and 11-12
  Vol. 27 (1977-79); 3-4 and 7-8
  Vol. 31 (1985-86); 9-10
  Vol. 32 (1987.88); 11-12
  Vol. 33 (1989); 7-9
  Vol. 34 (1990); 2 and 4
  Vol. 37 (1993-94); 1
  Vol. 38 (1994-96); 1 and 3
  Vol. 39 (1996-97); 1, 3 and 4
  Vol. 40 (1998); 2
  Vol. 41 (1999); 4
  Vol. 42 (2000); 1, 2, 3 and 4
  Vol. 43 (2001); 1, 2, 3 and 4
  Vol. 44 (2002); 1, 2 and 3

  $5 each
  Vol. 44 (2002); 4 (current issue)

Membership in the ALPO

The ***Association of Lunar and Planetary Observers* (ALPO)** was founded by Walter H. Haas in 1947, and incorporated in 1990 as a medium for advancing and conducting astronomical work by both professional and amateur astronomers who share an interest in Solar System observations. We welcome and provide services for all levels of astronomers: For the novice, the **ALPO** is a place to learn and to enhance and practice techniques. For the advanced amateur, it is a place where one's work will count. For the professional, it is a resource where group studies or systematic observing patrols are necessary.

Our Association is an international group of students of the Sun, Moon, planets, asteroids, meteors, and comets. Our goals are to stimulate, coordinate, and generally promote the study of these bodies using methods and instruments that are available within the communities of both amateur and professional astronomers. We hold a conference each summer, usually in conjunction with other astronomical groups.

Membership dues include a subscription to this journal and option to participate on the ALPO-Member-Discussion e-mail listserv. Memberships are for 1 year (4 issues) or 2 years (8 issues).

See notice on following page for old and new dues information.

There is a 20-percent surcharge on all memberships obtained through subscription agencies or which require an invoice. Make payment by check or money order, payable (through a U.S. bank and encoded with U.S. standard banking numbers) to **"ALPO".**

INCREASE IN MEMBERSHIP RATES

Unfortunately, increases in the cost of producing the *Journal A.L.P.O.* and maintaining the business of the A.L.P.O. have forcedus to schedule an increase in A.L.P.O. Membership rates. This is the first increase in rates that we have had in six years. The A.L.P.O. has tried to make this increase as modest as our finances will allow and we hope that you will stay with us as the A.L.P.O. continues its mission to disseminate information and data concerning amateur studies of the Solar System. **The new rates take effect on January 1, 2003.** They are listed below:

- ❑ $US 11.00 (Digital Journal; All countries; 4 issues, email address required)
- ❑ $US 19.00 (Digital Journal; All countries; 8 issues, email address required)
- ❑ $US 26.00 (Paper Journal; USA, Canada and Mexico; 4 issues)
- ❑ $US 46.00 (Paper Journal; USA, Canada and Mexico; 8 issues)
- ❑ $US 33.00 (Paper Journal; Other countries; 4 issues)
- ❑ $US 60.00 (Paper Journal; Other countries; 8 issues)
- ❑ $US 50.00 (Digital and Paper Journal; Sustaining Member; 4 issues, all countries)
- ❑ $US 100.00 (Digital and Paper Journal; Sponsor; 4 issues all countries)

To renew, just fill out the bottom portion of this notice and return it with your payment, payable to the A.L.P.O., to:

A.L.P.O. Membership Secretary
P.O. Box 13456
Springfield, IL 62791-3456

We are also very grateful for the support of those who choose to become Sponsors ($100.00 for four issues) or Sustaining Members ($50.00 for four issues). Sponsor and Sustaining Members are entitled to receive both paper and digital versions of A.L.P.O. Journal.

Name____

Address____

____

____

Email________________________ Interest____________________

Phone________________________ FAX______________________