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Journal of the Association of Lunar & Planetary Observers

The Strolling Astronomer

Volume 45, Number 3, Summer 2003

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

Inside...

Congratulations!!

We are proud to announcethe winners of the two ALPO service awards.

At left is Matt Will, winner of the 2003 Peggy Haas ALPO Service Award. Matt, who joined the organization in 1973. Matt has been an active observer and contributor since then (especially in the Mars Section), and is a co-founder of the ALPO Lunar & Planetary Training Program. He is now a member of the ALPO board of directors (currently serving as associate director until taking office as executive director in 2005), and is also our membership secretary/treasurer.

At right is Mario Frassati (with plaque) of Crescentino, Italy, winner of this year's Walter Haas Observing Award and who has been very active in the ALPO Mercury Section. This marks the first time that this award has been given to an Italian living in his native country. With Mario is his son, Lorenzo.

Also . . .

* Minutes of this past summer's ALPO board meeting
* Advice on solar imaging techniques
* Another in the great series on lunar domes
* A report on the 1990-91 Mars apparition
* A report on the 1986-1989 Jupiter apparitions

. . . plus reports about your ALPO section activities and much, much more.

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

Volume 45, No. 3, Summer 2003
This issue published in December 2003 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:

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

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Association of Lunar and Planetary Observers (ALPO)

Board of Directors

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

Publications

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: Acting Coordinator, Rick Gossett
Mercury Section: 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: 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 Look to the Future

By Richard Schmude, Jr., Executive Director of the ALPO

The three goals that I hope to attain as director are: 1) get the Jupiter section caught up, 2) carry out a slight reorganization of the Mars section to improve its efficiency and 3) begin laying the ground work for a National Office for the ALPO.

Please welcome Jamey Jenkins who is from Homer, IL and Kim Hay who is from Ontario, Canada; these two have been appointed as acting assistant solar coordinators. Both people have lots of enthusiasm and I know that they will be a big asset to the ALPO.

The ALPO, Astronomical League, AAVSO and the Astronomical Society of the Pacific along with several California astronomy clubs will be meeting together at AstroCon 2004. AstroCon 2004 will be held from July 20-24, 2004 (Tuesday through Saturday); however there will only be an evening welcoming and registration on Tuesday July 20. Several field trips are planned for this event including a trip to Lick Observatory. AstroCon will be held at Mills College which is in Oakland, California.

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By Ken Poshedly
Editor/Publisher,
“*The Strolling Astronomer*”

It should be obvious to you the reader that as evicenced by the designation on the front cover “Summer 2003”, this issue is several months late.

Well, unfortunately, life got in the way of my avocational interests a few months ago and lots of stuff was placed on the back burner.

Family matters, other pending activities and my final run as chairman of the Peach State Star Gaze here in Georgia all got to be too much.

Much of the family stuff is now settled (elderly parent matter), the other pending things are still there, with each being tended to in its own time, and I’ve retired as chairman of the PSSG, the event I founded as a fundraiser for the venerable Atlanta Astronomy Club 10 years ago. I enjoyed it, but too much is too much.

The lesson here is don’t bite off more that you can chew. Keep your hobbies and all things in your life in perspective with each other. Sorry.

Inside the ALPO
Member, section and activity news (continued)

ALPO Conference News

The next annual meeting of the Assn. of Lunar & Planetary Observers will be a held in conjunction with the Astronomical League, the American Association of Variable Star Observers, and the Astronomical Society of the Pacific on 20-24 July 2004 and is being co-hosted by the Astronomical Association of Northern California and the Eastbay Astronomical Society.

Mike Bennett, director of the ASP and Mike Reynolds, ALPO board member and Executive Director Emeritus of the Chabot Space & Science Center in Oakland, are co-chairing the meeting.

The AstroCon 2004 web site at http://www.astrocon2004.org will be up soon with more details, with registration packages available in early 2004.

And yes! Attendees will be able to register via a secure Internet address using credit cards. In addition to convention housing at Mills College, alternate hotels will be listed as well..

ALPO Membership Online

The ALPO now accepts membership payment by credit card. However, in order to renew by this method you MUST have access to the World Wide Web. See the inside back cover for details.

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 successful.

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.

Our Advertisers

As we all know by now, there is no free lunch. Everything costs money. This Journal and other 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.

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

A Report from the ALPO Membership Secretary/Treasurer

By Matthew L. Will

Current Membership

As of September 1, 2003, the ALPO had a total of 543 members. This is up from a mere 410 members last April. There are a couple of reasons for this. For the last several months, even the most casual amateur astronomer has undergone some form of "Mars Fever". It is an affliction that accompanies a great urge to want to observe Mars followed by sleep dep-

Table 1: ALPO Interest Areas

Area of Interest	Number of Members	Percentage of Members
Sun	126	23%
Mercury	59	11%
Venus	85	16%
Moon	228	42%
Mars	207	38%
Jupiter	242	45%
Saturn	204	38%
Uranus	69	13%
Neptune	68	13%
Pluto	49	9%
Asteroids	98	18%
Comets	126	23%
CCD Imaging	92	17%
Eclipses	18	3%
History	81	15%
Instruments	90	17%
Meteors	79	15%
Meteorites	22	4%
Photography	109	20%
Radio Astronomy	32	6%
Software/ Computing	65	12%
Tutoring	39	7%

Inside the ALPO
Member, section and activity news *(continued)*

Table 2: ALPO Sponsoring Memberships

Sponsors	City	State/Prov.	Country
Julius L Benton, Jr	Savannah	Ga	
Hank Bulger	Grants	Nm	
Craig Counterman	Wakefield	Ma	
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	
F R Kiesche	Franklin Park	Nj	
Cynthia Norrgran	Franktown	Co	
Mr And Mrs W P Pala, Jr	Centreville	Va	
Donald C Parker	Coral Gables	Fl	
James Phillips	Charleston	Sc	
Takeshi Sato	Hatsukaichi	Hiroshima	Japan
Berton & Janet Stevens	Las Cruces	Nm	
Gerald Watson	Cary	Nc	
Christopher C Will	Springfield	Il	
Matthew L Will	Springfield	Il	
Thomas R Williams	Houston	Tx	

ravation when actually observing the Red Planet. For some, this malady is so acute that certain amateurs have gone so far as to join the ALPO! Actually, the true reasons are a little more rational. The ALPO has had great coverage of our Mars observing activities and ALPO Training Program in such publications as *Sky & Telescope* magazine. This coupled with the recent development of online purchasing of ALPO memberships via the Astronomical League web site, has brought on more interest among amateur astronomers in becoming new ALPO members. Indeed, it has never been easier or cheaper to become an ALPO member! More newer members are responding to receiving the digital version of the Journal. One third of our membership exclusively receive the digital Journal.

Membership Status

I occasionally get requests from members asking me about their status of membership, namely when does my membership expire? There are a number of ways to find out. First, for our members receiving the paper Journal, the "issue of expiration" is now being printed above the member's address on the Journal's mailing envelope. Also, all new and current members receive acknowledgments when they pay for their memberships. Not only does that acknowledgment letter list your issue of expiration, but the enclosed membership card also has this information printed on it as well. I am now laminating these membership cards so that they will be more durable for storage in the wallet!

Renewals

With the issue of expiration, a member receiving the paper version of the Journal receives his or hers "first renewal notice", enclosed with that issue. On the assumption a member is simply late in renewing, one more issue is sent out thereafter with a final renewal notice enclosed. Our members that collect the digital version of this Journal, receive first and final renewal notices via the e-mail after the Journal issue is released.

Interest Areas

Our ALPO members have varied interest in Solar System astronomy across some 30 observing programs that the ALPO volunteer staff manage. Members communicate their interest to the membership secretary when applying for membership or renewing, using the interest codes on the membership applications and renewal forms. The latest tabulations are given in Table 2. Section coordinators are encouraged to contact the membership secretary for complete listings of prospective observers with interest in topic areas of Solar System astronomy.

A couple of comments. Both the Eclipse and Meteorites interest areas are relatively new to the interest codes listing, so this is the reason why the interest numbers are low. Also, the popularity of Mars undoubtedly rose with the major opposition of Mars occurring earlier this year.

ALPO Sponsors, Sustaining Members, and Newest Members

The ALPO wishes to thank those members listed in tables 2 and 3 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!

The ALPO would like to wish a warm welcome to those listed in Table 4 who recently became members; the table lists persons that have become new members from December 2, 2002 through September 1, 2003, their homes, and their interests in lunar and planetary astronomy. The legend for the interest codes is located on each page of the table.

Inside the ALPO

Member, section and activity news (continued)

Table 3: ALPO Sustaining Memberships

Sustaining Members	City	State/ Prov.	Country
Paul H Bock Jr	Hamilton	Va	
Raffaello Braga	Corsico (Mi)		Italy
Klaus R Brasch	Highland	Ca	
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	
Terry L Mann	West Manchester	Oh	
Michael Mattei	Littleton	Ma	
Dr. A K Parizek	Phoenix	Az	
Cecil C Post	Las Cruces	Nm	
Timothy J Robertson	Simi Valley	Ca	
Mark L Schmidt	Racine	Wi	
Ronald Sidell	San Carlos	Ca	
Lee M Smojver	Tukwila	Wa	
Roger J Venable	Augusta	Ga	
Elizabeth W Westfall	Antioch	Ca	

Observing Section Reports

Eclipse Section Report for 2003

By Dr. Mike Reynolds, coordinator

The year brought an opportunity for two total lunar eclipses to North American observers. In addition, observers who traveled to Antarctica in November were in position to observe a total solar eclipse near the South Pole.

In 2004, a full report of 2003 eclipse observations received will be published in this Journal. NOTE: If you have not sent in your report(s) and observations(s) of eclipses in 2003, please do so as noted below. We are interested in timings, estimates of totality color and darkness (lunar), photographs and digital images, etc.

Also featured in JALPO for 2004 will be highlights of 2004 eclipses, and primers on eclipse observing techniques (such as estimating total lunar eclipse darkness and color, timings, etc.).

Observers and interested eclipse chasers are reminded that "Observe Eclipses", the observing manual for the ALPO Eclipse Section, is available from this Section Coordinator for $15 postpaid (checks payable to Mike Reynolds). This 96-page book, with an excellent color section, outlines observing techniques and other recommendations for both lunar and solar eclipses.

Please send observations. Questions, and orders for Observe Eclipses to this section coordinator (Dr. Mike Reynolds), 2347 Foxhaven Drive West, Jacksonville FL 32224-2011; e-mail to astrogator90@aol.com

Visit the ALPO Eclipse Section on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/eclipse.html

Solar Section

By Rick Gossett, acting coordinator

As the Sun progresses toward solar minimum, the ALPO Solar Section continues to grow. During the last full rotation, CR 2005, we have averaged 9.5 digital and 1.5 hardcopy observations per day. The enthusiasm of our observers continues to keep us deluged with incoming data in photographs and drawings, digital photographs, video, and ccd iamges.

Digital images covering full rotations are available on the ALPO website at: http://www.lpl.arizona.edu/~rhill/alpo/solstuff/recobs.html

Rik Hill will continue to receive all digitally submitted observations. He is also working with this section as scientific advisor. His help is greatly appreciated. Please submit digital observations to rhill@lpl.arizona.edu .

Hardcopy observations should be mailed directly to our new archivist, Jamey Jenkins. His e-mail address is jenkinsjl@yahoo.com. We plan to digitize the observations as quickly as possible and post them at http://www.lpl.arizona.edu/~rhill/alpo/solstuff/recobs.html with the rest of the observations. Our goal is to make all of the Solar Section observations publicly available as quickly as possible.

Inside the ALPO
Member, section and activity news (continued)

Table 4: New ALPO Members, Dec. 2 2002 - Sept. 1, 2003

Member	City	State/ Prov.	Interest
Jorge Acosta	Queretaro	Qr, Mex	
Samuel Alston	Philadelphia	Pa	
Joseph Andersen	American Fork	Ut	
Kim Anderson	Globe	Az	
Peter Argenziano	Gilbert	Az	
Bruce Armstrong	Crystal Lake	Il	
Marion Bachtell	West Burlington	Ia	
Mark Bailey	Kneeland	Ca	3456acm
Howard Banich	Portland	Or	456c
John Bannen	Pacifica	Ca	
Mark Baratta	Seattle	Wa	
James E Barot, Jr	Glenn Falls	Ny	0456acdim
Larry Beaty	Arden Hills	Mn	
Bill Bernauer	Evansville	In	
David W Bigham	Phoenix	Az	234678ac himr
Bill Black	Grayson	Ga	Dopr
Susanna Bosrock	Redondo Beach	Ca	
Danny Bouchard	Lachute	Qc, Can.	
Robert (Bob) Brown	Georgetown	Ca	
W Tom Buchanan	Alpharetta	Ga	12456c
Thomas E Bullard	Bloomington	In	
Scott Burgess	Winterport	Me	
Joseph Cameron	Phoenix	Az	3567adht
Leonard I Casey	Niceville	Fl	
Kendra Cauble	Mc Donough	Ga	
Chris Clarner	New Haven	Nj	
Earlene F Clausen	Anaheim	Ca	
John E Cordiale	Glens Falls	Ny	3456acdi
Ricky Cosby	Midland	Tx	568
Mary Costantino	Lauderdale	Fl	
Patrick Craig	Fairborn	Oh	12345678 9achs
Glen Croasmun	San Jose	Ca	
Clifford A Cuffey	Midland	Tx	456
Stephan Cunha	Edmonds	Wa	
Chris Cunningham	Lansing	Mi	
Jim Dapkus	Westfield	Wi	12pr
Robert Davis	Takoma Park	Md	
Clyde G Davis	East Bank	Wv	
Donald H Dekarske	Colorado Springs	Co	26
Michael J Di Mario	Skillman	Nj	04569dp
Carol E Drebing	Warrenton	Va	2356h
Dale Dufresne	St Rose	La	

ALPO Interest Codes

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

Kim Hay has also joined the Section staff. She will be writing rotation reports.Observers may contact her at kimhay@adan.kingston.net .

As you may have already noticed, Rik Hill has stepped down from his position as Solar Section Coordinator. During his first calendar year, 1982, a total of 28 observations were submitted. We are on pace to exceed that number by over 100 times during 2003! These will most likely total more observations than all other sections combined. For 21 years, Rik has dedicated unparalleled time and effort toward the success of the Solar Section. He has offered members and non-members alike, the opportunity to contribute valid scientific data. Very simply, without Rik Hill there would be no ALPO Solar Section.

Visit the ALPO Solar Section on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/solar.html

Venus Section

By Julius Benton, coordinator

Virtually all observations for the 2002-2003 Western (Morning) Apparition have been received, and analysis of the data has begun in preparation of the next apparition report for the Journal of the ALPO. This ALPO Venus Section Coordinator expresses his sincere appreciation for all of the dedicated work and observational contributions by observers worldwide.

The 2003-2004 Eastern (Evening) Apparition of Venus has just begun, with the planet appearing as a brilliant object of visual magnitude -3.9 in the western sky right after sunset. Venus will reach Greatest Elongation East (-47°) on March 29,

Inside the ALPO
Member, section and activity news (continued)

Table 4: New ALPO Members, Dec. 2 2002 - Sept. 1, 2003 (cont.)

Member	City	State/ Prov.	Interest
Kenneth Edwards	Lawrenceville	Ga	
Melvin R Edwards	Houston	Tx	
Lawrence R Eicher	Charlottesville	Va	03456p
Paul Ellis, Md	Lexington	Ky	
Howard Eskildsen	Ocala	Fl	
Vincent S Foster	Barnegat	Nj	03456
David Garner	Mount Forest	On, Can.	
Roberto Garcia	Burke	Va	
Joseph Gelven, Jr	Falls Church	Va	
Ralph Geschwind	Massillon	Oh	3456
Gary Gramlich	Oro Valley	Az	
James Guilford	North Royalton	Oh	
Marie Hagan	Meridan	Ms	
Kenneth W Haney	Tarzana	Ca	
William D Hanna	Redmond	Wa	
Steve E Haugen	St Petersburg	Fl	0123456789acdehimops
Wayne Hensche	Grand Marais	Mn	
Carl Hergenrother	Tucson	Az	
Mark Hoffman	Stoughton	Ma	05h
George Iwaszek	Albuquerque	Nm	
Richard Jepeal	New Brittain	Ct	23456
Wade & Tina Jeske	Oconto Falls	Wi	
Alan Johnson	Stratford	Nj	
Norman D Johnson	Gold Beach	Or	
C Michael Jones	Sellersburg	In	
Grover F Jones, Jr	Lucasville	Oh	
Richard Jones	Las Cruces	Nm	
Christopher Kaiser	Chicago	Il	
Ron Kapanke	Livonia	Mi	
Mark Kedzior	Warren	Mi	03456p
Brian Kendrick	Los Alamos	Nm	
Lewis La Rue	Lexington	Va	
Frank Landherr	Cary	Il	
Alex Langoussis	Acworth	Ga	02345679cm
Steve Layman	Charlottesville	Va	4568cdips
Douglas Letendre	Mantua	Nj	
Robert A Lewis	Concord	Ca	
Frederick N Ley	Lancaster	Ca	03456dhimpt
Daniel Long	Marion	Ia	056sp
Matt Looby	Oak Lawn	Il	
Robert Lovelace	Austin	Tx	035678ht
Gregory Macievic	Camden	Oh	

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2003, and observers should try to catch the planet during twilight before it is too near the horizon for useful observation.

Observations of the atmosphere of Venus are organized into the following routine programs:

1. Visual observation and categorization of atmospheric details in dark, twilight, and daylight skies.
2. Drawings of atmospheric phenomena.
3. Observation of cusps, cusp-caps, and cusp-bands, including defining the morphology and degree of extension of cusps.
4. Observation of dark hemisphere phenomena, including monitoring visibility of the Ashen Light.
5. Observation of terminator geometry (monitoring any irregularities).
6. Studies of Schröter's phase phenomenon.
7. Visual photometry and colorimetry of atmospheric features and phenomena.
8. Routine photography (including UV photography), CCD imaging, photoelectric photometry, and videography of Venus.
9. Observation of rare transits of Venus across the Sun, especially the one on June 8, 2004.
10. Simultaneous observations of Venus.

Inside the ALPO
Member, section and activity news (continued)

Table 4: New ALPO Members, Dec. 2 2002 - Sept. 1, 2003 (cont,.)

Member	City	State/ Prov.	Interest
Jonathan Magill	Sassafras	Vic, Aust.	
James Manahan	New York	Ny	
Kevin, Tony, & Charles Marasciulo	Phenix City	Al	
Donald J Marchioni	Kimball	Mi	
Charles Mc Niss	Hudson	Nh	
Rick Menzel	Sandpoint	Id	
Hans-Joerg Mettig	Freiburg	Germany	
Miami Valley Astronomical Society	Dayton	Oh	0123456789acdimps
Harold Miller	Westminster	Ca	
Brian J Moccabee	Jackson	Nj	
Steve Mofle	New Franken	Wi	
Rod Mollise	Mobile	Al	5d
Steven Mondschein, Md	Creve Coeur	Mo	
Tim Morello	Wenatchee	Wa	
Charles P Morrow	Newark	Ca	
Ng Wai King Eric	Shatin	Hong Kong	1456ds
Cynthia Norrgran	Franktown	Co	
Bob O'connell	Keystone Heights	Fl	035c
Larry Owens	Alpharetta	Ga	345678adi
Michael Parl	München	Germany	
David Passmore	Gillett	Pa	
S Payne	Kirkland	Wa	
Damian Peach	Stevenage	Herts, UK	
Christophe Pellier	Bruz	France	
Anthony Pirera	Huntington	Ny	
T Lawrence Pitts	Nevada City	Ca	
Ronald E Powaski	Euclid	Oh	35d
Ronald A Pyle	Hot Springs	Sd	0123456789achmr
William S Quigley, Jr	Mt Laurel	Nj	3456ads
Elaine Quinn	Pittsburgh	Pa	
Bernie Rabalais	Plaucheville	La	
John L Rascher	Ft Worth	Tx	0356adhitps
Stubbe Bak Rasmussen	BagsvRd	Denmark	
Bob Rice	Nashville	Tn	
Carter Roberts	Berkeley	Ca	
Alan Rohwer	Boxborough	Ma	

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Complete details can be found on all of our observing programs in the ALPO Venus Handbook. Individuals interested in participating in the programs of the ALPO Venus Section are cordially invited to visit the ALPO Venus Section on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/venus.html

Lunar Section:
Lunar Domes

By Marvin W. Huddleston, coordinator, Lunar Dome Survey

The ALPO board of directors approved the revival of the Lunar Dome Survey during its annual board meeting in the summer of 2003. The revived program will concentrate on cleaning up the existing catalog, classification and confirmation of the objects contained therein, and analysis of the database created in the process.

It is also desired that, as a part of the overall effort, a digital image library be established eventually composing a digital catalog of all domes in the catalog. It is hoped that much as in the past the newly revived Lunar Dome Survey will be an international effort.

Persons interested in the revived survey are invited to join the Yahoo discussion group on Lunar Domes located at http://groups.yahoo.com/group/lunar-dome/

The Lunar Dome Survey is open to all interested parties and contributions are invited.

Visit the ALPO Lunar Dome Survey Section on the World Wide Web at http://www.lunar-dome.com

Inside the ALPO
Member, section and activity news (continued)

Table 4: New ALPO Members, Dec. 2 2002 - Sept. 1, 2003 (cont.)

Member	City	State/ Prov.	Interest
Carl Roussell	Hamilton	On, Can.	36
Kim Rowe	Creemore	On, Can.	
Joseph Roy	East Wenatchee	Wa	3456
Jens A Rummler	University	Ms	
Ronald & Margo Russell	Mexico	Ny	0123456789
Art Russell	Atlanta	Ga	35678cm
Daniel Salters	High Ridge	Mo	
Jeff Sandstrom	Tucson	Az	
Michael Schoenhoft	Oakland Park	Fl	
Fred Schmude	Houston	Tx	
Janice Sean	Sarasota	Fl	
Keith Shank	Carrollton	Tx	456acd
Brian And Scott Shields	Hainesville	Il	
Kelli Shipp	La Porte	Tx	
Philip Skau	Scottsdale	Az	1456
Bruce Skelly	Castro Valley	Ca	
Michael Sparkes	Saginaw	Mi	
Charles S Specht, Md	Columbia	Md	
Daryel Stager	Spring Valley	Ca	
Wayne Stanfield	Haysville	Ks	
Carol J Stewart	Cape Coral	Fl	03456
Johannes Stolt	BorS	Vg, Swed.	
Ted Stryk	Knoxville	Tn	9h
Tan Wei Leong	Ubi Teckpark	Singapore	13456ds
Keng The	Sunnyvale	Ca	
William R Thorum	Annville	Pa	
Tracy R Tuttle	North Newton	Ks	
Frank Varisco	Baltimore	Md	
Charles Vince	Swindon	UK	
Robert C Wanzong	Fullerton	Ca	
Valerie Anne Warr	Fayetteville	Ga	
Edward Weintraut	Macon	Ga	
Samuel Wickersham	Pittsburgh	Pa	
Ted Wilbur	Oxford	Ma	359acd
Darryl W Willard	Aurora	Co	3456
Thomas Williams	Robertsdale	Al	
Walter Winton, Iii	Cape Coral	Fl	35
Robert Witt	Hemet	Ca	
Jim Work	Louisville	Ky	
John E Worley	Kansas City	Mo	

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A = Asteroids	M = Meteors
C = Comets	O = Meteorites
D = Ccd Imaging	P = Photography
E = Eclipses	R = Radio Astronomy
H = History	S = Astronomical Software
I = Instruments	T = Tutoring

Lunar Selected Areas

By Julius Benton, coordinator

While there is a definite requirement to know how various lunar features change their normal appearance throughout a lunation in response to variations in phase angle, even more intriguing are those lunar features that behave in an unusual, sometimes unpredictable, and non-repeating manner as solar illumination changes.

The ALPO Lunar Selected Areas Program (SAP) is chiefly concerned with systematically monitoring regular and cyclical, long-term variations during many lunations of specifically designated, or "selected," areas on the Moon. The SAP is designed to intensively study and document for each of these features the normal albedo changes in response to conditions of varying solar illumination. The standard SAP procedure is to visually monitor as many of the selected lunar features as possible throughout successive lunations, employing established systematic, objective methods of observation.

Thus, observations of the Moon that are specific to the Lunar Selected Areas Program may be summarized as:

1. Visual photometry of specific lunar features, defining their normal albedo profiles throughout a lunation as a function of changing solar illumination.

2. Visual photometry of specific lunar features, monitoring variances from their normal albedo that are not simply a result of changing solar illumination.

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3. Drawings of specific lunar features throughout a lunation and from lunation-to-lunation in conjunction with visual photometry.

4. Routine photography, CCD imaging, photoelectric photometry, and videography of specific lunar features to supplement visual photometry programs throughout a lunation and from lunation-to-lunation.

5. Comparative analysis of lunar features and albedo profiles.

Areas that are currently being studied as part of the Selected Areas Program are:

Table of SAP Features

Feature	Selenographic Latitude	Selenographic Longitude
Alphonsus	4°W	13°S
Aristarchus	47° W	23 °N
Atlas	43°E	46° N
Copernicus	20 °W	9° N
Plato	9° W	51° N
Theophilus	26° E	11° S
Tycho	11 °W	42 °S

All of the areas listed above were chosen because they are relatively easy to find, convenient to observe, and have historically shown numerous instances of suspected anomalies. Complete outline charts and observing forms are available from the ALPO Lunar Section for each of the features noted. Complete details on our observing programs can be found in the *ALPO Lunar Selected Areas Handbook*. Individuals interested in participating in the ALPO Lunar Selected Areas Program should contact the author for further information and assistance.

Visit the ALPO Lunar Selected Areas Program on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/lunarstuff/selarea.html

Mars Section
By Dan Troiani, coordinator

(Report in preparation for next Journal.)

Minor Planets Section
By Frederick Pilcher, coordinator

The *Minor Planets Bulletin*, Vol. 30, No. 3, 2003 July-September, published light curves of 29 different asteroids by 19 observers at 9 different observatories.

One of the most significant was by Colin Bembrick and Barney Pereghy of Australia of the aten-type minor planet (5604) 1992FE at an unusually close approach not to be repeated for many years. Due to faintness, the light curve is extremely noisy but complete coverage indicates a period of 6.026 $\pm$ 0.009 hours, amplitude 0.15$\pm$ 0.05 magnitudes.

Robert D. Stephens of Rancho Cucamonga, CA, and Brian D. Warner of Colorado Springs, CO, found for 5468 Hamatonbetsu a remarkably long period of 42.02 $\pm$ 0.05 hours, amplitude 0.43 $\pm$ 0.03 magnitudes, and an unsymmetrical light curve. They explain the challenges of merging light curves of slow rotators from two different observatories.

During the 1990's the widespread introduction of CCD's and precision astrometric reduction software fostered a “golden age” in which amateurs with small telescopes could discover new asteroids and obtain very accurate astrometric positions. In the 21st century, the enormous quantity of observatories by professional surveys, including especially LINEAR and LONEOS, is overwhelming the amateurs and bringing this golden age to a close.

But Richard A. Kowalski explains that even as the golden age of amateur astrometry is closing, a new golden age of amateur astrometry is opening, as evidenced in part by the number of asteroid light curves published in a single three-month interval as described above.

Upon discovery of a close approaching asteroid, participating amateur observers perform CCD photometry to obtain rotation periods and shapes. These photometric observations can be combined with radar observations to provide more information on asteroid shapes and rotational axes alone. These methods are also being applied to main belt asteroids.

Mikko Kaasalainen of the University of Helsinki (Finland) is developing light curves of a single asteroid at widely separated places in the sky essential for shape modeling and locating pole positions. Thus, each asteroid in the program must be observed at several

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different apparitions. This, in turn, increases without upper bound the number of opportunities for amateur CCD photometrists to make scientifically valuable observations.

Visit the ALPO Minor Planets Section on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/minplan.html

Jupiter Section

By Richard W. Schmude, Jr., coordinator

Dr. Schmude has just completed the 2002-03 Jupiter report and it is now in the hands of JALPO editor Ken Poshedly for future publication.

The 2003-04 Jupiter apparition has just begun. Two events to keep an eye on are the darkening of the Great Red Spot and a small dark oval in the South Tropical Zone. The North Temperate Belt is still very weak. People are encouraged to watch all longitudes of Jupiter and not just the area near the Great Red Spot. Please continue to send observations to Dr. Schmude and to John McAnallly.

Visit the ALPO Jupiter Section on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/jup.html

Saturn Section

By Julius Benton, coordinator

The 2003-2004 Apparition of Saturn is well-underway, and observers have already begun to submit images, drawings, and descriptive reports. Opposition occurs on December 31st with Saturn well-placed throughout the winter months for long-term observation.

Some highlights of the current apparition so far include numerous reports and images of small white spots in the STrZ and STeZ, along with several dark features along the SEBs. Several confirming reports of these discrete phenomena have been received, including a few simultaneous observations. Observers have been sending in their reports in a very timely manner, permitting comparative analysis much sooner during the apparition than in the past.

Regular observing programs include:

1. Visual numerical relative intensity estimates of belts, zones, and ring components.
2. Full-disc drawings and sectional sketches of global and ring phenomena (the Saturn Section furnishes templates with the correct global oblateness and ring geometry to facilitate drawing). All drawings submitted for publication must be originals, not photocopies copies.
3. Central meridian (CM) transit timings of details in belts and zones on the globe of Saturn (utilized to deterimine or confirm rotation rates in various latitudes).
4. Latitude estimates or filar micrometer measurements of belts and zones on the globe of Saturn.
5. Colorimetry and absolute color estimates of globe and ring features.
6. Observation of “intensity minima” in the rings (in addition to observations of Cassini’s and Encke’s divisions).
7. Observational monitoring of the bicolored aspect of the rings of Saturn.
8. Observations of stellar occultations by Saturn's rings (the most recent occultation of a 8.4 magnitude star by Saturn and its ring system occurred on November 14-15, 2003).
9. Visual observations and magnitude estimates of the satellites of Saturn.
10. Routine photography, CCD imaging, photoelectric photometry, and videography of Saturn and its ring system.

In addition to the above programs, all ALPO Saturn observers are strongly encouraged to participate in a systematic observational patrol of the planet as part of an Amateur-Professional Cassini Observing Patrol during 2004 (this means observations will begin during the current 2003-2004 apparition). Cassini's arrival at Saturn (orbit insertion) occurs on July 1, 2004, followed by the Titan Probe Entry and Orbiter flyby on November 27, 2004.

What will be most useful to the professional community will be digital images of Saturn at wavelengths ranging from 400 nm - 1 micron in good seeing using webcams, ccd’s, digital cameras, and videocams. This effort will begin with great intensity during April of 2004 (to coincide with when Cassini starts observing Saturn at close range). Classical broadband filters (e.g., Johnson system: B, V, R and I) are recommended. For telescopes with large apertures (e.g., 30.0 cm. and greater), imaging through a 890-nm

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narrow band methane filter will also be extremely worthwhile.

The Cassini Team is hoping that ALPO Saturn observers will carefully and systematically patrol the planet every clear night to search for individual features, their motions and morphology, to serve as input to Cassini's imaging system, thereby indicating to Cassini scientists where interesting (large-scale) targets exist. Suspected changes in belt and zone reflectivity (i.e., intensity) and color will be also useful, so visual observers can also play a very useful role by making careful visual numerical relative intensity estimates. The Cassini team also would like to combine ALPO Saturn Section images with data from the Hubble Space Telescope and from other professional ground-based observatories (a number of proposals have been submitted).

Please contact the ALPO Saturn Section coordinator for more details on how to participate in this very important program.

Further information on ALPO Saturn programs, including observing forms and instructions, can be found on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/sat.html

All are invited to also subscribe to the Saturn e-mail diuscussion group at Saturn-ALPO@yahoogroups.com

Remote Planets Section

By Richard W. Schmude, Jr., coordinator

The 2003 apparitions of Uranus, Neptune and Pluto are winding down. You may still be able to see Uranus in the early evening until January. Uranus and Neptune were about as bright as they were last year. People are encouraged to observe the limbs of Uranus. There have been reports of some areas on that planet appearing brighter than other areas.

The 2002 Apparition report of Uranus, Neptune and Pluto was submitted to the editor back in the Summer. This section coordinator will begin writing the 2003 apparition report next May so please send in any 2003 observations as soon as possible.

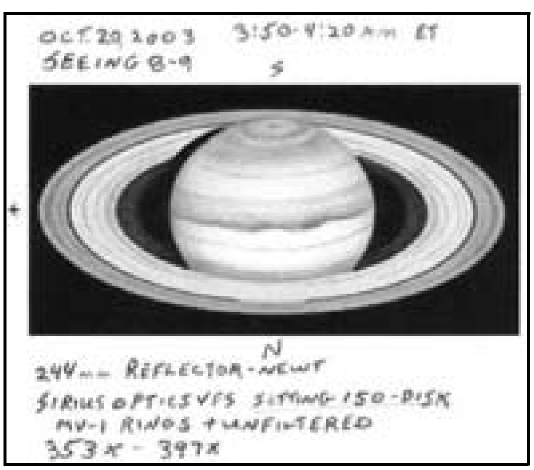
Visit the ALPO Remote Planets Section on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/remplan.html

Interest Section Reports

Training Section

By Tim Robertson, acting coordinator

The ALPO Training Program would like to congratulate Carol Stewart of Cape Coral, Florida, for her successful completion of the Basic Level of the Training Program in only seven months. She is now perfecting her observing skills as she advances through the Novice Level to finally obtain Observer Status. Great job Carol!



(Left) Drawing of Saturn by Sol Robbins on October 20, 2003 at 08:50-09:20UT; CCD image by Ed Grafton on the same date October 20, 2003 at 10:43UT. Details included in images. See text of Saturn Section report.

Inside the ALPO
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The ALPO Training Program currently has 10 active students at various stages of training. And in the past three months, we have had orders for over 50 copies of the *Novice Observers Handbook*. This spike in orders has been attributed to the June 2003 ALPO Training Program article in *Sky & Telescope* magazine that accompanied the Mars 2003 article.

During the month of August, I presented "Mars Observing" workshops at the Griffith Observatory Satellite facility in Los Angeles. During the presentations, I showed the latest observations made of Mars-both ccd images and drawings, then I had the attendees draw Mars using the ALPO Mars Observing Form and a small image of Mars on the projection screen. The image is an example of what Mars looked like that particular evening; we then identified the various features, so when we got out to the many telescopes setup in the parking lot later, we were able to identify the features we discussed.

At the time of this writing, I had already completed two of the sessions, which highlighted the work done by the ALPO and also instructions on how to make valuable observations of Mars with a telescope. On August 2nd, we had over 600 people at the Griffith Observatory Mars observing session, and my talk was before a standing-room-only audience. The second evening, August 9th, the Observatory had over 2,000 persons in attendance, and once again, a standing-room-only audience for my presentation.

In my discussions with Griffith Observatory Astronomer Tony Cook that week, he expressed concerns regarding the size of the crowds at the upcoming evenings (August 16, 23, 26 and 30th). This was the first time that the Observatory, which is currently under re-construction, has held an evening event away from the main observatory location. For more information visit http://www.griffithobs.org/

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The ALPO Training Program is a two-step program, and there is no time requirement for completing the steps. But I have seen that those students that are motivated usually complete the steps in a short amount of time. The motivation comes from the desire to improve their observing skills and contribute to the pages of the Journal of the ALPO.

The Lunar and Planetary Training Program is open to all members of the ALPO, beginner as well as the expert observer. The goal is to help make members proficient observers. The ALPO revolves around the submission of astronomical observations of members for the purposes of scientific research. Therefore, it is the responsibility of our organization to guide prospective contributors toward a productive and meaningful scientific observation.

The course of instruction for the Training Program is two tiered. The first tier is known as the "Basic Level" and includes reading the ALPO's *Novice Observers Handbook* and mastering the fundamentals of observing. These fundamentals include performing simple calculations and understanding observing techniques. When the student has successfully demonstrated these skills, he or she can advance to the "Novice Level" for further training where one can specialize in one or more areas of study. This includes obtaining and reading handbooks for specific lunar and planetary subjects. The novice then continues to learn and refine upon observing techniques specific to his or her area of study and is assigned to a tutor to monitor the novice's progress in the Novice Level of the program. When the novice has mastered this final phase of the program, that person can then be certified to "Observer Status" for that particular field.

For more information on the ALPO Training Program, send e-mail to cometman@cometman.net, or write to Tim Robertson at 2010 Hillgate Way #L, Simi Valley CA, 93065.

Visit the ALPO training program section on the World Wide Web at http://www.cometman.net/alpo

Astronomy History for ALPO Members at the AAS

ALPO members may be especially interested in attending a presentation of the Historical Astronomical Division of the American Astronomical Society (AAS) when it meets in Atlanta, GA, January 4 - 8, 2004. The division is chaired by ALPO member Dr. Thomas R. Williams.

On January 5, Ms. Melissa Gottwald, project archivist for the Tombaugh Papers in the New Mexico State University Library, will present the paper "Clyde W. Tombaugh Papers and the Rio Grande Historical Collections: Preserving the History of Astronomy".

For more information about this meeting on the World Wide Web, go to http://www.aas.org

Minutes of the ALPO Board Meeting, Boardman, Ohio, August 8, 2003

(Presented herewith are the official minutes of the ALPO Board of Directors meeting held at the ALPO Conference in Boardman, Ohio, on August 8, 2003 as compiled and submitted by ALPO Recording Secretary Elizabeth Westfall. All photos by Ken Poshedly.)

Attending: Ken Poshedly, Richard Schmude, Walter Haas, Matt Will, Don Parker, John Westfall, Elizabeth Westfall, Julius Benton by speaker phone.

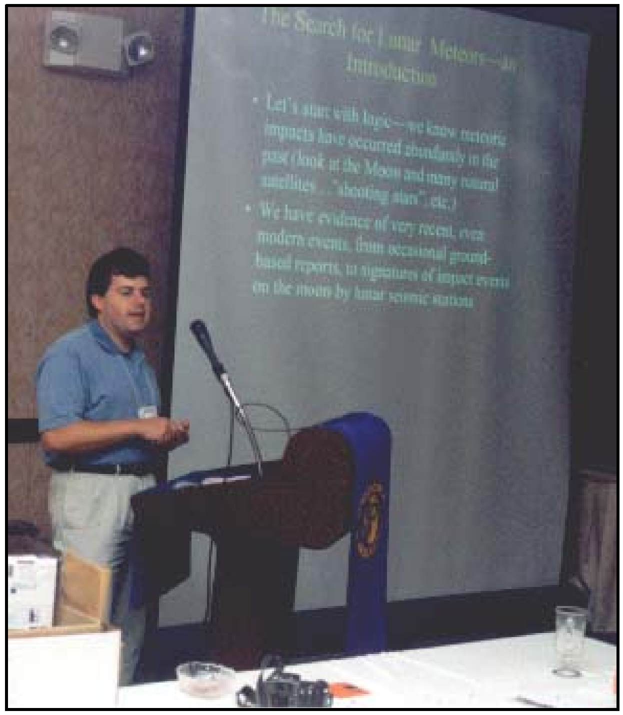
Invited guests for specific agenda items:

- Mike Reynolds re: 2004 meeting in Oakland, CA with other groups
- Terri Mann, Marion Bachtell re: ALPO share offices with AL

ALPO Meeting 2004

(July 20-24, 2004; paper sessions Wednesday, July 21, through Saturday, July 24)

Mike Reynolds updated the board on plans for the 2004 meeting, originally planned for Chabot Science Center in Oakland. It has expanded from an ALPO meeting to an inclusive meeting now called "AstroCon 2004". The organizations participating now are the ALPO, Astronomical League (AL), American Assn. of Variable Star Observers (AAVSO), and the Astronomical Society of the Pacific (ASP). For size and scheduling reasons, the meeting will now be held at Mills College in Oakland. The umbrella group, Astronomical Associations of Northern California (AANC) has already taken the lead to be the host group and has begun to organize arrangements. Dorm housing and meetings will be at Mills College; alternative hotels will also be available. Mike hopes to have an opening reception and observing on Tuesday night, July 20, and the closing banquet on Saturday night, July 24, on the USS Hornet. Possible field trips may include Lick Observatory, Bay Area family tours, and a post-convention Yosemite Observing trip.



Brian Cudnik reports on the continuing search for impacts by lunar meteorites.

With so many groups, the Board would like to avoid concurrent sessions as much as possible to increase interaction between attendees of the several organizations. One suggestion was to have shorter (20-minute) presentations, and fewer longer presentations. Also, the ALPO speakers will be integrated with those from other groups. However, ALPO will select their speakers, and hopefully schedule them into ALPO-allotted time slots. Mike Reynolds will work with Executive Director Richard Schmude on details. John and Beth Westfall will represent the ALPO at planning meetings being held in Oakland, and will keep in touch with Mike and Richard.

Group photo of most attendees at this year's ALPO Conference at Boardman, Ohio. ALPO founder and director emeritus Walter Haas is just right of center in front row with white shirt

ALPO Offices at the Astronomical League HQ in Kansas City

Terri Mann and Marion Bachtell of the AL presented their proposal for the ALPO sharing office space at the new AL headquarters in Kansas City, due to open this fall. ALPO would have one approxi-

On tour at Brashear LP (Wampum, near Pittsburgh, PA), a producer of the most precise telescope systems in the world.

mately 120 sq. ft. office in their suite of 4 offices for $300 per month ($3,600 per year). Included are desks, filing cabinets, utilities, and office support.

After extensive discussion, the board decided that we could not afford an on-going expense of $3,600 per year. The motion was made and approved that we support the efforts of the AL, but we cannot support this financially, and will revisit the issue in one year. Don Parker will so inform the AL.

Treasurer's /Membership Report

Matt Will reported that membership has increased in the past year to 492 members as of June 30, 2003, helped perhaps by the interest in Mars, and also by the ease of joining using the Web site and on-line payments via the Astronomical League; many thanks to Don Parker and to Bob Gent and Marion Bachtell of the AL for setting up this procedure. In addition, more people are subscribing to the electronic version of the Journal. For all of these reasons, there is no need to increase dues at this time.

Bank Account Balances

- Springfield account (6/29/03) -- $8,339.81 *
- Las Cruces account (6/4/03) -- $2,546.15
- San Francisco account (6/13/03) -- $2,131.98
- Endowment Fund (3/31/03) -- $14,333.62

(*Springfield account is somewhat inflated, as it includes conference registrations paid, but no conference expenses had yet been paid.)

Matt pointed out that several staff members had not yet renewed their membership, probably due to oversight. They will be contacted, as their membership must be current for them to hold staff positions.

Many more details are available in the excellent and detailed Treasurer's report of July 14, 2003.

Standing Rules

Matt Will added guidelines to clarify the process for selecting awardees for the Walter Haas Award (for observing), selected by a committee named by the Director Emeritus; and the Peggy Haas Award (for service), selected at the discretion of the Executive Director. Suggested names for either award winner can be submitted by members to the appropriate person.

Staff Changes

The following staff were changed from "acting" to permanent status:

- Publications: Ken Poshedly
- General Editor: Roger Venable
- Graphics: John Sanford
- Staff Writer: Eric Douglass
- Mercury Section: Frank Melillo
- Lunar Section-LTP: Anthony Cook
- Mars Section: Deborah Hines
- Meteors Section: Robin Gray
- Youth Section: Tim Robertson
- Historical Section: Tom Dobbins

A motion was made and passed that coordinators should report each year to the Board prior to the Annual Meeting,

At the University of Pittsburgh (PA) Allegheny Observatory with the 30-inch Thaw refractor.

ALPO Historical Section Assistant Coordinator Tom Dobbins with (from left) Tan Wei Leong of Singapore, Eric Ng of Hong Kong, and Alan Chou also of Hong Kong. Messrs. Leong, Ng and Chou are currently working back home to found an ALPO-like amateur astronomy organization for those in Asia.

recommendations on whether acting coordinators should be made permanent, dropped, or remain as acting.

Bylaw Changes

The Board approved an amendment to the Bylaws to change the address of record from San Francisco, CA, to Antioch, CA, as required by California law. The ALPO Secretary will file the appropriate papers with the State of California Department of Corporations.

Lunar Domes Survey

Marvin Huddleston requested that the Lunar Domes Survey program be re-activated under his leadership. The Board approved this program, and Ken Poshedly will add a note in the journal about the renewed program, and that the more general Topographical Studies program will also continue.

Dark Sky Representative

Richard Schmude reported that Bob Gent of the AL has asked all organizations to appoint a "dark sky representative" to promote dark sky regulations. Since the ALPO is not organized on a geographical basis, the Board was unclear how we might implement this request. Richard will write up the responsibilities and then solicit a volunteer.

Board Vacancy

During the spring, Rik Hill resigned from the Board for health reasons. The Board thanked him for his productive participation on the Board. The Board will take the time to select a replacement. Three names were put forward, each individual confirmed interest in the Board, and each has been asked to submit a statement of qualifications and vision of ALPO. These statements will be reviewed by the Board. (Note: Mike Reynolds has since been named to the board position.)

Future Meetings

- 2004 – July 20-24, Mills College, Oakland, CA, confirmed
- 2005 – Possibly with the Astronomical League in Kansas City. Don Parker will contact AL
- 2006 – Ken Poshedly asks ALPO to consider another meeting in Atlanta

Endowment Fund

Matt Will had prepared a document outlining a plan to build our endowment fund through grant proposals and fund raising. One of the first steps is defining the purpose of the fund. Discussions regarding the ALPO office at the AL headquarters helped us to focus our ideas. Walter Haas mentioned that papers of members are already scattered. For example, Chick Capen's papers are at Roper Mountain Science Center, and Walter's papers are at New Mexico State University. It was agreed that the greatest need is a central repository for archived observations, reports, solar system images from other sources that are in danger of being discarded, and historical books and instruments donated by members. Matt Will is writing up proposals for goals and a timeline for grants/funding. Matt also stated that he thought that the Springfield, IL, ALPO account might be able to transfer approximately $2,000 into the Endowment Fund, but he had to carefully examine the accounts before committing any funds.

ALPO Scrapbook

The Board enjoyed Phil Budine's meeting paper, a photographic reminiscence of his years of ALPO activities. Can we find a volunteer to assemble a similar record of people and events to enhance our corporate memory?

Next Director

At the close of this annual meeting, Richard Schmude was recognized as the incoming Executive Director, with Matt Will to succeed him in two years.

Adjournment

With no other business before it, the Board moved and approved adjournment.

ALPO board members in attendance at this year's meeting include (from left) Ken Poshedly, Matt Will, Elizabeth Westfall, Walter Haas, Richard Schmude, Don Parker and John Westfall.

ALPO Feature: The Sun
High Resolution Solar Imaging

By Gordon Garcia,
assistant coordinator, ALPO Solar Section
e-mail: gordg@megsinet.net

Abstract

Solar imaging is much like lunar and planetary imaging in that quality optics, a stable mount and long focal lengths are needed to achieve good results. Reduction of glare and both infrared and ultraviolet radiation is the primary difference. This can work to the observer's advantage by allowing very short shutter speeds, even at extremely long focal lengths. Apertures from 6 to 10 inches and larger can produce professional results.

Considerations

Imaging the Sun is much like imaging the Moon or the planets. Excellent optics and a stable mount are necessary to achieve good results. The Sun, because it is so bright, does not require huge apertures to collect light. In fact, daytime seeing conditions necessitate smaller apertures most of the time. However, apertures in the 6-to-10-inch range and even larger can produce truly professional results.

Patience and attention to local seeing conditions at your observing site are key to high resolution work. One must know when the seeing is best due to localized heating conditions. In the summer, the early morning hours – when the Sun is 20 to 30 degrees above my eastern horizon – give me my best seeing and highest resolution photos. And, due to my locale (northern Illinois), winter results in my worst solar seeing, due to heat from local houses and the Sun's southern declination.

Also, the number of images you take during an observing session will affect your results. The more images you take, the higher the probability that you will get some good ones.

Equipment

I initially began solar imaging using an 8-inch Schmidt-Cassegrain (S-C) telescope on its standard fork mount. I found my results instantly improved when I put the optical tube assembly on a more stable German equatorial mount. I used the Celestron 8-inch S-C telescope with a 75 mm off-axis mask containing a single layer of Tuthill "Solar Skreen" mylar film. For Hydrogen-alpha (H-alpha) work, I used a 63 off-axis energy rejection filter. Although my results were good, this wasn't enough aperture for high-resolution work. I have since been using a 5.1 inch, f/8 apochromat refractor. and a 6.1 inch, f/9 apochromat refractor for solar observing and imaging. I use both telescopes at full aperture and at long focal lengths (over 10,000 mm).

I first began photographing the Sun using an Olympus OM-1 camera body with color slide and color print film. Again my results were acceptable, but not

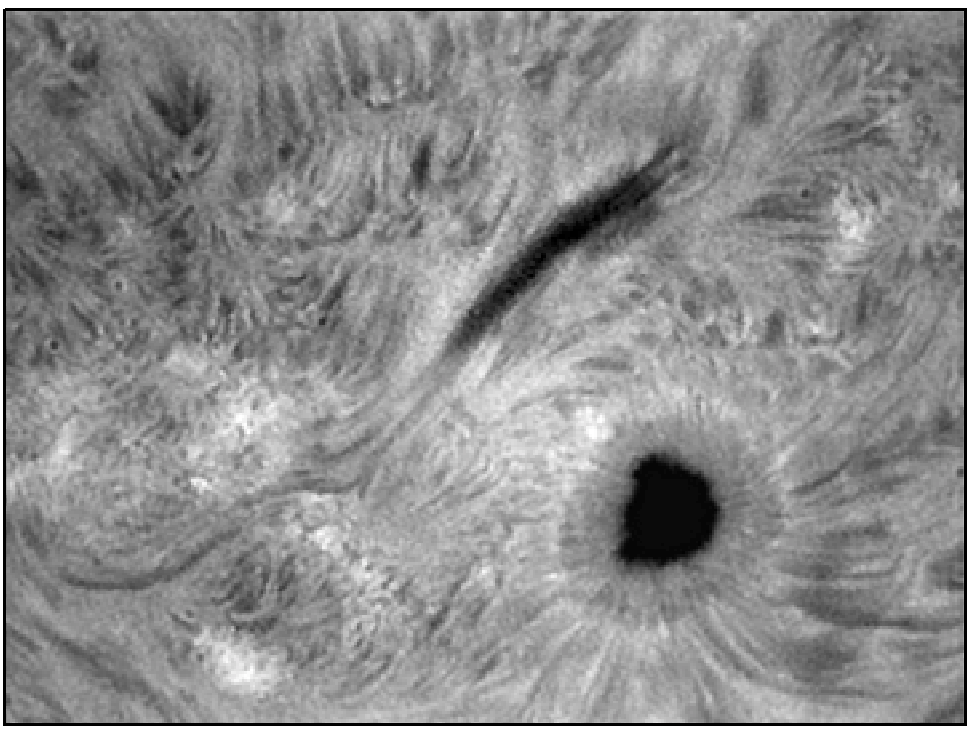


Figure 1: Image taken 18 May 2002, 17:32 UT; Rotation 1989, AR 9948. Astro-Physics refractor with 120 mm ERF AP Tele-centric system with 26 mm plossl (9x). DayStar 0.38 A. H-alpha filter; AVA Astrovid 2000 video camera (live frame-grab). North is at top, west to right. Photo by the author.

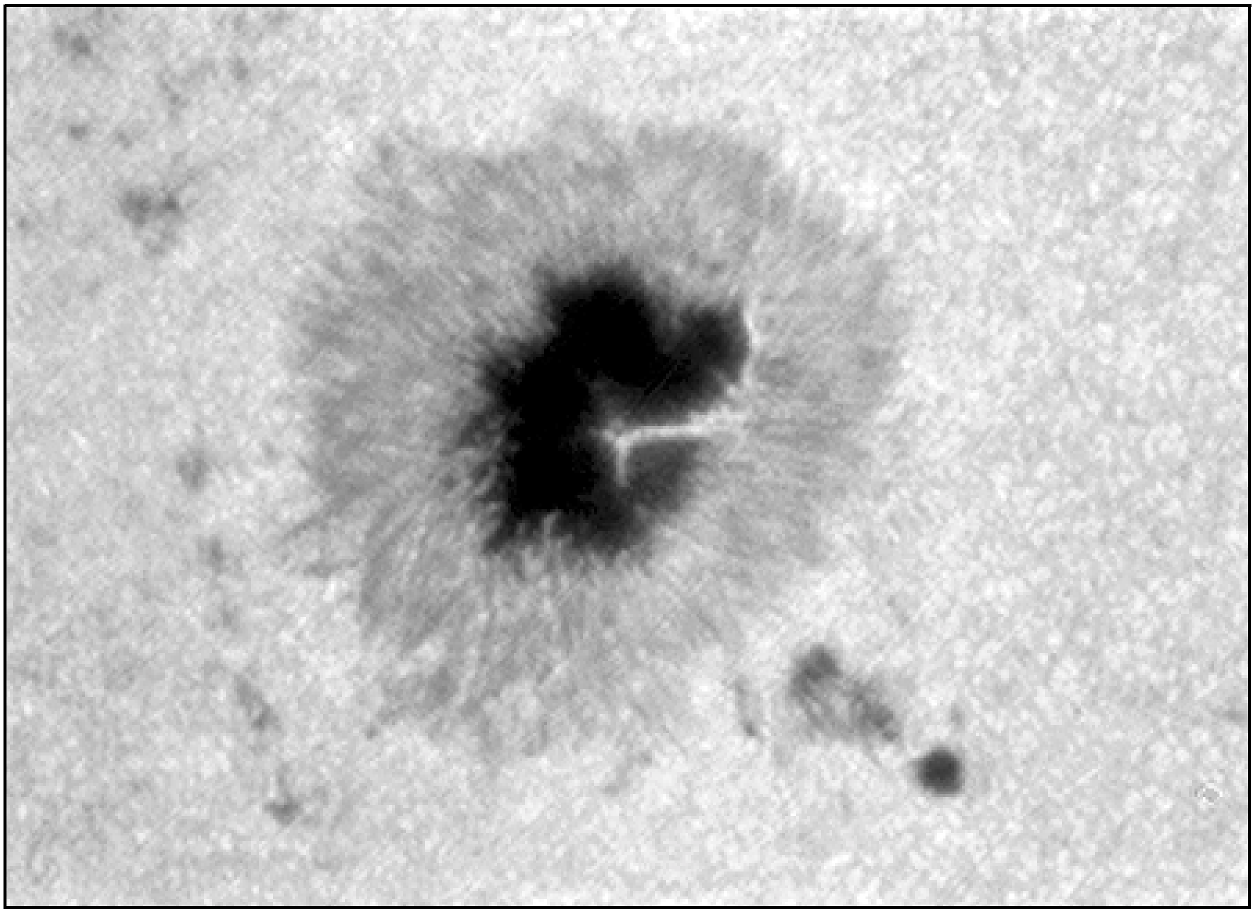


Figure 2: Image taken 23 June 2002, 13:19 UT; Rotation 1991, AR 0008. Astro-Physics 155 mm, f/9 Star ED refractor with Baader Herschel wedge prism and Baader flat field corrector; 14 mm Pentax eyepiece with ND1.0 and green filters; AVA Astrovid 2000 video camera (live frame-grab). North is at top, west to right. Photo by the author.

what I would consider now as high resolution work. I then began photographing the Sun with Kodak Technical Pan 2415 black and white film (in 1989). Technical pan film has excellent resolution and very fine grain. It also has extended red sensitivity for H-alpha solar imaging. I use Kodak D19 developer for H-alpha work and Kodak HC-110 (Dilution B) for white light negatives. The only problem is that you must develop and print your own images to achieve desirable results. Also, the price of photographic supplies has steadily risen over the years, so the time and cost involved in developing and printing several roles of film become somewhat expensive.

I used the Olympus clear (1-12) focusing screen and right angle "varimagnifier" to achieve final focus. I also used a single layer of Tuthill "Solar Skreen" mylar behind the camera since the image through the optical system was far too bright to view with the unaided eye. I used a single layer of Tuthill "Solar Skreen" in front of the telescope aperture (approximately ND 1.5). This allowed a 1/1,000 second exposure (the fastest exposure setting on the camera) with a broadband green filter and approximately 9,500 mm focal length. I also used an air bulb cable release to prevent vibration.

Monitoring seeing was a problem, since shutter speeds slower than 1/500 of second required locking the mirror up to prevent vibrations from mirror slap. However, at slower shutter speeds I was usually doing whole disk H-alpha imaging (resolution on the order of 3-4 arc seconds). I would monitor the seeing with an additional piece of mylar (ND 1.5) between my eye and the camera when using longer focal lengths and then snap the shutter during periods of good seeing. Although I was achieving good results at this point, I was seldom using an entire role of Technical Pan film during a single observing session. To achieve better results I would have to take more images during an observing session.

In 1995, I purchased a digital imaging camera. This was my initiation into electronic imaging. The camera had a small ccd sensor (320 x 240 pixels) — adequate for planetary imaging, but rather small for high resolution solar work. To achieve high resolution with a small image sensor, several images must be taken and then assembled together with computer software.

While the digital camera allowed me to take many more images than I could with the 35 mm SLR camera and conventional film, there were also disadvantages. One of the drawbacks was that it was difficult to focus. I used an eyepiece that was parfocal with the camera and a dual-aperture imaging mask. Also, it was very difficult to see the computer screen in broad daylight. Plus, I kept the computer in the house and ran the necessary serial cable to the computer from the house, a distance of about 20 feet.

The fastest shutter speed was 1/100 of a second, which was slow for high resolution solar work. Another problem with this digital camera was that an interference fringe pattern was produced when imaging the whole disk of the Sun with a H-alpha solar filter, thereby limiting its usefulness to imaging only solar prominences.

Download times with the serial connection to the camera were also fairly slow. Most newer digital cameras use USB now as the camera-to-computer connection.

I worked with this camera for a few years before deciding to try my hand at video imaging. Consumer digital cameras now have very large either ccd or CMOS sensors. These are now available at affordable costs. Most require that you do afocal projection as they have fixed lenses. They also have faster shutter speeds than digital cameras designed solely for long exposure astronomical imaging. Digital cameras with removable lenses are still very expensive, but prices continue to fall. These cameras also produce excellent results and usually allow more images during an observing session.

I then purchased a video camera and a digital framegrabber. I liked this video camera (Astrovid 2000) because the camera controls were all external on a separate box so you did not have to touch the camera once it was attached to your telescope. Having control over the camera shutter speed, gain and gamma without having to adjust it with a screwdriver is a big plus. This camera also had a much larger

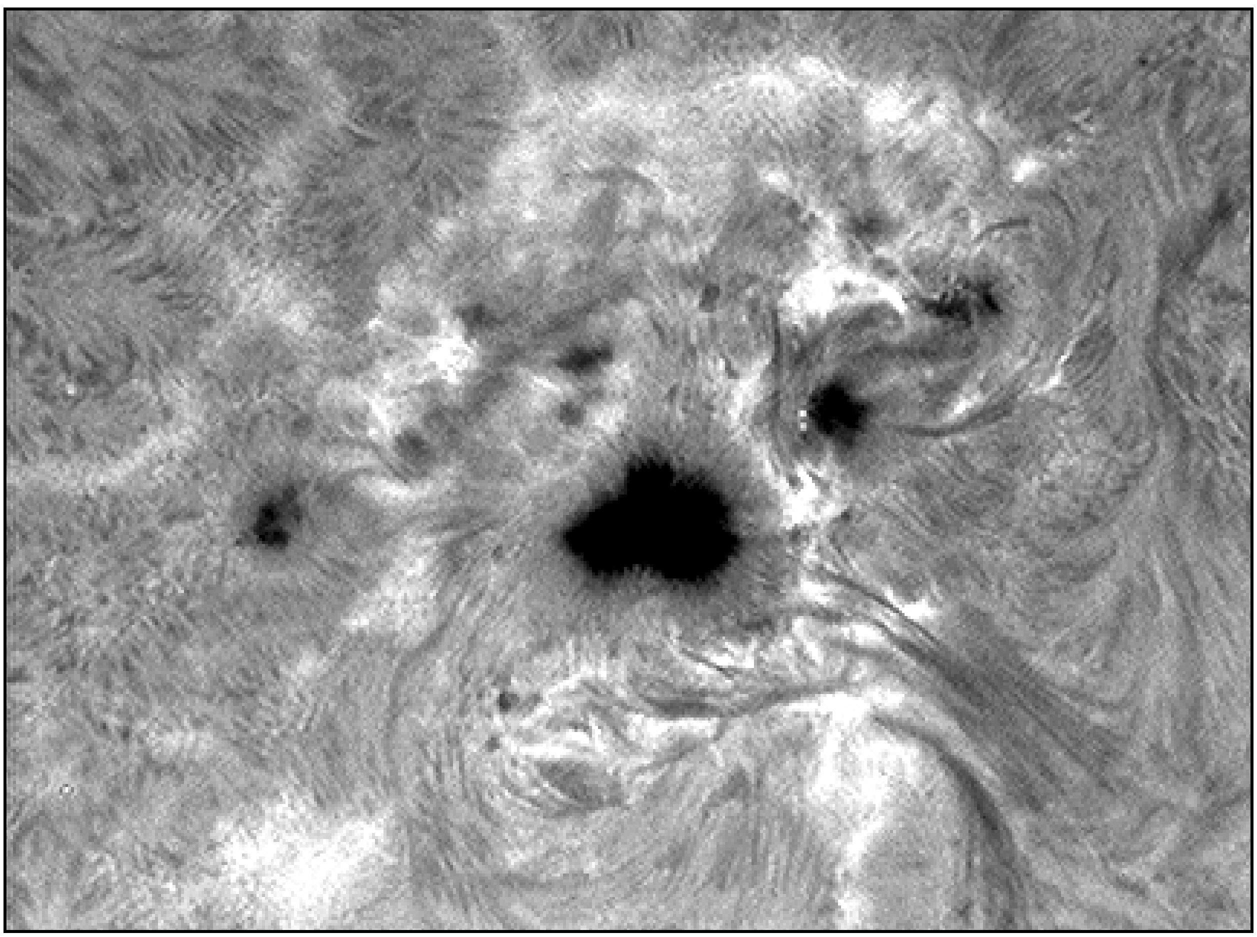


Figure 3: Image taken 18 August 2002, 16:14 UT; Rotation 1993, AR 0069. Astro-Physics EDT refractor at 130 mm, f/8, with 120 mm ERF. DayStar 0.38 A. H-alpha filter; Barlow projection (f/30); AVA Astrovid 2000 video camera (live frame-grab). North is at top, west to right. Photo by the author.

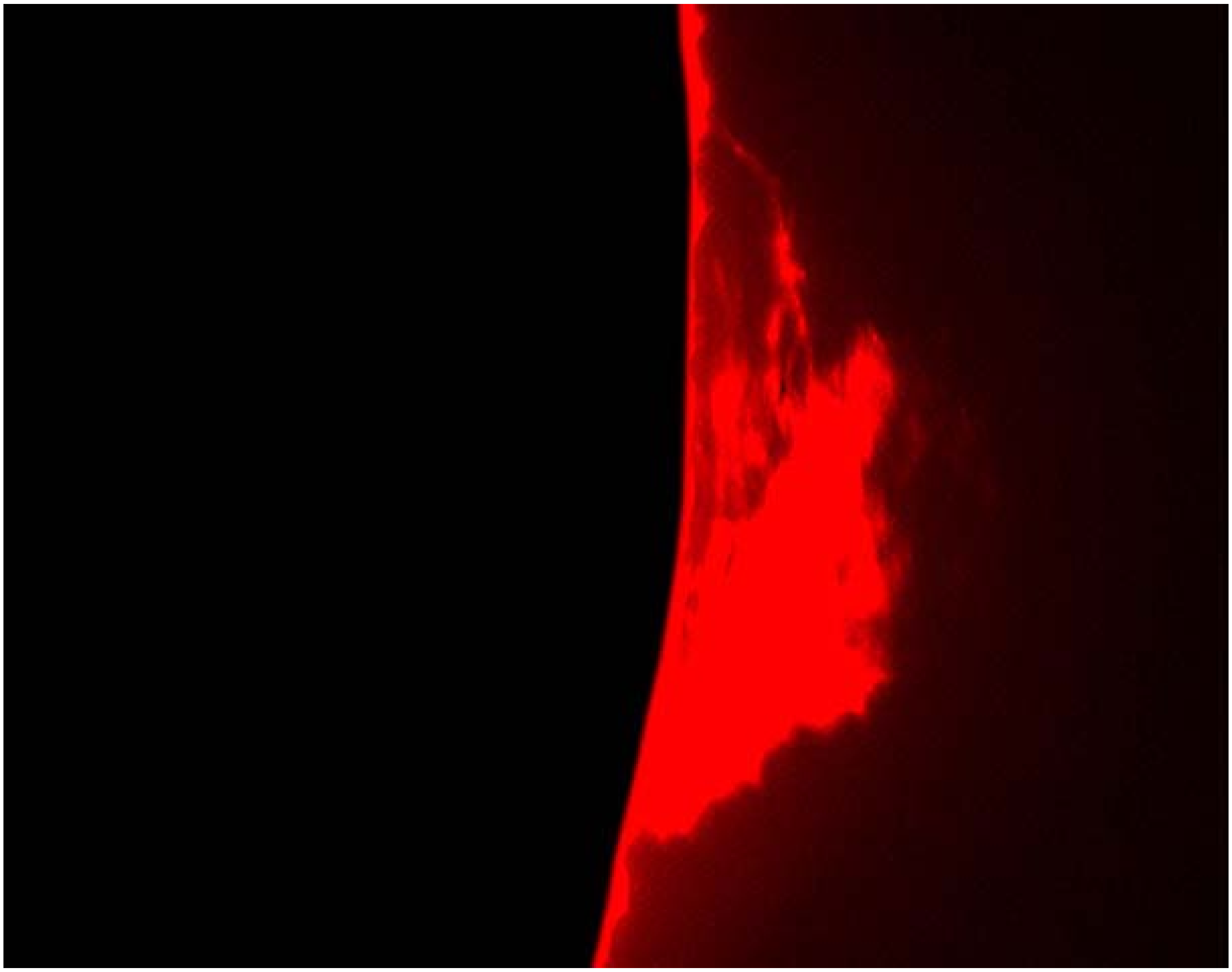


Figure 4: Image of prominence on west limb of Sun taken 5 March 2000, 16:55 UT; Rotation 1960. Astro-Physics 130 mm, f/8 Starfire ED refractor with 4x TeleVue Powermate, 120 mm Baader ERF (on-axis), and DayStar 0.56 A. H-alpha filter tuned to the centerline; AVA Astrovid 2000 video camera (live frame-grab). North is at top, west to right. Photo by the author.

CCD sensor than the digital camera I previously owned.

I now record images either to Super-VHS tape or capture them directly from the video camera to the computer using a frame grabber that converts the analog video signal to a digital image. The initial frame-grabber I used was too slow for imaging. I then purchased one that allowed me to grab an image to computer RAM as fast as I could press the Enter key on my computer keyboard. This is important for capturing a large number of images. When I see an image that looks good, I save it to the computer's hard drive. This allowed a ten-fold increase in images I could produce in an imaging session. And capturing to video tape at 30 frames (60 fields) each second results in a huge amount of images to choose from.

To achieve better results, I would suggest using a digital VCR or camcorder as the recording device, or a frame-grabber that is able to capture many images directly to the computer (digital mini-DV recording allows more resolution than S-VHS, 500 versus 400 horizontal lines). I check the initial image or two to ensure proper exposure. I do not process the images until after the imaging session has been completed. The goal is to capture as many images as possible during your observing session.

The next step is review, select and process the images to enhance the image's contrast and sharpness using computer software. There are many software packages to choose from. I find that I use several software packages to process my images. Using separate programs — one geared towards astronomical imaging and another geared towards graphic arts — is the ideal way to go. The astronomical image enhancement software is great for adjusting the histogram, increasing contrast, sharpness, etc. And the software geared towards graphic arts is needed to add titles or text, crop the image, create mosaics, etc. The differences between the two general types are gradually disappearing. On the other hand, software that is intended to perform one function such as stacking images and stitching them together, is becoming very popular. Some of this software is available at no cost to the observer.

My own H-alpha set-up includes a DayStar 0.38 Angstrom filter, 150 mm energy rejection filter and various Barlows, including a 4x TeleVue Powermate amplifier. The 4x gives a focal length of 5,600 mm with my 6-inch refractor. I also have added eyepiece projection behind the filter-Barlow combination to increase the focal length of the system even more.

With the video camera, a moderately sized sunspot group will fill the screen. I use a Toshiba 12-inch, high-resolution (800-line) monitor for focusing. The image on my laptop screen is simply not sharp enough to accurately judge focus. I made a cardboard shield and head-cover for the high-resolution monitor screen so I can see it in bright sunlight, then I use a bungee cord to attach the shield to the monitor which is on a small cart with wheels. I then place the monitor in a position so I can easily focus the telescope while viewing the monitor. My laptop is kept in the garage in darker conditions. I will usually take approximately 700 images and save about 150 to 200 images to disk during an observing session. Early morning hours in the summer months give me the best seeing conditions. After I am done imaging, I will take the camera off and sit back and do some visual observing.

After I started film photography and video imaging, I ceased to do drawings and sunspot counts. Someday, when I have more time, I would like to return to more visual observing.

When I am done imaging, I review the video tape or frame-grabbed images from the live grabs and select the best images for processing. I use Adobe's *Photoshop*, *Maxim DL*, *ImagesPlus* and now *Registax* software for processing the images. Each program gives different results. *Registax* is a program for aligning and stacking images. I will try several unsharp masking routines on my images. For H-alpha images I prefer to actually create an unsharp mask and subtract it from the original image. This technique was developed by deep sky photographer Jerry Lodriguss and adapted for planetary imaging by planetary observers Jim Ferreira and David Moore (Videoastro).

When I am finished processing I add descriptive text in Adobe *Photoshop*. I always save an original raw image, a processed TIFF image and a JPEG image for electronic transmission to amateur solar astronomy organizations.

For white light imaging, I now prefer using a Baader Planetarium Herschel wedge and eyepiece projection. There is nothing now in front of the lense to add wave front error. The key thing to remember is take many images as often as you can. I have to take many images to get a few outstanding ones. Take notes including date and accurate Universal Time for each image. Also record what equipment you used and what settings, etc. You can then later compare what works and what does not. The eyepieces I prefer are the Pentax XP series. These are 0.965-inch eyepieces designed for eyepiece projection photography.

I also began using them with the Baader Flat Field Corrector to achieve even longer focal lengths and I am also gearing up to try a new frame-grabber that will allow me to grab video directly to the hard disk so I will have a lot more images to work with. Grabbing and stacking a few images (10-50) in *Registax* reduces noise, but I find that it doesn't bring out any more detail than my single best image in the imaging run. I believe for this method to work in solar imaging, more images will be needed (100-1000) to average out seeing conditions in any given part of the image. The other method that works is to cut and paste the best portions of the best images taken during an imaging run. Because solar features change rapidly, note the time of the first and last images in a stack. Some features are moving so rapidly that you will not be able to stack them (e.g., eruptive prominences).

Conclusion

Like any astronomical imaging experience, patience and attention to detail pay off in the end. If you live in an area where seeing is often unsteady, you need to take a lot of images to get a few "keepers." It is well worth the effort. Use a telescope with good optics at long focal lengths, but with filtration to allow fast exposures on a steady clock-driven mount to achieve high resolution solar images. Be very careful though when imaging the Sun — provide adequate eye protection if you need to look visually through the optical system.

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ALPO Feature: The Sun
An Interesting Solar Prominence

**By Jamey Jenkins,
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Solar prominences are dense clouds of gas held above the surface of the sun by loops of magnetic field. Seen against the disc of the sun, prominences appear dark and are called filaments. When a prominence is viewed at the limb and suspended before the background sky it will appear bright. Filaments and prominences often remain in a quiet state for many days or weeks. However, as the magnetic loops that support them change, the prominences can erupt and vary in appearance over a time span of hours or a few minutes(1). For many observers, it is this dynamic aspect of solar prominences that make their study so appealing.

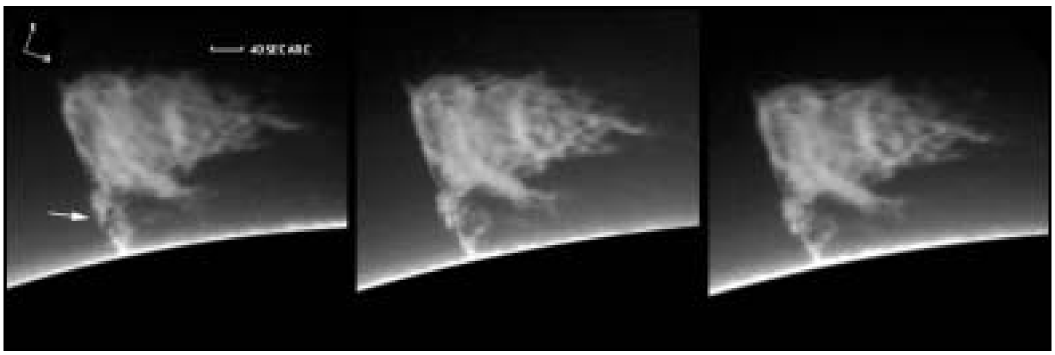

Figure 1. The prominence visible at 120× on the solar limb on 24 April, 2002. From left to right, these photos were obtained at 3-minute intervals beginning at 1403 UT. Note the development in the slender connection between the cloud and the solar limb (arrowed). Obtained with a 125mm aperture refractor at f/39 through a 10Ý hydrogen alpha filter. Photos by Jamey Jenkins.

On 24 April, 2002, an interesting prominence became visible at Position Angle 120× on the southeast limb of the Sun. This was a relatively compact feature that seemed to be attached to the limb by a very slender connection(2). Striking changes were visible minute by minute in the connecting "funnel" (see arrowed feature in Figure 1). Another unique character of this prominence was the apparent "wind swept" display of the cloud suspended above the limb.

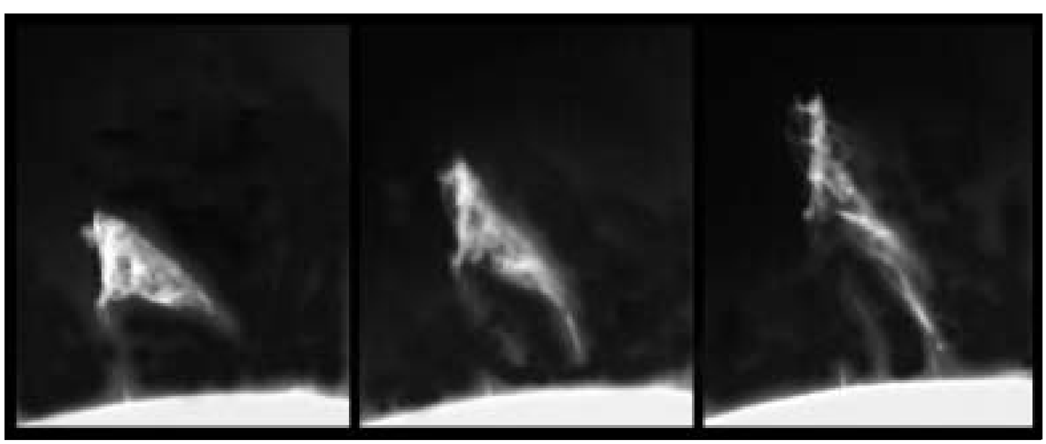

Figure 2. At approximately 1700 UT the prominence began to be ejected into space. From left to right, the images were obtained at 1702 UT, 1707 UT, and 1712 UT. Ejection was complete by 1723 UT. A Celestron C-8 was stopped down to 70mm aperture with an energy rejection filter and coupled with a 1.5Ý hydrogen alpha filter for these video-grabbed images. Photos by Larry McHenry.

The prominence maintained this status for quite a long period until about 1700 UT, when it was then ejected into space (see Fiure 2).

A search of Pic Du Midi coronograph images shows only a slight disturbance at PA 120× on 23 April, 1421 UT. This was surely about the time the prominence began to develop.

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2) BAA Solar Section Newsletter, April 2002, British Astronomical Association

ALPO Feature: The Moon

A Generic Classification of the Dome Near Piccolomini

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(Geologic Lunar Research group, GLR)

Introduction

Lunar domes are “positive relief features", which are similar to the low shield volcanoes found on Earth [1-2]. They represent the terminal phase of lunar volcanism and they occur mostly in the maria. There are a few in the highlands, but these are usually difficult to discern because of the brightness and ruggedness that characterises the surrounding highland materials. One theory argues that the higher reflectance of these domes suggests that they have a different mineralogy, and this is most consistent with lava having a lower iron and titanium content [3-5]. This idea is in agreement with the majority of highland domes being steep because low Fe and Ti lavas are less viscous and thus can be thought to pile up more easily, producing steeper constructs. The classical example of Highland domes is Gruithuisen Gamma which has a higher albedo than the nearby Mare Imbrium and also a steeper slope. This refers to " an early volcanism which was both unrelated to the physical maria and was also of different mineralogy " [5]. A second theory argues that highland domes are mare domes covered by a thin veneer of ejecta from the Imbrium impact [4].

Two papers which recently appeared in *Selenology*, the Journal of the American Lunar Society, described two highland domes, one near Zollner in [4] and the other near Piccolomini in [5]. The latter dome is the subject of this report. As described by some of us in [5], this dome “was originally drawn by Harold Hill on February 18, 1987 [6], without specific details as to the dome position or presence of summit craters”. By using our images, we described the position of this highland dome, not listed in the ALPO dome list, at 28.69° E and 27.50° S (Xi 0.426 and Eta -0.462). In this study, we report further measurements and include ccd imaging. This has made it possible to extract additional information for its classification and interpretation.

Figure 1: Lunar Orbiter frame 4-77 H1. The subject of this report is visible as the central craterlet.

Table 1: Contributing Observers and Instruments

Contributing Observers	Telescope Diameter and F/D	Type	Number of submitted reports
Bares A.	Newtonian, 250 mm, f/10	CCD	1 (M)
Fattinnanzi C.	Newtonian, 250 mm, f/6	Web-cam	1 (E)
Konkel G.	SC, 250 mm, f/10	Digital cam	1 (E)
Lena R.	Refractor, 100 mm f/15	Visual	4 (M) 2 (E)
Nardella S.	Maksutov150 mm, f/6	Web-cam	2 (M) 1 (E)
Viegas R.	Schmidt-Cassegrain, 250 mm f/10 Newtonian, 114 mm, f/8	Visual	4 (M) 2 (E)

NOTE: (M) and (E) refer to morning and evening illumination respectively.

Instruments and Measurements

This report is based on an analysis of 12 visual observations and 6 images taken under different solar altitudes and sent to us. We strongly encouraged observers to participate in organized, simultaneous observations.

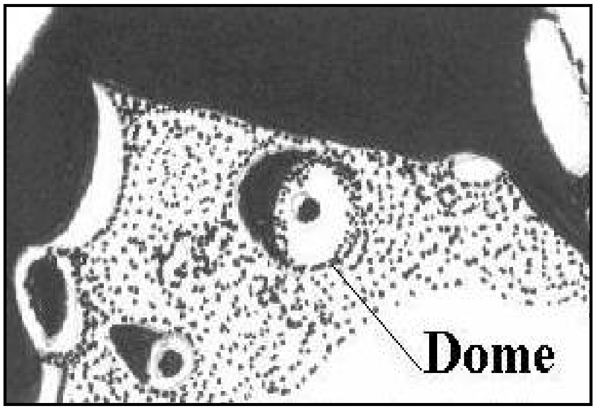

Figure 2: Evening illumination over the dome located at 28.69° E and 27.50° S. Observation carried out by R. Lena on 23 March 2003 at 03:13 UT. (H = 1.8°, A = 269.5°, C = 149.8°) with a refractor 100 mm f/15 at 250 x. Seeing II Antoniadi scale and X =0.25.

Table 1 lists the 6 observers, their instruments, and the number of observations they submitted. Utilizing a digitized version of the Lunar Orbiter Atlas, frame 4-77H1, with a resolution of 300 meters per pixel (Figure 1), the diameter values were obtained (Table 2). For each observation, we calculated the solar altitude (H) and azimuth (A) as seen from the dome, and the colongitude (C), using the *Lunar Observer's Tool Kit* software by Harry Jamieson.

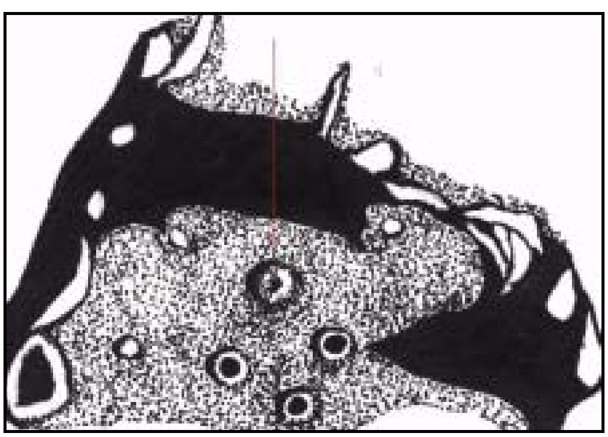

Figure 3: Evening illumination over the dome located at 28.69° E and 27.50° S. Observation carried out by R. Lena on 30 June 2002 at 03:00 UT. (H = 1.9°, A = 271.7°, C = 148.8°) with a refractor 100 mm f/15 at 250 x. Seeing II Antoniadi scale.

Table 2: Dimensions of the dome localized at 28.69º E and 27.50º S

E - W Diameter (Km)	N - S Diameter (Km)	Major - Minor Axes Ratio
11.4 ±0.3	9.8±0.3	1.163

Information about the vertical cross-section was obtained using the Ashbrook method, as described in [7]. Using this method, we estimated for different solar altitudes the fraction **x** of the dome's east-west diameter that is covered by black shadow.

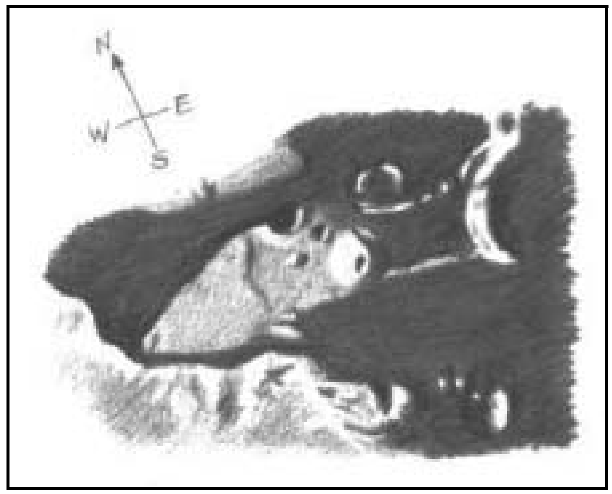

Figure 4: Evening illumination over the dome located at 28.69° E and 27.50° S. Observation carried out by R. Viegas on 23 March 2003 at 05:30 UT. (H = 0.8°, A = 268.9° , C = 151.1°) with a Newtonian 114 mm f/8 at 225 x. Seeing I-II Antoniadi scale and X =0.50.

According to Ashbrook [7], the average slope of the dome flank is equal to the solar altitude when x is 0.25 (where x is the fraction of the dome's east-west diameter that is covered by black shadow).

The height (H) of the dome was then calculated by the formula (1):

$$H = r(\tan s)$$

where r is the radius of the dome and (tan s) is the tangent of the average slope angle when the dome is ¼ covered by black shadow (see Table 3). Furthermore, we were able to distinguish between the black shadow and the dark grey shading of the dome flank which represents grazing illumination by sunlight.

Table 3: Slope observations of the dome under evening (E) and morning (M) illumination: .

Date and Ttimes (UT)	Illumination	H ° Solar Altitude	Type	X	Remarks
6 February 2003 20:00 UT	M	0.4°	visual		Shadow entered the terminator
6 April 2003 23:44 UT	M	0.5°	visual		Shadow entered the terminator
23 March 2003 05:30 UT	E	0.8°	visual	0.50	
23 March 2003 04:10 UT	E	1.4 °	visual	0.50	
23 March 2003 03:40 UT	E	1.6°	visual	0.40	
16 November 2000 09:00 UT	E	1.7°	Digital camera	0.45	
23 March 2003 03:13 UT	E	1.8°	visual	0.25	
30 June 2002 03:00 UT	E	1.9°	visual	0.25	
23 March 2003 02:13 UT	E	2.1°	Web-cam	0.0	Penumbra
23 March 2003 02:13 UT	E	2.4°	Web-cam	0.0	Penumbra
7 February 2003 00:40 UT	M	2.5 °	visual	0.0	West foot dark, but no umbra
17 April 2002 19:30 UT	M	2.6 °	visual	0.0	West foot dark, but no umbra
17 April 2002 19:40 UT	M	2.6 °	Web-cam	0.0	West foot dark, but no umbra
13 April 2001 06:30 UT	E	3.4°	visual	0.0	Penumbra
15 June 2002 23:00 UT	M	4.0 °	visual	0.0	Penumbra
8 March 2003 19:52 UT	M	4.8 °	Web-cam	0.0	Penumbra
10 November 2002 18:00 UT	M	7.0 °	visual	0.0	Penumbra
15 July 2002 23:50 UT	M	9.8 °	visual	0.0	

On the best image, the dome diameter and the length of its shadow were both measured in pixels. The corresponding scale of the image was obtained, allowing diameters and shadow lengths to be expressed in kilometers. From the lengths of the black shadows cast and the local solar altitudes, we were able to calculate the height of the dome.

Estimated **x** values (visual and imaging) were obtained both under evening (E) and morning (M) illumination; the results are summarized in tables 3 and 4. Furthermore, Table 4 reports the classification according to Westfall [8].

Results: Observations

We received 7 observations from 5 observers for evening illumination and 11 observations from 4 observers for morning illumination (Table 1).

Figure 5: Evening illumination over the dome located at 28.69° E and 27.50° S. Image taken by G. Konkel on 16 November 2000 at 09:00 UT (H = 1.7°, A = 272.3°, C = 148.6°) with a digital camera fitted to a Schmidt-Cassegrain 250 mm f/10. Seeing II Antoniadi scale and estimated X =0.45.

Evening Illumination

Figures 2-5 show the aspect of this region as imaged and sketched by several observers. This dome requires a specific solar altitude for it to be observed clearly and requires a narrow solar angle for maximum detail.

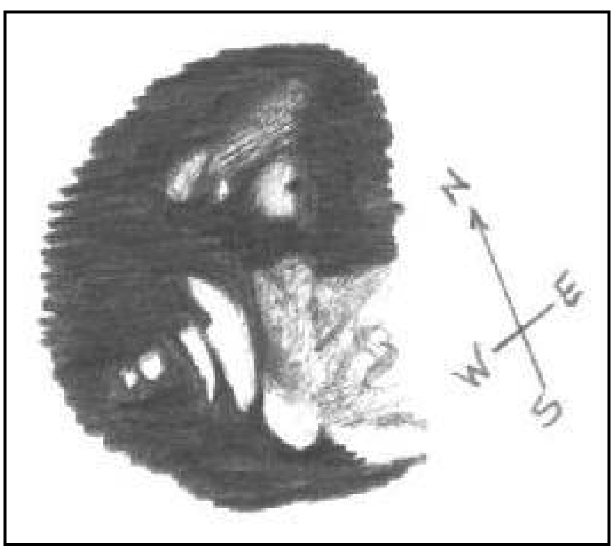

Figure 6: Morning illumination over the dome located at 28.69° E and 27.50° S. Observation carried out by R. Viegas on 6 April 2003 at 23:44 UT. (H = 0.5°, A = 91.0°, C = 331.2°) with a Newtonian 114 mm f/8 at 225 x. Seeing III Antoniadi scale.

The dome appears to be hemispherical, with the presence of a small feature on the top that suggests a craterlet, likely representing the central vent. In fact, the Lunar Orbiter imagery (Figure 1) shows a small summit crater and reveals other craterlets in this region, but the angle of illumination makes it difficult to determine if these have rims or are volcanic in nature.

The image shown in Figure 5 reveals very fine detail on the dome including the central craterlet.

Morning Illumination

Inspection of figures 6 and 7 reveals that the cast shadow entered the terminator.

In figures 8 and 9, made at H values of 2.5° and 4.0° respectively, the West foot was dark but no black shadow (umbra) was cast. Figure 8 was made under very good seeing conditions, making it possible to see the summit craterlet. Undoubtedly, this craterlet is a difficult target which requires very low solar altitudes.

On the other hand, under a higher solar altitude, the dome does not project a black shadow but a penumbra on the partly illuminated flank.

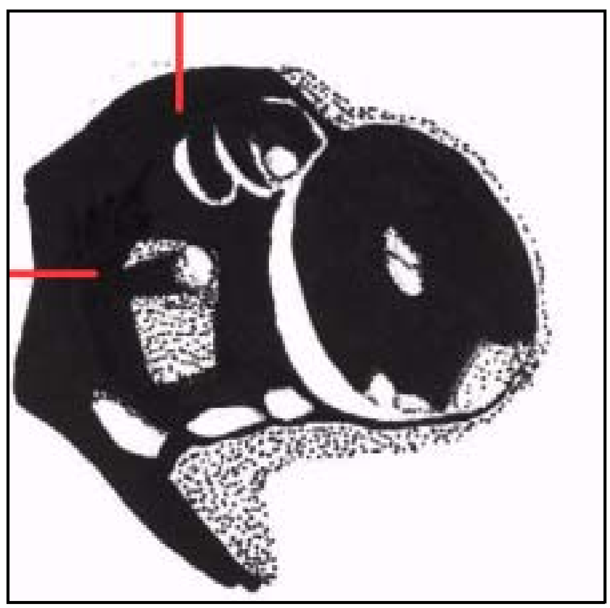

Figure 7: Morning illumination over the dome located at 28.69° E and 27.50° S. Observation carried out by R. Lena on 6 February 2003 at 20:30 UT. (H = 0.6 °, A = 91.2°, C = 331.5°) with a refractor 100 mm f/15 at 250 x. Seeing II-III Antoniadi scale.

Table 4: Slope determination and Westfall Classification [8].

Data	Diameter (pixel, km)		Shadow Length (pixel, km)		Height (m)	Average Slope °	Classification
Figure 5	20	11.4±0.57	9	5.2±0.57	155±17	1.7°±0.17	DU/2a/5f/7j

Slope Estimation

The visual estimations agree very closely with ccd images. The **x** values, along with the corresponding solar altitude and illumination (Morning or Evening), are summarized in Table 3.

A penumbra (not black shadow) is visible from H = 2.1° to H = 4.0° and certainly up to H = 7.0° (Table 3).

From Table 3, it follows that the average slope angle of the dome is about 1.8°. Furthermore, even the steepest parts of the eastern and western flanks have no slopes greater than about 5°. The height of the dome was then estimated using the formula 1 and assuming a radius of 5.7 kms from the Lunar Orbiter images. It turns out that the summit of the Piccolomini dome is 179 meters higher than the surrounding plain.

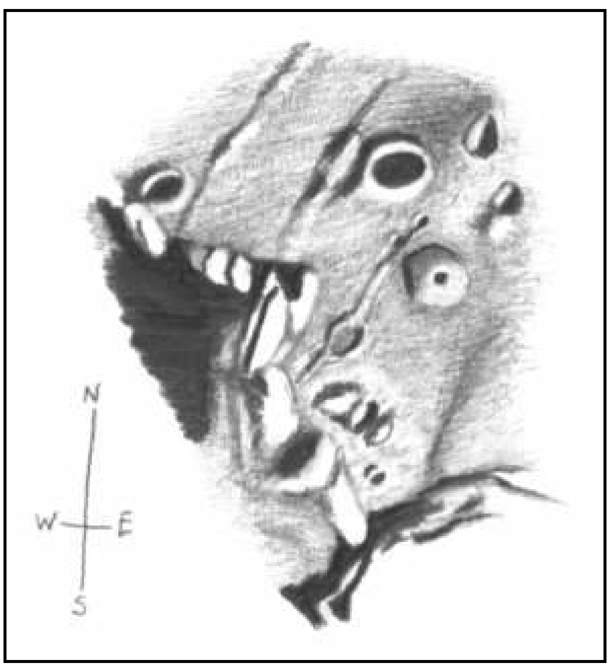

Figure 8: Morning illumination over the dome located at 28.69° E and 27.50° S. Observation carried out by R. Viegas on 7 February 2003 at 00:40 UT. (H = 2.5°, A = 90.4°, C = 333.3°) with a Newtonian 114 mm f/8 at 225 x. Seeing II Antoniadi scale.

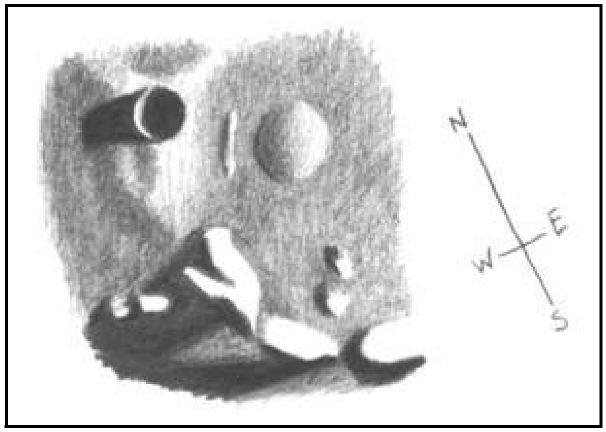

Figure 9: Morning illumination over the dome located at 28.69° E and 27.50° S. Observation carried out by R. Viegas on 15 June 2002 at 23:00 UT. (H = 4.0°, A = 87.7°, C = 335.9°) with a Newtonian 114 mm f/8 at 225 x. Seeing II Antoniadi scale.

This estimated slope and height are comparable with the value measured in the frame shown in Figure 5, where we calculated, from length of its shadow, a height of 155±17 meters and an average slope 1.7°±0.17.

Geological Considerations

The exceptionally low slope of this dome compared with the steepness of ordinary highland domes is an aspect of note.

A highland dome was recently reported near crater Zollner in [4] that also shows a low slope, which appears to be under 2 °.

A highland dome already reported at 24.72 ° E and 29.21 ° S [4], near crater Rothmann-D, lies about 110 km away from the dome we are dealing with in this paper. Its slope is classified as 5 in the Westfall classification scheme, that is, under 2°.

These three low highland domes have something in common: they are all positioned within the Nectaris basin, in the surroundings of the Altai Scarp. On the Moon, there are only 2 more reported highland domes with slopes under 2° [4]. There are a total of 8 reported highland domes within the Nectaris basin [4].

The Nectaris basin was partially filled by lavas that formed the Mare Nectaris. Nevertheless, the outpouring of lavas was not enough to cover appreciably all the basin. This “lack of outpouring” can be related with the formation of low instead of steep highland domes. This could imply that the sources of highland dome volcanism are closely related with the sources of mare lavas. This, together with the observation that these three highland domes are low, could favor the second theory mentioned in the Introduction.

Conclusion

This dome at 28.69° E and 27.50° S is a clear example of the elusive nature of highland domes. Using our data, this highland dome may be classified according to the Westfall classification scheme as DU/2a/5f/7j.

At the same time, this study shows that a combination of careful visual and ccd observations made by different observers provides powerful tools for the study and interpretation of lunar domes.

In our view, a careful study of the domes inside the Nectaris basin can provide useful clues as to the nature of the highland dome volcanism. For this reason, data on the Zollner dome, described in [4], are already being obtained.

Finally, international participation in our programs continues in an apparently favorable response to our efforts to foster increased cooperation among lunar observers worldwide.

Acknowledgements

We wish to thank all the observers for their contribution to this paper.

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ALPO Feature: Mars
The 1990-91 Apparition of Mars

By: Jeffrey D. Beish, assistant coordinator, Mars Section; dustymars@tnni.net

Abstract

Mars was favorably placed for telescopic observation in the northern hemisphere from January 1990 through March 1991. This report outlines the International Mars Patrol (IMP) observational programs of the Association of Lunar & Planetary Observers and summarizes the observations of the 1990-1991 Apparition. The Martian South Polar Region's seasonal aspects are described the environmental conditions that favored the development and the movements of two individual dust storms during October and November 1990 are discussed. Although several reports on this apparition were presented previously to ALPO members at meetings and in popular astronomy magazines, a comprehensive report has not yet appeared in *The Strolling Astronomer*. Note: See Special Reference list at the end of this article for previous papers pertaining to the 1990 apparition.

Introduction

The ALPO International Mars Patrol (IMP) is a cooperative effort involving observers around the world in order to obtain 24-hour surveillance of all Martian longitudes. Established in the late 1960's, by Charles F. Capen, the IMP has amassed more than 25,000 observations of Mars. These are contained within the archives of the ALPO Mars Section library and include the records of 13 apparitions of Mars covering a span of 25 years. The IMP is supported by observers in the following 14 countries: Argentina, Australia, Belgium, Brazil, Canada, China, Czechosolvakia, England, France, Germany, Italy, Japan, Sweden, and the United States.

Observational Summary

Mars reached opposition on November 27, 1990 [planetocentric longitude 340° Ls] and was closest to Earth on November 20, 1990 (336° Ls) with a distance of 48,050,617 miles (77,330,127 km) and an apparent disk diameter of 18.10 arcsecs. The 1990-91 apparition was considered transitional because opposition occurred exactly 90 degrees from perihelion (250° Ls).

The first observation of the apparition was obtained on 23 January 1990 (157° Ls) by Gerard Teichert of Hattstatt, France at an apparent disk diameter of only 4.3 arcsecs and the last was obtained on 20 September 1991 (Ls 117°) by Daniel M. Troiani of Schaumberg, IL, when Mars subtended a disk diameter of only 3.7 arcsecs. Approximately 57% (205° Ls) of the Martian year was observed during the apparition, including a substantial part of each season, 6% (5° Ls) of the southern winter; 60% (54° Ls) of the southern spring; 100% (90° Ls) of the southern summer; and 62% (56° Ls) of the southern autumn.

Nintey-seven ALPO/IMP Mars observers contributed a total of 2,033 observational reports including 1,411 visual and 556 multi-colored photographic observations of Mars, 22 filar micrometer measurements of the south polar cap (SPC), and 44 video tapes of CCD images. The observers used 122 telescopes this apparition, ranging from 3-inch (7.6cm) refractors to 88-inch (2.3m) reflectors. The average aperture per telescope was 11.1 inches (28.5cm) or 14.0 inches (37cm) per observer. A list of observers, their locations, and telescope(s) is presented in Table 1.

1990 - 1991 Meteorology of Mars

Bright Martian atmospheric clouds and hazes are classified by the color of light in which they are best observed. Blue/violet filter observations are frequently cross checked with those made in red light to facilitate detection of cloud formations and hazes and to improve their boundary definition. Without the aid of color filters, condensates in the atmosphere of Mars are difficult, if not impossible, to detect.

The atmosphere of Mars became dusty after two transient dust storms appeared during October and November 1990 (discussed in detail below), resulting in an increase in meteorological activity from late November onward.

LIMB HAZE — IMP observers recorded intermittent morning limb hazes during April, May, and June 1990. By the end of July, morning limb hazes were reported with increasing frequency. Photographs by Isao Miyazaki, Parker, and others, and visual reports during August and September show morning limb hazes had developed from the south polar region to the north polar region. These morning hazes fell off during late Martian southern summer.

As a result of the dust storm in October, morning limb haze increased in extent and brightness beginning on 05 October. These morning hazes became bright and prominent again on 04 November, at the start of the November dust events. Evening limb haze was reported only a few times during mid-November

1990. By late southerrn summer and early spring, the evening limb became increasing hazy.

LIMB CLOUDS — Morning and evening limb clouds were reported only rarely during the 1990-91 apparition, just as the Mars Section meteorology survey had predicted [Beish et al, 1986, 1987, and 1990].

OROGRAPHIC CLOUDS — A bright cloud was reported over Arsia Mons by J. Dijon (France) on 31 July 1990 (270° Ls). On 10 and 12 September (295°, 296° Ls) and again 13, 18 and 20 October (315°-319° Ls), an orographic cloud was photographed over Arsia Mons by Isao Miyazaki (Okinawa, Japan). This cloud was observed from 21 September (302° Ls) through 30 October (324° Ls) by J. Beish, W. Haas, D. Parker, K. Rhea, R. Robinson, A. Rogers and J. Warell. It was seen by J. Beish again on 24 November 1990 (338° Ls).

Parker also made a visual observation of orographic clouds over Olympus Mons on 26 and 27 October, as did M. Morrow on 27 October. J. Beish also saw a light orographic cloud over Apollinaris Petera on 07 February 1991.

TOPOGRAPHIC CLOUDS — Recurrent topographic clouds are dense whitish clouds of limited extent. They occur seasonally and regionally and persist for days, showing growth and displacement within a region. Topographic clouds tend to appear in or near large, deep craters and over great plains and valleys on Mars – Aram, Edom, Libya, and Ophir, where white clouds form during most apparitions. Inspection of these areas with blue-green (W64), blue (W38A), or violet (W47) filters aid in detection of such clouds.

Discrete cloud activity on Mars remained minimal until September 1990, when observers employing blue and violet filters were able to detect a few interesting clouds and hazes in Chryse, Candor, and Tharsis.

One topographic cloud that appears in Libya nearly every apparition was reported from 08 October through 14 October 1990 and again from 16 November though 07 December 1990 by J. Beish, P. Budine, R. Buggenthiem, M. Gelinas, W. Haas, D. Parker, K. Rhea, R. Robinson, B. Talaga, D. Troiani, J. Warell, and M. Will. I. Miyazaki photographed it on 03 and 07 December 1990.

WHITE AREAS — White areas are bright surface or near-surface frosts and/or fogs that are visible in all colors. B. Talaga, D. Boyer, K. Rhea, and S. Whitby reported bright white areas in Edom (345°W, 4°S) frequently from mid-October through November.

Another region often covered with frosts and/or ice-fogs is Ophir (65°W, 10°S). It was reported bright white by J. Beish on 27 August, R. Robinson on 01 November, and C. Evans on 04 November. Eridania appeared white on 23 October and Argyre on 20 December.

J. Beish, R. Buggenthiem, T. Platt, J. Rogers, B. Talaga, and S. Whitby reported Edom bright with fog from 08 thru 17 October and again from 04 thru 21 November.. C. Evans, M. Morrow, R. Robinson, and D. Troiani reported Ophir as bright during 01, 02, 03, and 04 November. This brightening may have been a prelude to the November dust storms, as discussed below. Viking images have revealed that Ophir, containing tributaries of the Vallis Marineris, is often the site of small, localized dust clouds [James and Martin, 1989].

Martian Dust Storms of 1990

One of the most exciting events for the Mars observer is to catch a dust storm on the move. It is rare indeed when one can watch one of these great dust clouds slowly move over the Martian landscape, covering features that were dark and well-defined just hours before. However, without the aid of color filters, the observer is unlikely to notice a dust storm in its infancy.

While no two dust clouds appear the same, they nevertheless exhibit similar characteristics. Dust clouds are frequently confused with bright white areas, frosts, or localized fogs, and some dense white clouds. In addition, after identification is made, it becomes difficult to distinguish active dust clouds from fresh surface dust deposits. Such misinterpretation can make time studies difficult.

Transient dust storms occurred on Mars in early October and again in early November 1990. Despite their fleeting character, they were well studied by 23 IMP observers in 7 countries: Leo Aerts (Belgium), Jeff Beish (USA), Dan Boyar (USA), Klaus Brasch (USA), Chen Dong-hua (People's Republic of China), Charles L. Evans (USA), Karl Fabian (USA), Walter H. Haas (USA), Charles Jacobson (USA), George R. Jones (USA), Richard McKim (Great Britain), Frank Melillo (USA), Masatsugu Minami (Japan), Isao Miyazaki (Japan), Don Parker (USA), Terry Platt (Great Britain), Kermit Rhea (USA), Robert L. Robinson (USA), John Rogers (Great Britain), Gérard Teichert (France), Dan Troiani (USA), and Johan Warell (Sweden). Over 160 drawings, photographs, CCD images and videotapes were submitted. Additional reports were received from the Mars coordinators of the British Astronomical Association (BAA) and the Oriental Astronomical Association (OAA) summarizing observations forwarded to them.

Transient Dust Clouds of October

During the first week of October 1990 the phone at ALPO's International Mars Patrol headquarters began to ring. News of bright spots on Mars, "maybe a dust cloud or something," scoffed the cautious observers. Their words were restrained and with good reason -- past experience has led them to a more conservative approach and not to jump to conclusions, especially about this Martian dust storm business. After all, these storms are very rare and often mislead the most experienced Martian dust storm watchers!

The genesis of the latest disturbance began on September 25, 1990. Reporting from Paragould, Arkansas, Kermit Rhea noted that Chryse appeared brighter than usual from the 25th. of September through October 2nd. His observations indicated unusual activity in the regions of Chryse, Candor, and Xanthe.

On 03 October, Dan Troiani observed Chryse as very bright in red light. The next day, 04 October, F. Melillo called that he had identified a dust cloud in Chryse. While observing Mars at 0400 UT on October 4th (310° Ls), Don Parker suspected that the bright streak bordering northern Aromatum Promontorium, in the south of Chryse, might be the beginning of a dust storm. The following night (310° Ls) J. Beish watched with delight as the dust cloud, correctly identified by Parker the night before, had moved southwest onto Eos. The cloud partially obscured Aurorae Sinus and appeared as a bright oval spot followed by a long streak.

The morning side of Mars had lost its usual limb darkening and displayed a bright arc extending along the limb from pole to pole. Subsequent visual reports by G. Jones, C. Jacobson, R. Robinson, and K. Rhea and photographs by D. Parker and J. Beish show that a dust cloud extended from eastern Margaritifer Sinus (30°W, 0°) to just south of Aurorae Sinus. By 06 October the dust cloud had moved 575 miles farther southwest, obscuring the southern half of Aurorae

Figure 1: Dust activity in Chryse on October 4, 1990 at 0653 UT as shown on this photograph by Don Parker; 41-cm, f/6 Newtonian reflector, 2415 film at f/164.

Sinus and completely covering Eos (40°W, 12°S). A dull streak or "dusty trail" was observed to extend from the southeast of Aurorae Sinus westward into Ophir.

The next day, 07 October, the main dust cloud had moved west-southwest another 475 miles to a longitude of 50°W and latitude of 20°S. A peculiar Y-shaped dust cloud hung over Aurorae Sinus and extended into Ophir -- as if transferring dust particles into that region from the main disturbance.

At last, the small Martian dust storm appeared to be over by 08 October. With perfect "seeing" on that date (312° Ls), Beish saw a familiar Martian landscape. Only a few alterations to the usually dark and well-defined Aurorae Sinus were obvious. Eos appeared to have grown in size a little. As he

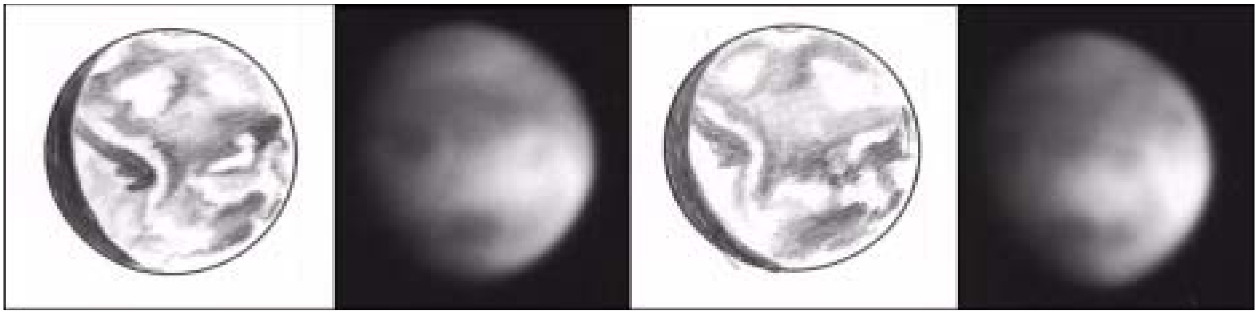

Figure 2: Dust cloud over Eos and obscuring Aurorae Sinus- Erythraeum Mare. LEFT: drawing by J.D. Beish on October 5, 1990 at 0510 UT (CM 4°). CENTER LEFT: October 5 at 0604 UT (CM 16°) by Don Parker captures dust cloud . CENTER RIGHT: Dust cloud again in drawing by J.D. Beish on October 6, 1990 at 0640 UT (CM 16°). RIGHT: D.C. Parker photograph shows same dust cloud at 0739 UT.

expected, a dull dusty haze covered the south polar region [*Beish et al*, 1984]. The morning limb was bright with blue and reddish hazes.

Transient Dust Clouds of November

D. Troiani, K. Rhea, and J. Jones provided observational reports of unusual atmospheric activity in Chryse on 31 October.. A CCD image from T. Platt (England) reveals what must have been a dust cloud over Chryse-Candor. More reports of dust cloud activity followed from K. Rhea, J. Rogers, and C. Evans.

Dust clouds were definitely identified on 04 November by ALPO's Frank Melillo. Don Parker's photographs from 04 through 09 November show several small bright and well-defined dust clouds crossing from Chryse over Aurorae Sinus onto Solis Lacus. By 04 November 1990, reports from R. McKim (England), Jacohson, J. Jones, A. Rogers, J. Beish, D. Boyer, R. Robinson, K. Rhea, M. Morrow, D. Troiani, and M. Will agreed remarkably as to the size and distribution of three dust clouds located over the Solis Lacus region.

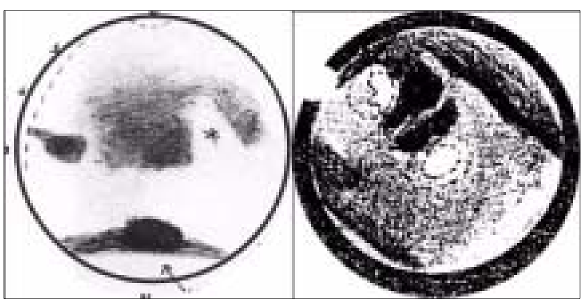

Figure 3: LEFT: Drawing of November 3, 1990, 0100 UT (CM 38°) dust cloud in Thaumasia-Solis Lacus area by John Rogers. RIGHT: Same dust cloud shown in Roger Van Loo drawing on November 04, 1990 at 0447 UT (CM 84°).

Jeff Beish, who was observing and photographing Mars atop Mauna Kea at the time, received a call from Don Parker alerting him of yet another dust storm on Mars. During the first two weeks in November, Beish was using the University of Hawaii's 24-inch telescope to photograph Mars for Lowell Observatory's International Planetary Patrol. On 06 November 1990, he photographed three dust clouds moving across the Aurorae Sinus-Solis Lacus regions.

Polar Regions

During both the October and November storms, most observers reported that the North Polar Hood (NPH) underwent significant changes, becoming dull and broken. Photographs and drawings from both periods show albedo features visible beneath the hood,

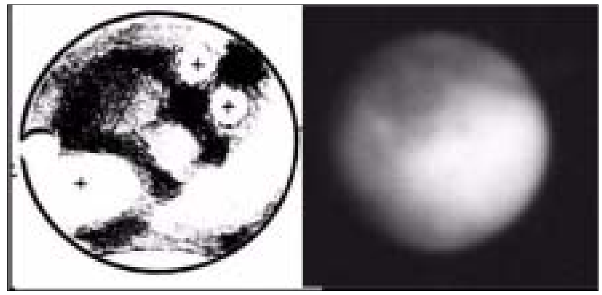

Figure 4: LEFT: Drawing of November 5, 1990, 0420 UT (CM 69°) dust cloud in Thaumasia-Solis Laucs area by John Rogers. RIGHT: Same dust cloud shown in DC Parker photograph on November 05, 1990 at 0558 UT (CM 92°).

suggesting a thinning of the canopy at those times. The NPH diminished in size and intensity between 5 and 7 October. On 8 October the Martian north polar region was again brilliant, but in reviewing the observations, there is some question about whether it was the hood that was seen or perhaps the North Polar Cap (NPC) shining through a thinned hood. Unfortunately not enough color filter work was done on the polar regions to answer this question.

The behavior of the NPH followed much the same pattern during the November dust outbreaks. It became dull on 05 November and by 07 November, albedo features in Mare Boreum could be seen through it, giving the hood a broken appearance. By 09 November the hood appeared somewhat brighter in red and integrated light than in violet, suggesting the appearance of the cap. This condition persisted over the next several days, but by 18 November, the North Polar Hood had returned to normal.

The South Polar Cap (SPC) was visible throughout both the October and November dust storms. Although Antarctic hazes were frequently sighted dur-

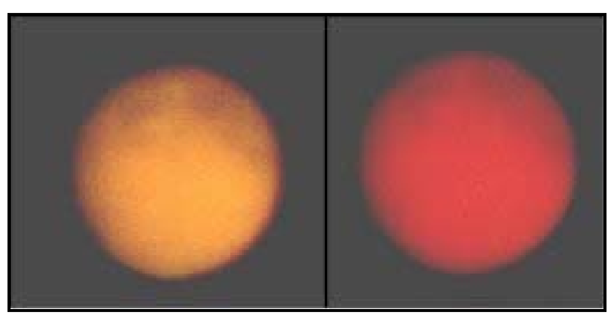

Figure 5: Dust clouds on Mars obscuring the NW part of Solis L. In red light (right image) Phoenicis L. and Phasis can be seen forming the western border of this cloud. Daemon is visible. The second cloud lies SSW of Solis Lacus in Claritas-Foelix. Three discrete dust clouds noted east, south, and northwest of Solis Lacus. Photo by J. Beish using University of Hawaii's 24-inch f/75 Cassegrain at Mauna Kea, HI on November 06, 1990 (Ls = 329°). Film Fuji-100.

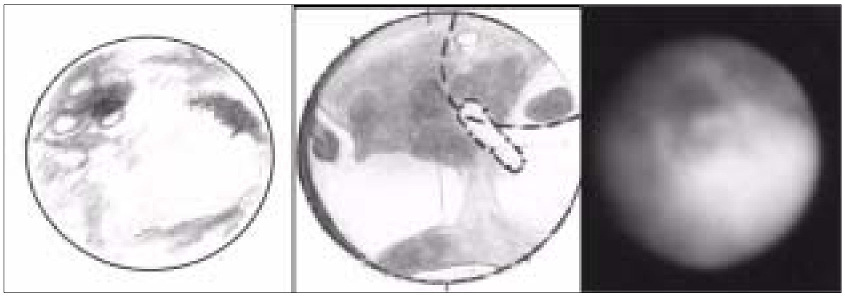

Figure 6: LEFT: Drawing of November 6, 1990, 0845 UT (CM 124°) dust cloud in Thaumasia-Solis Lacus area by J.D. Beish. CENTER: Drawing by George Jones, November 7, 1990 at 0330 UT (CM 39°). RIGHT: Same dust cloud shown in DC Parker photograph on November 07, 1990 at 0648 UT (CM 86°).

ing these periods, observers employing large apertures and color filters were able to see the SPC through early December.

The Martian Antarctic – 1990

A bright, well defined Martian South Polar Cap (SPC) was first reported by D. Troiani, R. Schmude, W. Haas, and D. Parker during mid-February 1990. The South Polar Region (SPR) remained clear and conspicuous throughout February, March, and April 1990. However, the SPC became difficult to observe during two months prior to and after opposition because the sub-earth point (De) was near the Martian equator during the time of maximum retreat of the polar cap (01 August - November 1990).

The SPC was also partially obscured by dusty hazes from two brief dust storms in October and November. Although these storms were small and short-lived, the resulting dust haze did blanket the SPR, rendering it nearly impossible to see even with IMP's largest telescopes. An increase in meteorological activity over the SPR during this period further decreased the feature's visibility. Some observers even reported the complete disappearance of the SPC during November; however, others reported seeing the SPC intermittently until shortly after opposition and into the first week of December.

South Polar Hood Again, as mentioned in the 1987-89 apparition report, the existence of an extensive Martian South Polar haze canopy or "hood" during its southern winter and spring was called into question by the ALPO Mars Recorders [*Beish, et al*, 1990]. Visual observations and photographs of Mars taken during these seasons from 1987 throughout 1991 show no signs of this so-called polar hood, although many clouds and bright spots were seen. Previous reports of the SPH may have merely been sightings of dense seasonal clouds over Hellas and Argyre. During southern winter the Martian South Pole is tilted away from the Earth, and clouds over these areas appear to be on the south limb, giving the false appearance of a polar hood.

Dark Rifts Numerous dark rifts are often observed in the SPC during southern spring and summer as the polar cap begins to retreat. D. Parker reported several dull rifts in the SPC beginning on May 30th and continuing throughout June. One of these rifts forms what C.F. Capen referred to as the "Life-saver effect." At times, this effect is very prominent and appears as a great hole in the center of the cap. It has been suggested that this dark region is actually Martian surface material yet to be covered by the usual polar ice and/or frost.

Mountains of Mitchel Although conspicuous during the 1988 apparition, the Novissima Thyle, also referred to as the Novus Mons or the famous "Mountains of Mitchel," appeared only a few times to IMP observers in 1990. On 21 June 1990 J. Beish reported the first signs of a dull rift in the SPC where the separation of Novissima Thyle usually begins. D. Parker and D. Boyer also reported a similar rift appearing intermittently from July 1 throughout July 18 1990. The complete detachment of the "Mountains" (Novus Mons) was not reported during the 1990 apparition.

Several observers reported that the South Polar Cap seemed to disappear when viewed when viewed at Central Meridian 150° through 270°, and the planet's south limb resembled what can only be described as, a great "bald spot" where the SPC should be. The SPC is hard to see under these conditions because it is offset 7 degrees away from the pole in the direction of 30° longitude, on the side of the planet opposite the observer. From mid-August, the planetocentric declination of Earth (De) was -11.2 degrees and decreased to -3.9 degrees by the end of September making the South Polar Region of Mars difficult to observe. Since southern summer began on July 30th, the SPC was in rapid retreat at that time and would not appear very large.

The Martian Arctic Region - 1990-91

During spring and summer in Mars' southern hemisphere (northern autumn and winter), the north polar region is covered by a dense irregularly shaped layer of condensates known as the "North Polar Hood (NPH)." The appearance of the polar hood in integrated light, which is without the aid of color filters, varies from a dull blue-gray during winter to off-white during early spring. The dates when this hood appears or disappears are not predictable and are a significant study project for the ALPO Mars Section.

D. Parker first observed hazes in the north polar region on 01 March 1990, followed by D. Troiani, R. Schmude on 03 March, and again on 10 March. B. Talaga, M. Gelinas. Rhea and G. Teichert saw polar hazes from May through late July.

A very dull north polar hood was first detected by M. Bosselaers on 04 August, J. Dijon on 11 August, J. Beish on 15 August, D. Boyer on 17 August, and photographed by I. Miyazaki during 14 and 27 August. The Miyazaki photographs from 22 September through 13 December 1990, revealed a dense north polar hood. Although the hood persisted into 1991, visual drawings made by IMP observers suggest the north polar cap began to break through the hood on 18 December 1990.

During the first week of October observers reported that the NPH appeared to be affected by atmospheric dust and to thin by 07 October. The hood lost its usual blue-gray color and appeared dull reddish-white. By 08 October, it had retreated northward enough to reveal previously undetected dark surface materials that had been covered by the dense haze. Again, the north polar hood was affected by atmospheric dust between November 10, 1990 through late November 1990.

Discussion

Several observers reported "white hazes" rather than dust. These astronomers did not employ color filters and relied only upon their own color perceptions of the clouds. This is usually unreliable, since correct color perception is virtually impossible with any but the largest telescopes. Classically, Martian dust clouds appear bright in yellow light, they are in fact brighter in red and orange light than they are in yellow. On Mars nearly everything appears bright through a yellow filter!

The behavior of the North Polar Hood was particularly well-documented during both the October and November dust storms. Martin [1991] has shown that the hood receded during the 1971 global storm, and postulated that the condition of the hood is a sensitive indicator of atmospheric dust. A number of independent observers reported that the hood retreated and thinned during both 1990 storms.

Martian meteorology has become an important field of investigation in recent years. Studying the Red Planet's atmospheric phenomena can improve our understanding of Earth's climate and weather. Studying the natural history of Mars' dust storms can reveal much about the planet's atmospheric dynamics. With manned flights to Mars being planned in the next few decades, understanding dust storms has assumed even more significance. Only rarely have astronomers been able to track one of these events from its inception to its dissolution. Recent funding cutbacks have severely limited the ability of professional astronomers to obtain this type of information. It is hoped that the IMP astronomers will continue to take up this slack and provide data on one of the Solar System's most spectacular phenomena -- the dust storms of Mars.

Finally, this author wishes to thank the dedicated observers who contributed their data to the IMP and encourage them to continue monitoring Mars for dust activity in the future. Since the next two apparitions will be aphelic, Mars will not be as easy to observe. In addition, the Martian northern hemisphere spring and summer will be the dominant seasons during these apparitions — times when dust storms are supposed to be rare. However, reviews of the literature and recent IMP observations reveal that dust clouds can occur during any Martian season. [Martin, 1991; Beish and Parker, 1990].

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Table 1: Members of the ALPO International Mars Patrol for the 1990 Apparition of Mars.

In "Observer" columns V is for visual drawings, P is for photographs & CCD image recording sessions, and M is for micrometer measurements. In "Telescope" column, CA is for Cassegrain, ST is for Catadioptric, KU is for Kutter, N is for Newtonian, R is for Refractor, and TRIS is for Tri-Schieispiegler. All telescope apertures shown in inches.

Observer	Location	Observer			Telescope
		V	P	M	
M. Adachi	Japan	5	-	-	12" N
B. Adcock	Australia		2		12.5" KU
L. Aerts	Belgium	2	3		12" N
T. Akutsu	Japan		15		12.5" N
J. Albert	NJ - USA	1			11" ST
T. Back	OH – USA	1			6" R
W. Baldwin	FL – USA	2	127		8" N
J. Beish	FL - USA	57	51		11" ST, 12.5" N, 16" N
					24" CA, 88" CA
W. Bickel	Germany		7		41.0 N
M. Bosselers	Belgium	59			4.9 KU, 10" N
D. Boyer	FL - USA	10			6" N, 10" N
K. Brasch	CA - USA	19	3		7" R, 14" ST
P. Budine	NY - USA	1			4" R
R. Buggenthiem	Germany	20			6" N
G. Cameron	IA - USA	1			12.5" N
G. Canonaco	Belgium	22			8" R
T. Cave	CA - USA	32			12.5" N, 18.8" N
V. Cave	CA - USA	5			12.5" N
B. Copeland	AZ - USA	2			10" N
F. Daerden	Belgium	20			6" N
J. Dijon	France	9			8.3" N
D. Drake	IL - USA	1			?
E. Verwichte	Belgium	9			8" R
C. Evans	VA - USA	17			6" N
K. Fabian	IL - USA	9			8" N, 8"ST
N. Falsarella	Brazil	18	5		8" N
D. Fell	Canada	23			8" ST
T. Fuller	CA - USA	4			10" ST
F. Funari	Brazil	3			8" N
M. Gelinas	Quebec	13	6		6" R, 8" ST
M. Giuntoli	Italy	2			4" R
H. Goetz	Belgium	4			8" R
D. Graham	England	15			4" R, 6" R, 16" N
W. Haas	NM - USA	34			8" N, 12.5" N
A. Heath	England	25			12" N
R. Hill	AZ - USA	9			5" ST, 14" ST
Y. Hongtao	China	23			3.1" R
C. Hua	China	35			4" N
C. Jacobson	WA - USA	15			10" TRIS
M. Janes	AZ - USA	1			10" ST
A. Johnson	England	10			8" N
G. Jones	MD - USA	43			16" CA
T. Jorgenson	WI - USA	1			18" N

Observer	Location	Observer			Telescope
		V	P	M	
D. Joyce	IL - USA	9			10” N, 20” N
C. Kirkpatrick	CA - USA	7			10” ST, 16.5 CA
D. Klos	WI - USA	16			13.1” N
A. Kruijsloop	England	3			8” ST
P. Leonard	CA - USA	1			10” ST
C. MacDougal	FL - USA	9			6” N
J. McKenzie	WI - USA	1			18” N
R. McKim	England	12			8.5” N, 12” R
F. Melillo	NY - USA	1			8” ST
J. Melka	MO - USA	13	17		8” N
F. Mennella	Argentina	37			6” N
M. Minami	Japan	39			8” R
I. Miyazaki	Japan		98		16” N
M. Morrow	HI - USA	19			16” N
G. Nowak	VT - USA	8			3” R, 5” ST
R. Neil	France	12			12” N
J. Olivarez	KA - USA	2			10” N, 12.5” N
M. Orsil	MD - USA		1		16” CA
D. Parker	FL - USA	93	129	22	16” N
T. Platt	England		17		12“ N
R. Regester	CA - USA	1			8” ST
K. Rhea	AK – USA	112			6” N, 8” N
D. Richter	WI - USA	1			12.5” N
R. Robinson	WV - USA	11			10” N
R. Robotham	Canada	10			6” N, 8.3” R
J. Rogers	England	6			10” N
J. Sanford	CA - USA	1			14” ST
J. Schaefer	VA - USA	2			3” R
C. Schambeck	Germany	6			6” R
M. Schmidt	WI - USA		54		14” ST
R. Schmude	TX - USA	42			10” N, 14” ST
K. Schneller	OH - USA	8			8” N
V. Simon	Czechoslovakia	10			3.5” N, 5” R
P. Stepan	Czechoslovakia	13			6” R, 10” CA
J. Stern	CA - USA	10			8” ST
B. Talaga	AZ - USA	40			6” R
G. Teichert	France	72			11” ST
D. Troiani	IL - USA	49	3		6” R, 8” R, 17.5” N
F. Van Loo	Belgium	29			6” R, 8” R, 10” N
H. Vandenbruaene	Belgium	12			8” N
E. Verwichte	Belgium	10			8” R
D. Ward	Canada	19			6” N
J. Warell	Sweden	23			6.3” TRIS
M. Wasiuta	VA - USA	11			9” R
R. Webb	CA - USA		2		36” CA
J. Westfall	CA - USA	10	6		10” CA
S. Whitby	VA - USA	15			6” N
R. White	CA - USA	2			16.5” CA
M. Will	IL - USA	12			8” N
B. Flach-Wilken	Germany		4		12” TRIS
D. Wyman	WI – USA	1			18” N
E. Weinman	WI - USA	1			13.1” N

ALPO Feature: Jupiter
The 1986, 1987 and 1988 Apparitions of Jupiter

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Abstract

Drift rates and wind speeds for several Jovian currents in 1987-89 are summarized. The Great Red Spot (GRS) remained at the same longitude during 1987, but moved westward in late 1988. Ovals BC and DE were 60º apart in 1988 but by early 1989 they were 25º apart. The oscillating spot, observed in mid 1987, may have oscillated in longitude because of latitude changes.

Introduction

Budine (1997, 160) reviewed the drift rates and appearance of Jupiter during 1986. (Budine, 1988; 1989b), (Olivarez, 1988), and (Schmude, 1988; 1989) published preliminary reports of Jupiter for 1987-89. Rogers (1990a,b; 1991a,b) has reviewed drift rates made mostly by British observers for 1986-89. This report focuses on ALPO observations of Jupiter made between 1986 and 1989. Table 1 lists characteristics of Jupiter during the 1986-88 apparitions while Table 2 lists participating observers.

Disc Appearance

The nomenclature of key jovian features is shown in Figure 1. Figures 2 and 3 show disc drawings and photographs of Jupiter made during 1986-89. Figures 4 and 5 show drawings of the GRS and ovals BC/DE during 1986-89. Feature longitudes are shown in figures 6-10.

Table 1: Characteristics of the 1986-89 Apparitions of Jupiter (All values indicated correspond to the date of opposition.)

	1986	1987	1988
Opposition date	Sep. 10	Oct. 18	Nov. 23
Equatorial diameter (arc-seconds)	49.6	49.7	48.8
Magnitude	-2.9	-2.9	-2.9
Geocentric declination of Jupiter	-6.2º	8.1º	19.4º
Declination of the Sun	1.8º	3.3º	3.5º
Declination of the Earth	2.2º	3.7º	3.7º

In Figures 1-5, south is at the top and the preceding edge is to the left.

West refers to the direction of increasing longitude. [Three longitudes are used for Jupiter: "System I" (λ_I) applies to the EZ, "System II" (λ_{II}) applies to most of the remaining areas and "System III" (λ_{III}) is the planet's underlying "radio" rotation period.]

Positive wind speeds are those that move from west to east. In previous reports (Schmude, 2002, 2003a) the sign convention on wind speeds was opposite to the convention adopted here.

The author analyzed photographs to determine the relative brightness of features and the results are shown in Table 3. (Photographs at different system II longitudes were considered to prevent a longitude bias.) During 1988-89, both the NNTB and the GRS became darker while the NTB became fainter. The brightest zone for all three apparitions was the EZs. The NTrZ was brighter than the STrZ for 1986-88, but the STrZ was brighter during 1988-89. Heath (Ref; Table 2) also made visual light intensity estimates of the belts and zones and his results are similar to those presented in Table 3 except for the STB. My estimates of the STB are based on all parts of the STB and not just dark parts.

Heath also estimated the light intensity of Jovian features through blue and red filters. Based on those estimates, the GRS, SEB and NEB were the reddest features on Jupiter in 1988-89.

The planetographic (or zenographic) latitudes of belt edges were measured from photographs for different longitudes; see Table 4. The formulae in Peek (1981, 49) were used in computing latitudes; sub-Earth latitudes were taken from the Astronomical Almanac (1986 to 1989). One distinct change was an increase in the width of the NEB from 6.8° in 1985 (Budine, 1990, 7) to 10.4° in 1986. In early 1989 the width of this band was 14.1° compared to 8.7° in late 1987; most of this increase due to a more northerly boundary of the NEBn in 1989. A similar NEB width increase occurred in 1996 (Schmude, 2003b).

The author measured the sizes of several white ovals from high- resolution photographs; see Table 5. Dimensions were computed as described previously (Schmude, (2002). The average aspect of the SSTB ovals was 0.94 (1986-87), 0.91 (1987-88) and 0.83 (1988-89), which are close to the average values in 1991-93 (Schmude, 2002; 2003a). The aspect equals the north-south dimension divided by the east-west dimension.

The average area of the SSTB ovals during 1986-89 was 2.2 x 107 km^2, which is close to the average in 1992-93 (2.1 x 10^7 km^2), but larger than the corresponding values in 1991-92 (1.6 x 107 km^2), 1996 (1.5 x 10^7 km^2), 2001-02 (1.5 x 10^7 km^2), (Schmude, 2002,

Table 2: Contributors to This Apparition Report

Name	Instrument	Location	Contribution
Adcock, Barry	0.32m RR	View Bank, Victoria Australia	P, TT
Aerts, Leo	0.28m SC	Heist-op-den-Berg, Belgium	D, TT
	0.15m RR		
Akutsu, T.	0.41m RL	Okinawa, Japan	DN
Barbany, Domenec	several	Granellers, Spain	D, DN, SS, TT
Benninghoven, Claus	several	Burlington, IA USA	D, DN, P, SS, TT
Bock, Paul	0.08m RR	Sterling, VA USA	D, TT
	0.10m RR		
Browning, Robert	0.20m RL	Audubon Park, NJ USA	D
Brunkella, James	0.25m RL	Thousand Oaks, CA USA	D
Budine, Phillipa	0.09m Mak	Walton, NY USA	D, R, SS, TT
	0.10m RR		
Bunn, Eric	0.15m RR	Westford, MA USA	D
Dal Santo, Mauro	0.32m RL	Padua, Italy	D, SS, TT
	0.20m RL		
Daniels, Mark	0.20m RL	Scottsdale, AZ USA	D, SS, TT
Darling, David	0.32m RL	Sun Prairie, WI USA	D, SS, TT
De Karske, Donald	0.10m RR	Colorado Springs, CO USA	SS
Dragesco, Jean	0.61m RR	Flagstaff, AZ USA	P
Dusek, Jiri	0.20m RR	Brno, Czech Republic	SS
Echaniz, J.C.	0.26m	Barcelona, Spain	DN
Graham, David	several	North Yorkshire, UK	D, DN, SS, TT
Graham, Francis	several	Kent State University, OH USA	D, P
Haas, Walter	0.20m RL	Las Cruces, NM USA	DN, SS, TT
	0.32m RL		
Heath, Alan	0.30m RL	Nottingham, England	D, DN, SS, TT
Himes, Don	0.32m RL	Chagrin Falls, OH USA	D
Jordi, Aloy	0.31m RL	Sampsor, Italy	D, TT
Joyce, Dan	0.25m RL	Chicago, IL USA	V
	0.60m RL		
Kikkonen, Flmo	0.08m RR	Espoo, Finland	SS, TT
Kruijshoop, A.	0.20m RL	Melbourne, Victoria Australia	TT
Lehky, Martin	0.20m RR	Kralove, Czech Republic	D
Lerner, Eric	0.15m RL	Lawrenceville, NJ USA	SS, TT
LIADA (group)	several	Merida, Venezuela	TT
Lindemann, David	0.15m RL	Poughkeepsie, NY USA	TT
Lopez-Caparros, B.	0.26m	Barcelona, Spain	DN
Louer, Clinton, Jr.	several	Port Deposit, MD USA	D
Lunsford, Robert	0.15m RR	Chula Vista, CA USA	D
	0.40m RL		
Lux, Barbara	0.10m RR	Mckeesport, PA USA	D, DN, SS, TT
	0.15m RL		
MacDougal, Craig	0.15m RL	Tampa, FL USA	D, DN, TT
Makela, Veikko	0.09m RR	Helsinki, Finland	SS, TT
Manner, Olli	0.13m RR	Helsinki, Finland	SS, TT
	0.14m RL		

(Continued)

Table 2: Contributors to This Apparition Report (cont.)

Name	Instrument	Location	Contribution
Mattei, Mike	0.15m RR	Littleton, MA USA	D, DN
McArthur, Robert	0.20m RL	Andover, KS USA	D, TT
McNamara, Geoff	0.41m RL	Sutherland, Australia	TT
Melillo, Frank	0.20m SC	N. Valley Stream, NY USA	D, SS, TT
Miyazaki, Isao	0.20m RL 0.40m RL	Okinawa, Japan	D, DN, P, SS, TT
Modic, Bob	0.20m RL	Richmond Hts., OH USA	D, TT
Morris, Woodie	0.25m RL 0.15m RL	Manahawkin, NJ USA	D, DN, P, TT
Morrow, Michael	0.41m RL	Ewa Beach, HI USA	D, DN
Nelson, Peter	0.32m RL	Nilma, Victoria Australia	D, DN, TT
Nousiainen, Markku	0.08m RR 0.13m RR	Espoo, Finland	SS, TT
Nowak, Gary	several	Essex Jct., VT USA	D, DN
Olivarez, Jose	several	Wichita, KS USA	D, R, SS, TT
Paolo, Tanga	0.15m RR	-------	SS
Park, Jim	0.20m SC	Glen Waverley, Australia	D, DN, SS, TT
Parker, Donald	0.32m RL	Coral Gables, FL USA	DN, P
Pedersen, Steen	several	Hinnerup, Denmark	D, DN, SS, TT
Phillips, James	0.20m RR	Charleston, SC USA	SS, TT
Robinson, Robert	0.25m RL	Morgantown, WV USA	D, DN, TT
Robotham, Rob	0.08m RR 0.15m RL	Scarborough, ON Canada	D, DN, SS, TT
Rogers, John	0.20m RR 0.25m RL	Cambridge, England	D, SS, TT
Schmude, Richard, Jr	several	College Station, TX USA	SS, TT
Scott, Pete	0.20m RL 0.09m RR	Indiana, PA USA	DN, TT
Talaga, Bob	0.15m RR 0.20m RL	Tucson, AZ USA	D, DN, SS, TT
Tatum, Randy[b]	several	Richmond, VA USA	D, P, SS, TT
Torrell, J.	0.26m	Barcelona, Spain	DN
Torrell, Sebastia	0.26m	Barcelona, Spain	DN
Troiani, Daniel	several	Schaumburg, IL USA	SS, TT, V
Uhrhammer, Bob	0.15m RL 0.25m RL	Livermore, CA USA	TT
Weier, David	0.28m SC	Madison, WI USA	TT
Ziss, Ron	0.32m RL	Chicago, IL USA	D, DN, SS, TT

[a] = Also observed from Oxford, NY USA
[b] = Also observed from Charlottesville, VA USA
RL = reflector, RR = refractor, SC = Schmidt-Cassegrain, Mak = Maksutov
D = drawing, DN = descriptive notes, P = photograph, R = report, SS = strip sketch,
TT = transit time, V = video

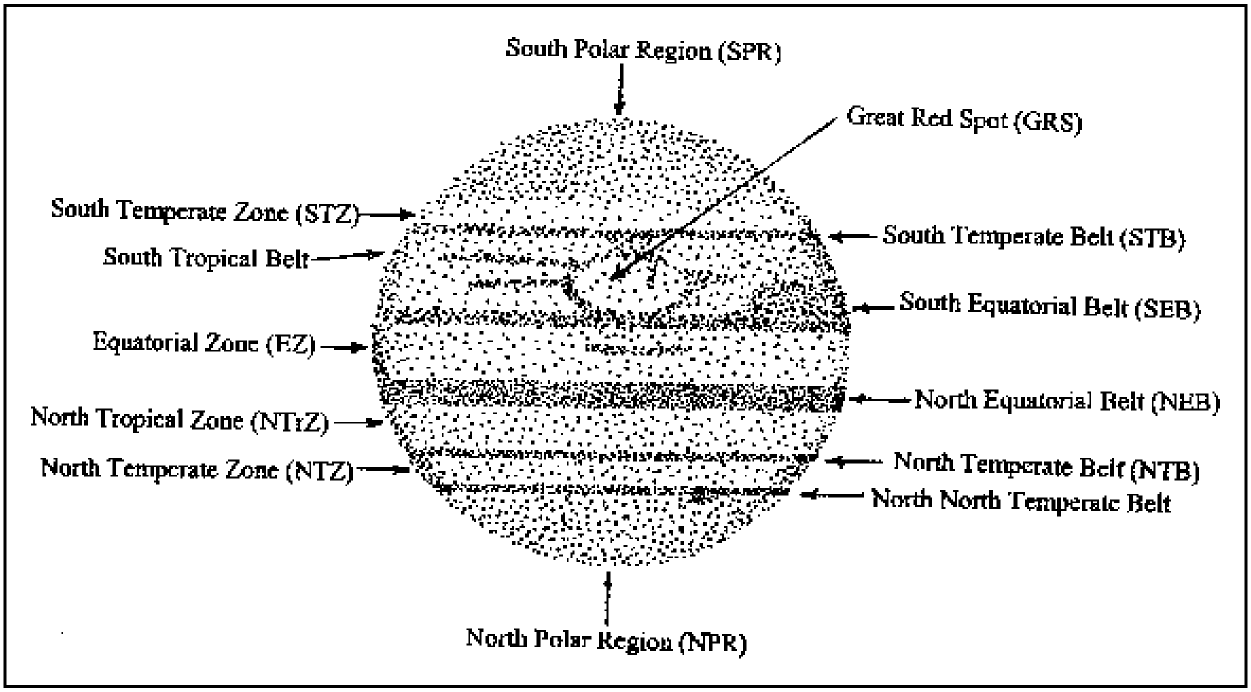

Figure 1: Jupiter nomenclature along with a drawing of Jupiter made by the writer on Oct. 18, 1987λ_I = 251º, λ_{II} = 45º with a 0.15 m Newtonian rreflector at 203X.

2003a, b, c) and 1994-2000 (1.2 x 10^7 km^2) (Morales-Juberias et al., 2002, 81).

Region I: Great Red Spot (GRS)

Figure 4 shows drawings of the GRS during 1986-89. A dark collar (arch) developed around the southern half of the GRS in mid-August, 1987 and by September the arch wrapped around the southern half of that feature. The arch became lighter near the south-following edge of the GRS in October and November. In a Nov. 29, 1987 photograph, the arch was either faint or absent. During June, 1988, Miyazaki drew an arch (Budine, 1991b). Jordi, Graham, Modic, McArthur, Talaga and the writer also drew an arch during late 1988. The arch was less distinct in early 1989.

Budine (1997) reported that the GRS usually had an orange color during late 1986 and early 1987. During

Table 3: Relative Intensities of Belts and Zones on Jupiter. (All intensities were estimated from photographs.)

Apparition	**Belts (darkest to brightest)**
1986-87	NEB, central third SEB, south third SEB, NPR=SPR, north third SEB, NTB, STB, NNTB, GRS, EB
1987-88	NEB, central third SEB, south third SEB=north third SEB, NPR, SPR, STB, NNTB, NTB, GRS, EB
1988-89	South third SEB, north third SEB, NEB, central third SEB, NPR, SPR, NNTB, GRS, STB, EB, NTB
	Zones (brightest to darkest)
1986-87	EZs, EZn=NTrZ, STrZ, NTZ
1987-88	EZs, NTrZ, EZn, STrZ, NTZ
1988-89	EZs, STrZ, EZn, NTrZ, NTZ

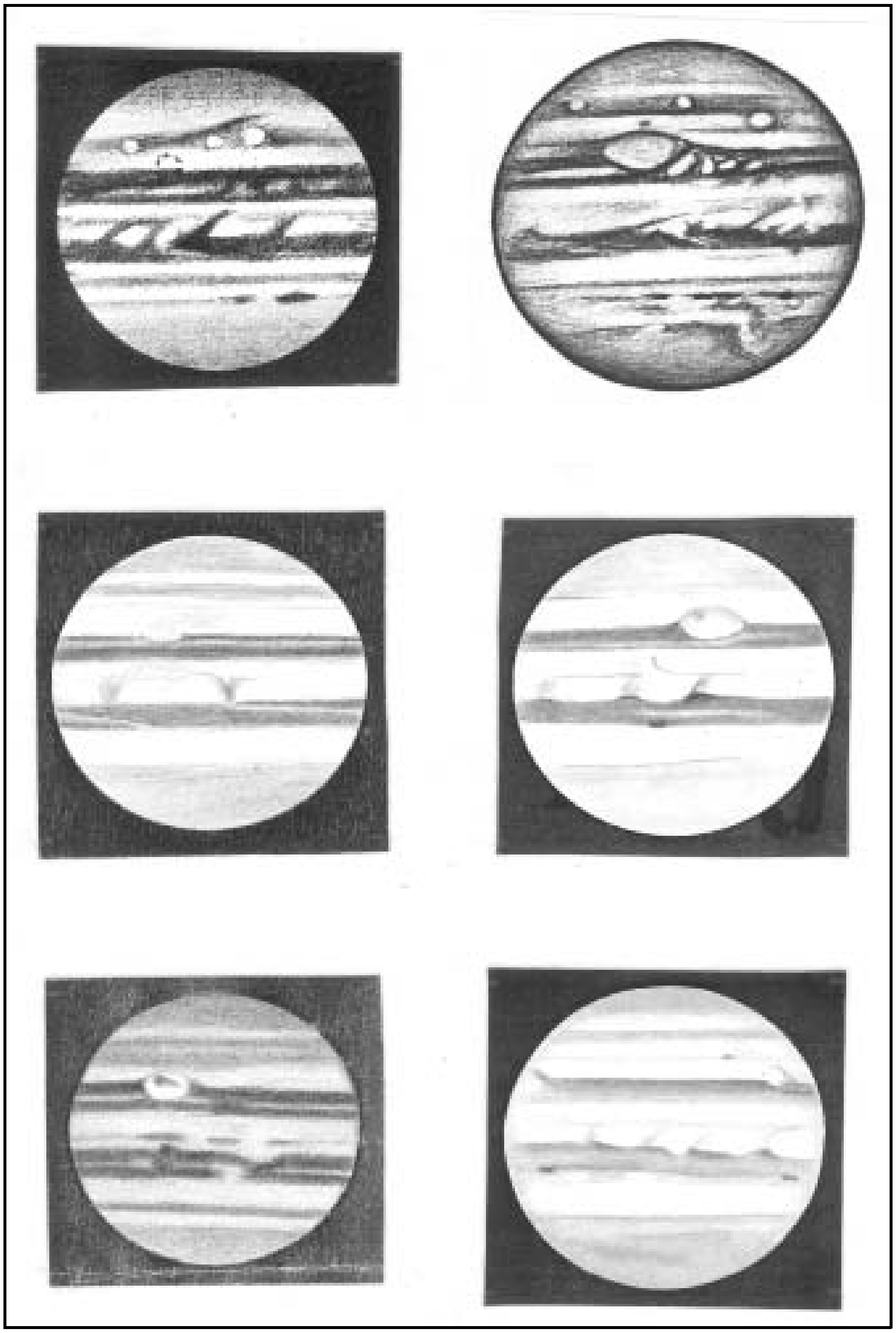

Figure 2: Drawings of Jupiter made in 1986-89.Top left: Sep. 19, 1986 (Daniel) 6:22-6:40 UT, λ_I=342º, λ_{II}=261º, 0.20m New, Seeing=5-8, 145X; Top right: Oct. 14, 1987 (Miyazaki) 13:02 UT, λ_I=209º, λ_{II}=30º, 0.20m New, Seeing=4-8, 395X; North at top

Middle left: Jan. 12, 1986 (MacDougal) 3:34 UT, λ_I=191º, λ_{II}=136º, 0.15m New, Seeing=8, 145X; Middle right: Jan. 16, 1986 (Robinson) 23:05 UT, λ_I=97º, λ_{II}=5º, 0.25m New, Seeing=7-8, 164-246X; North at top

Bottom left:Jan. 24, 1986 (Morris) 0:52-1:15 UT, λ_I=193º, λ_{II}=47º, 0.25m New, Seeing=7, 190X; Bottom right:Apr. 16, 1986 (Benninghoven) 0:37 UT, λ_I=149º, λ_{II}=98º, 0.29m Rfr, Seeing=4-5, 220X North at top

July and August of 1987, the writer observed a cream colored GRS (Schmude, 1988, 19), Benninghoven reported a pink or orange tint for the GRS in August and September 1988, but by late 1988 and early 1989, he noted an orange color for this feature. During early 1989, Modic reported a pink and orange hue for the GRS while Lux reported a grayish color for this feature.

The longitudes of the GRS on opposition day were: 16.4 ± 0.7° (1987), and 19.8 ± 0.3° (1988). The longitudes of the GRS are plotted in figures 6 and 8. Budine (1997) reported a 1986-87 drift rate of 0°/30 days (system II) for the GRS; the corresponding drift rates for the next two apparitions were: 0.1°/30 days (1987-88) and 0.9°/30 days (1988-89).

Region II: South Polar Region to the South Tropical Zone

The writer analyzed photographs using the same procedure as in Schmude (2003c) to determine the relative darkness of the two polar regions. The NPR was slightly darker than the SPR in 1987-88 and 1988-89, but the two polar regions appeared equally dark in 1986-87. During the 1987-88 apparition, Parker took several infrared pictures of Jupiter with a W29 filter. Based on an analysis of these pictures, the NPR was slightly darker than the SPR. Different longitudes were sampled in this

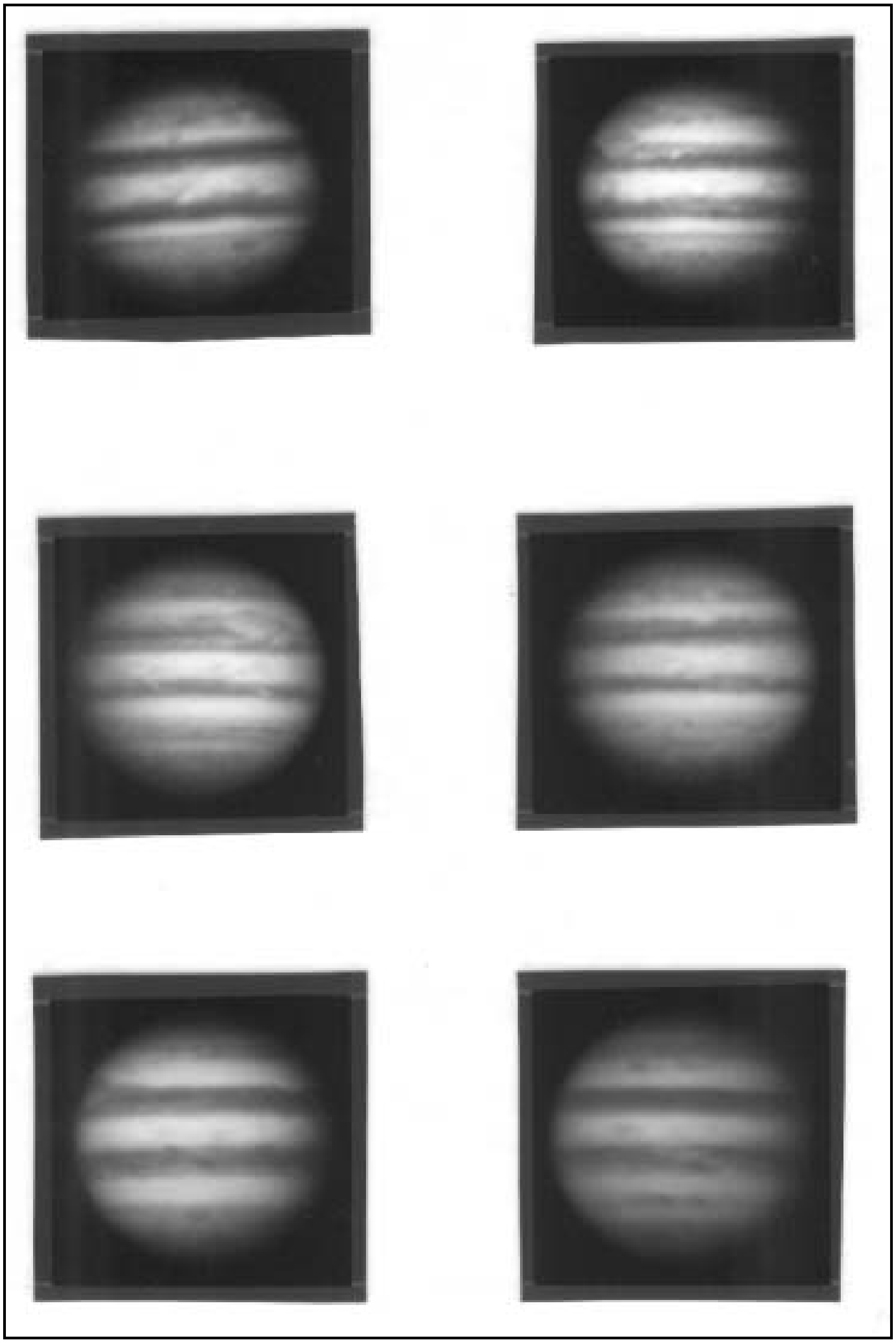

Figure 3: Photographs of Jupiter made in 1986-89.Top left: Sep. 19, 1986 (Parker) 4:47 UT, $\lambda_{I}=135^{o}$, $\lambda_{II}=253^{o}$, 0.32m New; Top right: Nov. 6, 1986 (Parker) 0:32 UT, $\lambda_{I}=149^{o}$, $\lambda_{II}=63^{o}$, 0.32m New;

Middle left:Sep. 19, 1987 (Parker) 6:27 UT, $\lambda_{I}=337^{o}$, $\lambda_{II}=351^{o}$, 0.32m New, Middle right:Sep. 27, 1986 (Parker) 6:22 UT, $\lambda_{I}=157^{o}$, $\lambda_{II}=110^{o}$, 0.32m New;

Bottom left:Jan. 31, 1989 (Miyazaki) 12:46 UT, $\lambda_{I}=286^{o}$, $\lambda_{II}=83^{o}$, 0.40m New; bottom right:Feb. 23, 1989 (Miyazaki) 12:06 UT, $\lambda_{I}=290^{o}$, $\lambda_{II}=271^{o}$, 0.40m New.

analysis and only regions pole- ward of 60° were considered.

The average drift rate for the SSTB ovals in 1987-88 was -25.3°/30 days (system II) and the corresponding value for the 1988-89 apparition was -28.9°/30 days. Longitudes for the SSTB ovals are plotted in figures 6 and 8. The system II longitudes of oval B2 were: 17° (Sep. 7.3), 15° (Sep. 19.3), 7° (Sep. 26.3), ~345° (Oct. 14.5 drawing) and 340° (Oct. 21.1).

Figure 5 shows the development of ovals BC and DE during 1986-89. These two features were 60° apart in 1986 but by early 1989, they were only 25° apart. A second development was the changing area between BC and DE. During 1986 and 1987, there were 2 - 7 bright ovals between BC and DE, but by late 1988 this number had dropped to 0 - 2. During most of the 1988-89 apparition, two dark rods near ovals BC and DE (features C1 and C2) were present. The rods are shown in Figure 5 (Nov. 23, 1988) and their longitudes are

Table 4: Planetographic Latitudes of Various Features on Jupiter During the 1986-87, 1987-88 and 1988-89 Apparitions.

Feature	1986-87	1987-88	1988-89
N^5TBn	---	---	58.3ºN±2º
N^5TBs	---	---	54.2ºN±2º
N^3TBn	---	---	48.9ºN±2º
N^3TBs	42.5ºN±1º	43.9ºN±1º	44.7ºN±2º
NNTBn	38.9ºN±2º	38.1ºN±1º	39.5ºN±1º
NNTBs	35.0ºN±2º	35.3ºN±1º	34.0ºN±1º
NTBn	29.0ºN±1º	27.5ºN±0.5º	29.7ºN±0.5º
NTBs	25.0ºN±1º	24.9ºN±0.5º	25.2ºN±0.5º
NEBn	17.5ºN±0.5º	16.3ºN±1º	21.3ºN±0.5º
NEBs	7.1ºN±0.5º	7.6ºN±0.5º	7.2ºN±0.5º
EBc	---	1.1ºN±0.5º	1.2ºN±0.5º
SEBn	7.2ºS±0.5º	6.9ºS±0.5º	8.1ºS±0.5º
SEBs	21.7ºS±0.5º	21.4ºS±0.5º	21.6ºS±0.5º
GRS	22.3ºS±1º	21.0ºS±0.5º	21.1ºS±0.5º
STBn	29.3ºS±1º	30.2ºS±1º	27.3ºS±1º
SSTBs	---	---	45.7ºS±1º
S^3TBn	---	---	48.7ºS±1º
S^3TBs	---	---	51.2ºS±1º

plotted in Figure 8. These rods had drift rates similar to BC and DE.

The longitudes of ovals BC, DE and FA are plotted in figures 6 and 8. The drift and rotation rates for these features are summarized in tables 6 and 7. Budine (1989a; 1990; 1997) reported system II drift rates for BC in degrees/30 days of: -13.6 (1984), -14.0 (1985) and -11.5 (1986), which are well above the values of -9.7 (1987) and -9.4 (1988). It appears that something caused BC to slow down in 1986.

A white oval (C1 in 1987-88, C3 in 1988-89) in the northern part of the STrZ and oval #2 (Wc) in the south tropical current, reported by Budine (1997) are believed to be the same feature because of similarities in appearance, drift rate and longitude. This feature often appeared as a bright oval (Figure 2, bottom right), but at other times it appeared as a bay in the SEBs (Figure 2 middle left and Figure 3 middle right). This oval had system II drift rates of 0.7°/30 days (1987-88) and 2.6°/30 days (1988-89).

A dark streak preceding the GRS was photographed on Sep. 7, 1987 and the streak's preceding edge was at λ_{II} = 354°; this feature is shown in Figure 3 (middle left). The preceding edge (C2) of this streak steadily moved eastward and by Oct. 6, it was at λ_{II} = 288°. The drift rate of C2 was -67.2°/30 days which is different from the value of the GRS. The most likely reason for this discrepancy is that C2 was at a more southerly latitude than the GRS. The wind speed on Jupiter at a latitude of 20°S is 100 m/s whereas at 25°S, it drops to -50 m/s (Rogers, 1990a, Figure 1).

Budine (1988) described an "oscillating spot" that was observed from July 1 to Sep. 1, 1987. The longitudes of this spot are plotted in Figure 6 and all longitudes are from Budine (1988). This feature is called the oscillating spot because its drift rate changed directions at least 4 times in July and August. The mean planetographic latitude of this feature from 3 photographs was 30.2 ± 0.6°S. On Aug. 23, this feature had a north-south dimension of 3800 km, an east-west dimension of 10,600 km and an area of 3.1 x 10^7 km^2. The oscillating spot was about as dark as the NTB on Aug. 23, and it had a mean drift rate of -10.4°/30 days (system II).

The oscillating spot may have changed longitudes because of slight latitude changes. The wind speeds on Jupiter change dramatically with latitude. A southward shift of 0.5° on about July 30 would account for the temporary increase in longitude in early August. Similar shifts in latitude could account for the other three longitude reversals. One of Miyazaki's July drawings shows the oscillating spot much closer to the SSTB than to the SEB, but in an August drawing by this observer, this spot is almost midway between the SSTB and the SEB; this shift indicates a latitude change.

Peek (1981, 187) described an oscillating spot in 1941-42 that was in the STrZ. Peek notes that this spot changed latitude at least twice, but unfortunately accurate latitudes were not measured.

Region III: South Equatorial Belt

The width of the SEB was 14° for 1986-89, which is consistent with 1960-80 widths (Rogers, 1995, 167). At some longitudes, the central area of the SEB was darker than the northern or southern parts (see Figure 3, top left), but at other longitudes, the reverse was the case (see Figure 3, top right). Rifts in the SEB were present at λ_{II} = 230° (Dec. 15-20, 1986), λ_{II} = 100°, (Jan. 10, 1987) and λ_{II} = 55° (Aug. 2, 1987).

Region IV: Equatorial Zone

The average number of EZ festoons on Jupiter for 1986-88 was around 9 whereas during early 1989 this average fell to 6. The drift rate of one festoon in late 1987 was 9.1°/30 days (system I), whereas the average drift rate of 5 EZ features in 1988-89 was 9.4°/30 days (system I); see Table 8.

Region V: North Equatorial Belt

There were several bright rifts in the NEB during 1986-89; Figure 3 (bottom right) shows one of these. Budine (1989b) reports that 18 different rifts were present in the NEB during 1988-89. Many of the rifts followed a dark spot. In one instance, (Sep. 13, 1987 at λ_{II}=200°) a rift appeared as a group of white ovals that touched one another.

During late 1987, a dark, northward pointing bump on the NEB (N3) had a drift rate of 3.0°/30 days (system II). During 1988-89, three ovals (N1, N4, N6) inside of the NEB and three dark rods (N2, N3, N5) at the NEBn had an average drift rate of -1.3°/30 days (system II), which

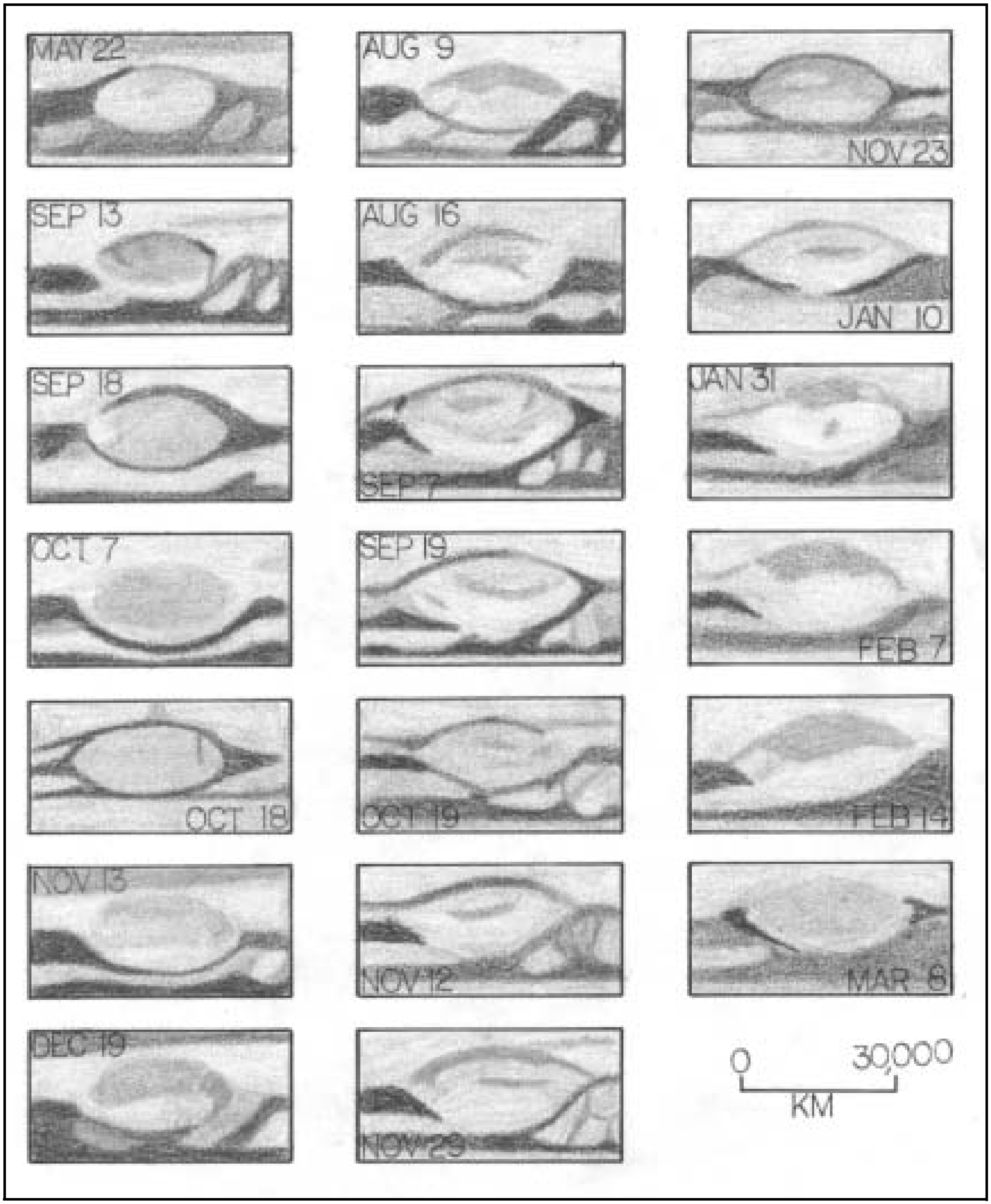

Figure 4: Drawings of the Great Red Spot made from drawings and photographs.The left column is drawings made in 1986 while the middle column shows drawings made in 1987 and the right column is drawings made in late 1988 and early 1989. Most of the drawings were drawn from photographs made by Miyazaki and Parker.

is consistent with historical NEBn rates (Rogers, 1995, 114-115).

Region VI: North Tropical Zone to North Polar Region

During 1986 and most of 1987, the NTB was relatively-dark but in late Nov. 1987, MacDougal and McArthur reported this belt as being faint (Budine, 1991a). During 1988 and early 1989, the NTB remained faint; see figures 2 and 3. A portion of the NTB ($240° < \lambda_{II} < 290°$) was dark in Feb. 1989 (Schmude, 1989, 125). Between Feb. 28 and March 12, 1989, a portion of the NTB ($190° < \lambda_{II} < 240°$) became darker. Almost two-thirds of the drawings in late March and early April show a moderately dark NTB. This belt returned to its normal appearance in 1990 (Lehman et al. 1999, 53).

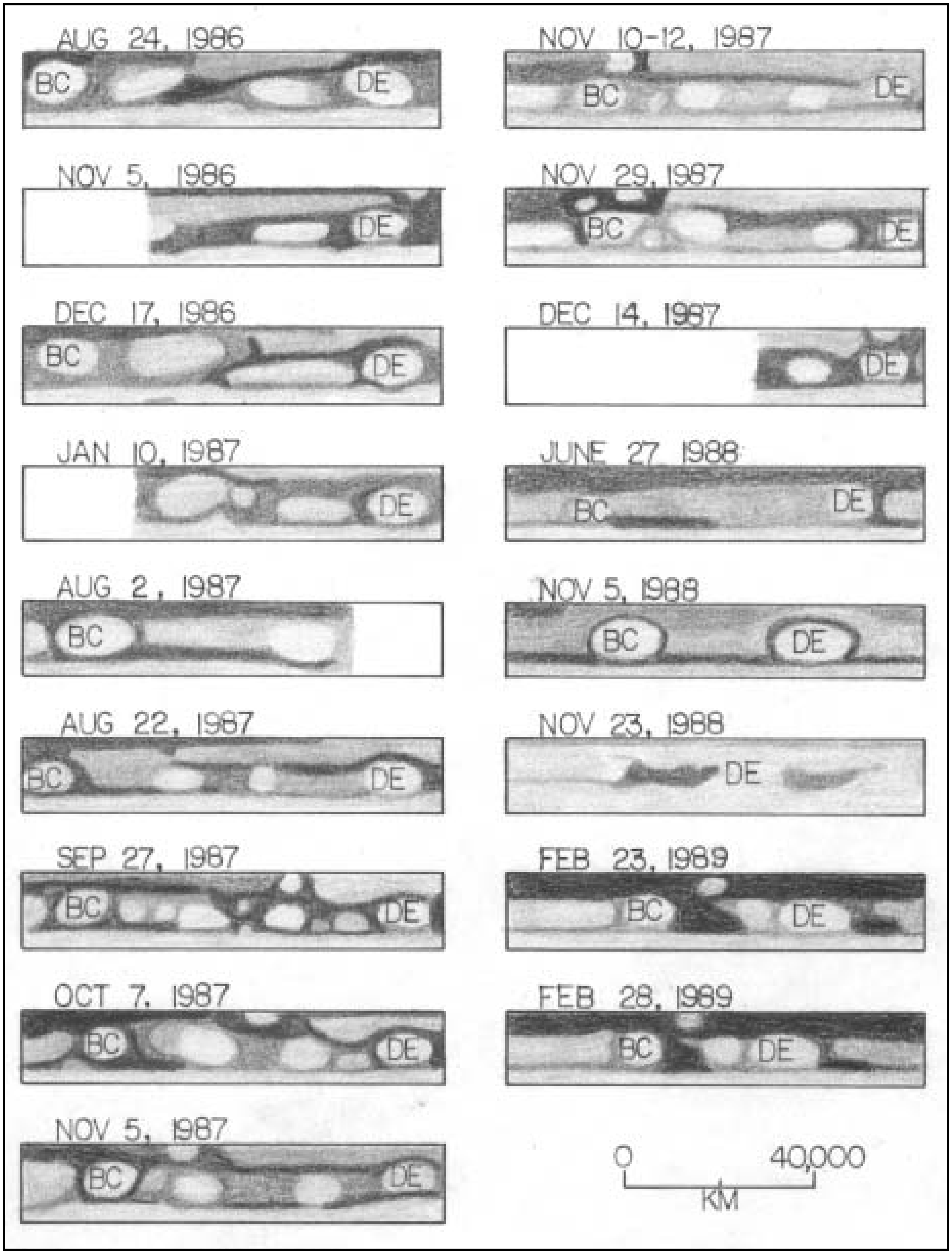

Figure 5: Drawings of ovals BC and DE made from drawings and photographs. Most of the drawings were made from photographs made by Miyazaki and Parker.

Table 5: Sizes, Shapes and Positions of White-Oval Storms on Jupiter

Feature	λ_{II} (deg)	North-South (km)	East-West (km)	Aspect	Area (10^6 km^2)
1986-87 Apparition					
Oval BC	221	6700	10,400	0.65	55±5
Oval DE	276	6800	11,700	0.59	63±1
B1	262	4700	6100	0.78	23±3
B2	96	5400	5500	0.99	24±3
B6	245	4700	4800	0.99	18±3
B10	56	4900	4900	1.00	19±3
1987-88 Apparition					
Oval BC	60	7200	9600	0.76	55±3
Oval DE	110	6400	9300	0.69	46±2
Oval FA	210[a]	5900	10,700	0.55	49±10
B1	82	5600	5200	1.07	23±1
B2	b	5000	5500	0.92	22±3
B3	136	5200	6500	0.82	27±3
B4	175[a]	4700	4300	1.09	17±4
B6	267	4400	5800	0.76	20±2
B10	c	3800	4900	0.79	15±3
1988-89 Apparition					
Oval BC	265	6300	7400	0.87	36±3
Oval DE	295	5800	8000	0.74	37±2
Oval FA	70[a]	5500	9100	0.60	39±5
B1	340[a]	4300	5000	0.87	17±2
B3	300[a]	4900	4800	1.02	19±2
B4	150[a]	5500	9000	0.61	39±5
B5	155[a]	5400	6800	0.81	29±1
N4	45[a]	4300	6200	0.72	21±1

[a] = Extrapolated to this value

[b] = Located at λ_{II}=32º on Aug. 16 (There was not enough data to compute a drift rate for this feature)

[c] = Located at λ_{II}=287º on Dec. 15, 1987 (There was not enough data to compute a drift rate for this feature.

The NNTB was usually darker than the NTB and was as wide as this feature during most of the 1988-89 apparition; see Figure 3 (bottom left). There were often dark spots in the NTZ or inside of the NNTB.

Six dark spots (G1-G6) in 1987-88 lying in the NTZ or along the NTBn had an average drift rate of 16.7°/30 days (system II), which is consistent with the North Temperate Current (Rogers, 1995, 102-103).

During 1988-89, two white ovals (G1 and G2) and a dark bar (G3) had a mean drift rate of 1.3°/30 days (system II), which is consistent with historical values (Rogers, 1995, 88-89), (Peek, 1981, 193).

Three irregularities (I1-oval, I2-dark rod, I3-rod and projection) all located at 54°N had a mean drift rate of 11.7°/30 days (system II). Using the framework in Rogers (1990a, 88), these features are located in the North North North North North Temperate Current.

Satellites

Parker photographed Io transiting Jupiter on Sep. 26, 1987 at 6:02 U.T. At this time, the solar phase angle of Io was 5° and so Io's albedo was 0.62 (Schmude, 2003d, 17). The albedo is the fraction of sunlight that an area reflects. Parker's photograph shows that Io was about as bright as the EZs (the brightest zone on Jupi-

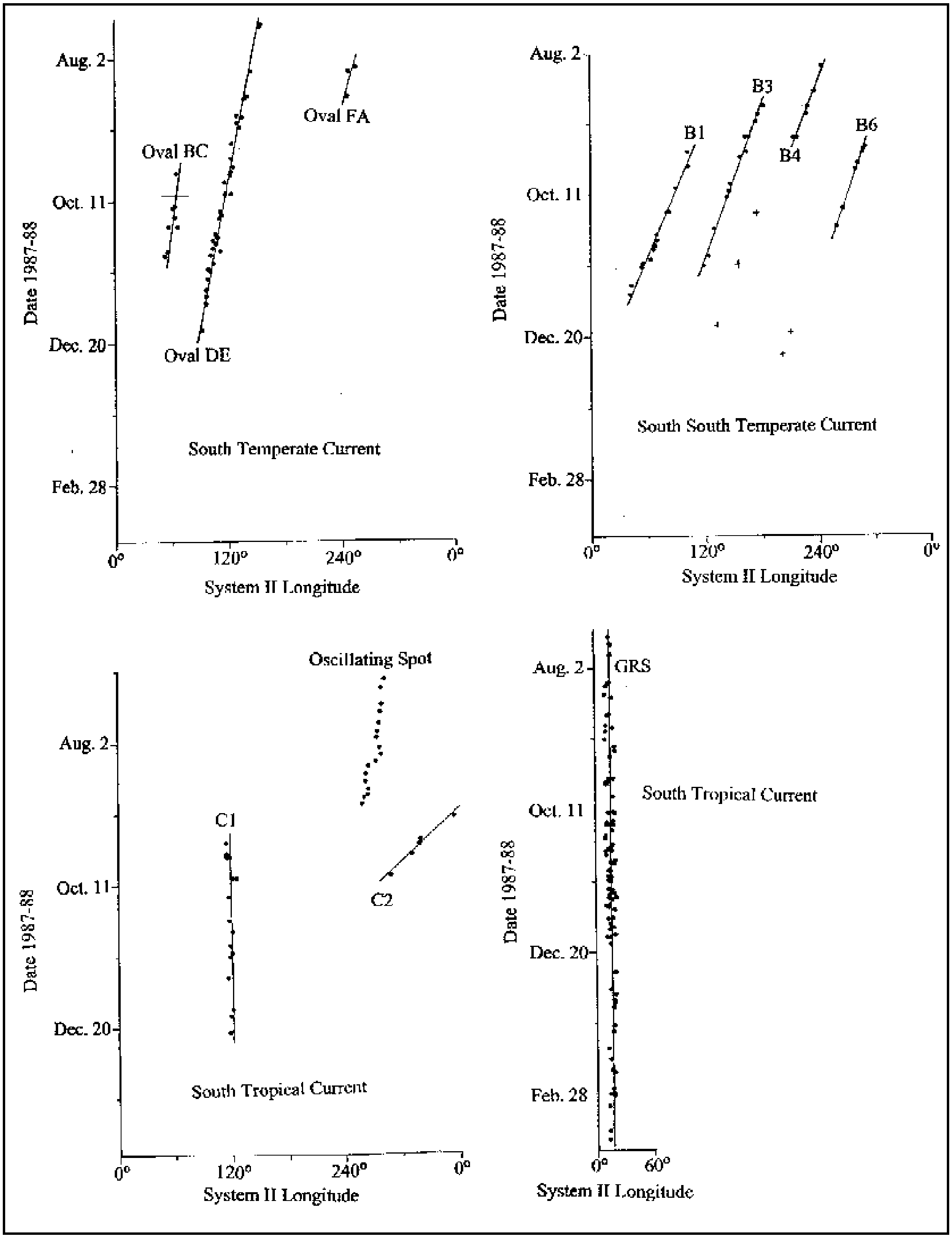

Figure 6: Longitudes of various features on Jupiter plotted for the 1987-88 apparition. Dots and Xs are longitude measurements, plus-signs (+) are longitude measurements for features that are suspected to be the same as features indicated by dots or Xs and lines are longitude estimates measured from drawings. Only longitudes indicated by dots or Xs were used in the linear fits.

Table 6: Drift Rates of Features on Jupiter During the 1987-88 Apparition.

Feature	Number of Points	Time Interval	Planetographic Latitude	Drift Rate deg/30 days (system II)	Rotation Rate
South South Temperate Current					
B1	14	Sep. 20-Nov. 29	43.5ºS	-26.9	9h 55m 04s
B2	4	Sep. 7-Oct. 21	39.9ºS	-26.9	9h 55m 04s
B3	13	Aug. 29-Nov. 15	41.1ºS	-24.0	9h 55m 08s
B4	6	Aug. 8-Sep. 13	41.7ºS	-25.4	9h 55m 06s
B6	7	Sep. 18-Oct. 27	40.3ºS	-23.4	9h 55m 09s
Average			41.3ºS	-25.3	9h 55m 06s
South Temperate Current					
Oval BC	7	Sep. 27-Nov. 7	34.4ºS	-9.7	9h 55m 27s
Oval DE	40	Jul. 16-Dec. 14	34.4ºS	-12.2	9h 55m 24s
Oval FA	3	Aug. 6-Aug. 21	31.3ºS	-12.8	9h 55m 23s
Average			33.4ºS	-11.6	9h 55m 25s
South Tropical Current					
GRS	99	Jul 17-Mar. 23	21.0ºS	0.1	9h 55m 41s
C1	17	Sep. 20-Dec. 22	21.4ºS	0.7	9h 55m 42s
South Tropical Current (preceding the GRS)					
C2	5	Sep. 7-Oct. 6	23.9ºS	-67.3	9h 54m 09s
North Tropical Current					
N3	9	Aug. 8-Sep. 21	16.3ºN	3.0	9h 55m 45s
North Temperate Current[b]					
G1	4	Nov. 3-Nov. 29	32.5ºN	21.7	9h 56m 11s
G2	6	Nov. 3-Nov. 29	32.5ºN	24.9	9h 56m 15s
G3	5	Nov. 3-Nov. 29	33.6ºN	7.5	9h 55m 51s
G4	7	Sep. 27-Nov. 3	32.2ºN	17.3	9h 56m 04s
G5	14	Sep. 27-Nov. 5	33.5ºN	15.9	9h 56m 02s
G6	23	Oct. 20-Jan. 12	33.4ºN	12.6	9h 55m 58s
Average			33.0ºN	16.7	9h 56m 04s
Equatorial Current					
N1	5	Aug. 2-Sep. 13	7.6ºN	9.1a	9h 50m 42s
aSystem I drift rate.					
bPeek (1981) called this the North Temperate Current A					

ter). It is concluded that at visible wavelengths on Sep. 26, 1987, the EZs had an albedo near 0.62 and that the STrZ, EZn and NTrZ had albedos just below 0.62.

Graham made a drawing of Ganymede transiting Jupiter on March 17, 1989 at 19:10 U.T. At this time, the solar phase angle of Ganymede was 10º (*Astronomical Almanac*, 1988), and so its average albedo was 0.34 (Schmude, 2003d). Graham drew Ganymede as dark as the darkest area on Jupiter, which was the southern quarter of the NEB. The writer concludes that the albedos of all portions of the SEB, STB, NNTB and the polar regions were higher than 0.34. The average

Table 7: Drift Rates of Features on Jupiter During the 1988-89 Apparition

Feature	Number of Points	Time Interval	Planetographic Latitude	Drift Rate deg/30 days (system II)	Rotation Rate
South South Temperate Current					
B1	9	Feb. 20-Mar. 19	42.1ºS	-27.7	9h 55m 03s
B3	5	Feb. 13-Mar. 6	41.3ºS	-34.1	9h 54m 54s
B4	4	Jan. 10-Jan. 31	39.4ºS	-28.8	9h 55m 01s
B5	3	Jan. 10-Jan. 31	40.7ºS	-25.0	9h 55m 06s
Average			40.9ºS	-28.9	9h 55m 01s
South Temperate Current					
Oval BC	27	Aug. 21-Mar. 19	34.6ºS	-9.4	9h 55m 28s
Oval DE	32	Aug. 21-Mar. 19	34.7ºS	-11.1	9h 55m 26s
Oval FA	5	Jan. 10-Feb. 12	31.7ºS	-6.6	9h 55m 32s
C1	15	Nov. 19-Jan. 11	33.0ºS	-8.7	9h 55m 29s
C2	15	Nov. 19-Jan. 11	32.5ºS	-11.9	9h 55m 24s
Average			33.3ºS	-9.5	9h 55m 28s
South Tropical Current					
GRS	142	Aug. 7-Apr. 20	21.1ºS	0.9	9h 55m 42s
C3	19	Oct. 29-Mar. 30	21.6ºS	2.6	9h 55m 44s
South Equatorial Current (north edge)					
S1	12	Jan. 31-Feb. 28	---	37.5	9h 56m 32s
S2	6	Jan. 1-Jan. 31	21.6ºS	12.4	9h 55m 58s
North Tropical Current					
N1	12	Aug. 24-Nov. 19	---	-1.0	9h 55m 39s
N2	15	Dec. 28-Feb. 26	19.8ºN	-0.5	9h 55m 40s
N3	15	Jan. 31-Apr. 8	20.0ºN	-2.9	9h 55m 37s
N4	10	Jan. 10-Apr. 1	21.0ºN	-3.1	9h 55m 36s
N5	10	Jan. 11-Feb. 28	18.1ºN	2.0	9h 55m 43s
N6	12	Dec. 29-Mar. 12	19.0ºN	-2.2	9h 55m 38s
Average			19.6ºN	-1.3	9h 55m 39s
North North Temperate Current					
G1	4	Jan. 10-Jan. 31	39.7ºN	2.3	9h 55m 44s
G2	4	Jan. 10-Jan. 31	41.8ºN	-2.2	9h 55m 38s
G3	4	Jan. 10-Jan. 31	40.6ºN	3.7	9h 55m 46s
Average			40.7ºN	1.3	9h 55m 43s
North North North North North Temperate Current					
I1	4	Jan. 10-Jan. 31	54.4ºN	12.9	9h 55m 58s
I2	4	Jan. 10-Jan. 31	54.4ºN	11.7	9h 55m 57s
I3	7	Jan. 10-Jan. 31	53.4ºN	10.6	9h 55m 55s
Average			54.1ºN	11.7	9h 55m 57s

Table 8: Drift Rates of Features on Jupiter During the 1988-89 Apparition

Feature	Number of Points	Time Interval	Planetographic Latitude	Drift Rate deg/30 days (system I)	Rotation Rate
Equatorial Current (north)					
E4	7	Oct. 18-Nov. 23	7.2ºN	11.8	9h 50m 46s
E5	11	Nov. 23-Jan. 16	7.2ºN	13.8	9h 50m 49s
E6	4	July 30-Aug. 31	7.2ºN	5.3	9h 50m 37s
E7	4	Aug. 21-Sep. 17	7.2ºN	4.9	9h 50m 37s
E9	6	Nov. 7-Dec. 5	7.2ºN	11.4	9h 50m 45s
Average			7.2ºN	9.4±1.6	9h 50m 43s
Equatorial Current (central)					
E8	4	Aug. 21-Sep. 17	3.0ºN	6.7	9h 50m 39s

albedo of the NEB was also higher than 0.34, but the darkest portion of this belt had an albedo of 0.34.

Westfall (1988; 1989; 1991) summarizes Galilean satellite eclipse timings for 1986-89.

Wind Speeds and Drift Rates

A large number of the longitudes from the 1987-88 and 1988-89 apparitions were measured from photographs with a device described by Rogers (1995, 391). Other longitudes are from Budine (1991a, b) and are based on visual transit times.

The calculated jovian wind speeds are summarized in tables 9 and 10. In all cases, wind speeds are with respect to System III longitudes. The wind speeds and uncertainties were computed as outlined in (Schmude, 2002) and are consistent with historical values (Rogers, 1995).

Acknowledgements

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Table 9: Average Drift Rates, Rotation Periods and Wind Speeds for Several Currents on Jupiter During the 1987-88 Apparition

Current	Feature(s)	Drift Rate (deg/30 day)			Rotation Period	Wind Speed m/s (Sys. III)
		Sys I	Sys II	Sys III		
SS Temp. Cur.	B1,B3,B4,B6	203.6	-25.3	-17.3	9h 55m 07s	6.6±0.3
S Temp. Cur.	Ovals BC, DE, and FA	217.3	-11.6	-3.6	9h 55m 25s	1.5±0.4
S Trop. Cur.	GRS	229.0	0.1	8.1	9h 55m 41s	-3.7±0.3
S Trop. Cur.	C1	229.6	0.7	8.7	9h 55m 42s	-3.9±0.3
S Trop. Cur.	C2	161.6	-67.3	-59.3	9h 54m 09s	26.3±0.5
Eq. Cur.	N1	9.1	-219.8	-211.8	9h 50m 42s	101.0±0.5
N Trop. Cur.	N3	231.9	3.0	11.0	9h 55m 45s	-5.1±0.5
N Temp. Cur. A	G1-G6	245.6	16.7	24.7	9h 56m 04s	-10.2±0.2

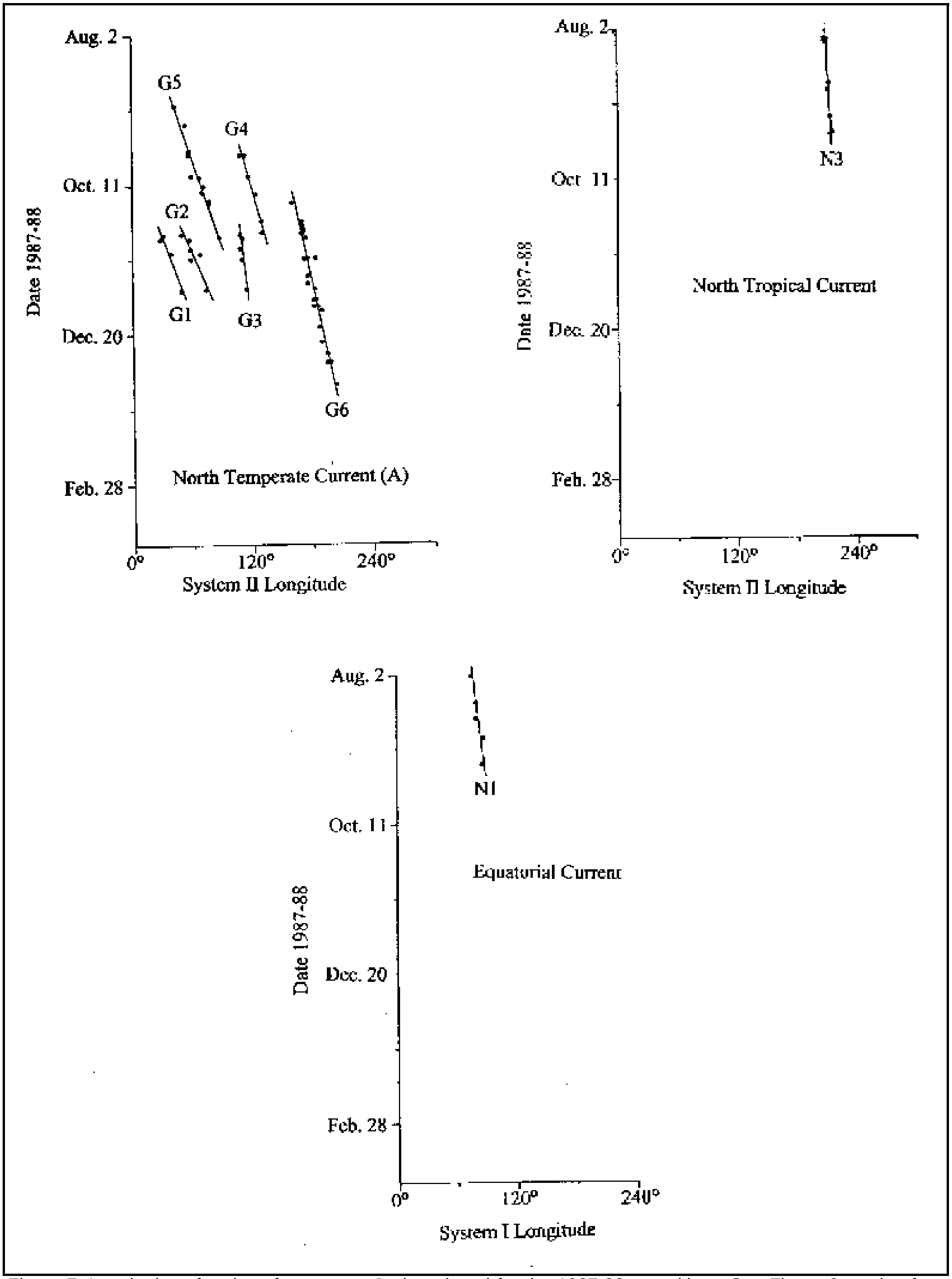

Figure 7: Longitudes of various features on Jupiter plotted for the 1987-88 apparition. See Figure 6 caption for symbol meanings.

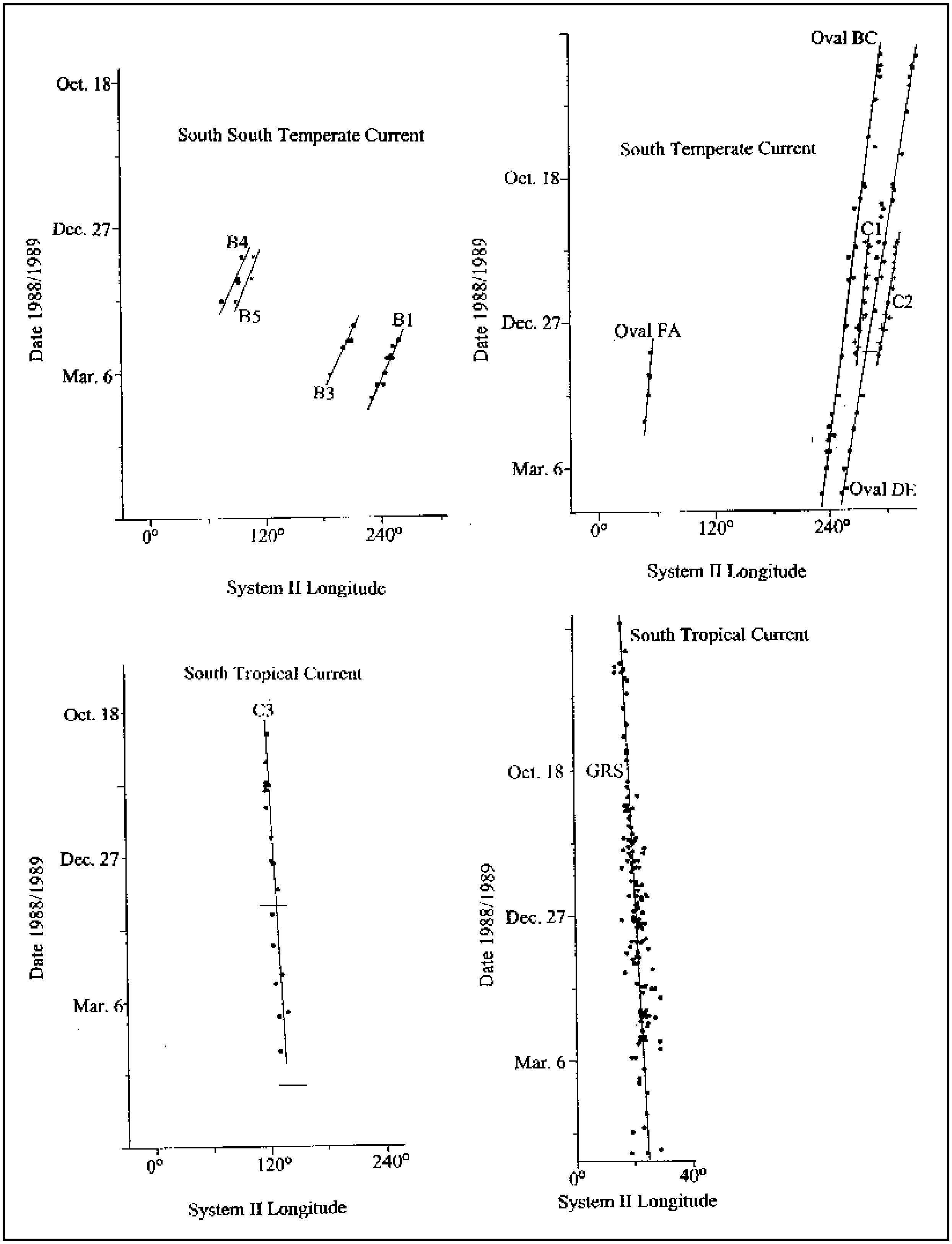

Figure 8: Longitudes of various features on Jupiter plotted for the 1988-89 apparition. See Figure 6 caption for symbol meanings.

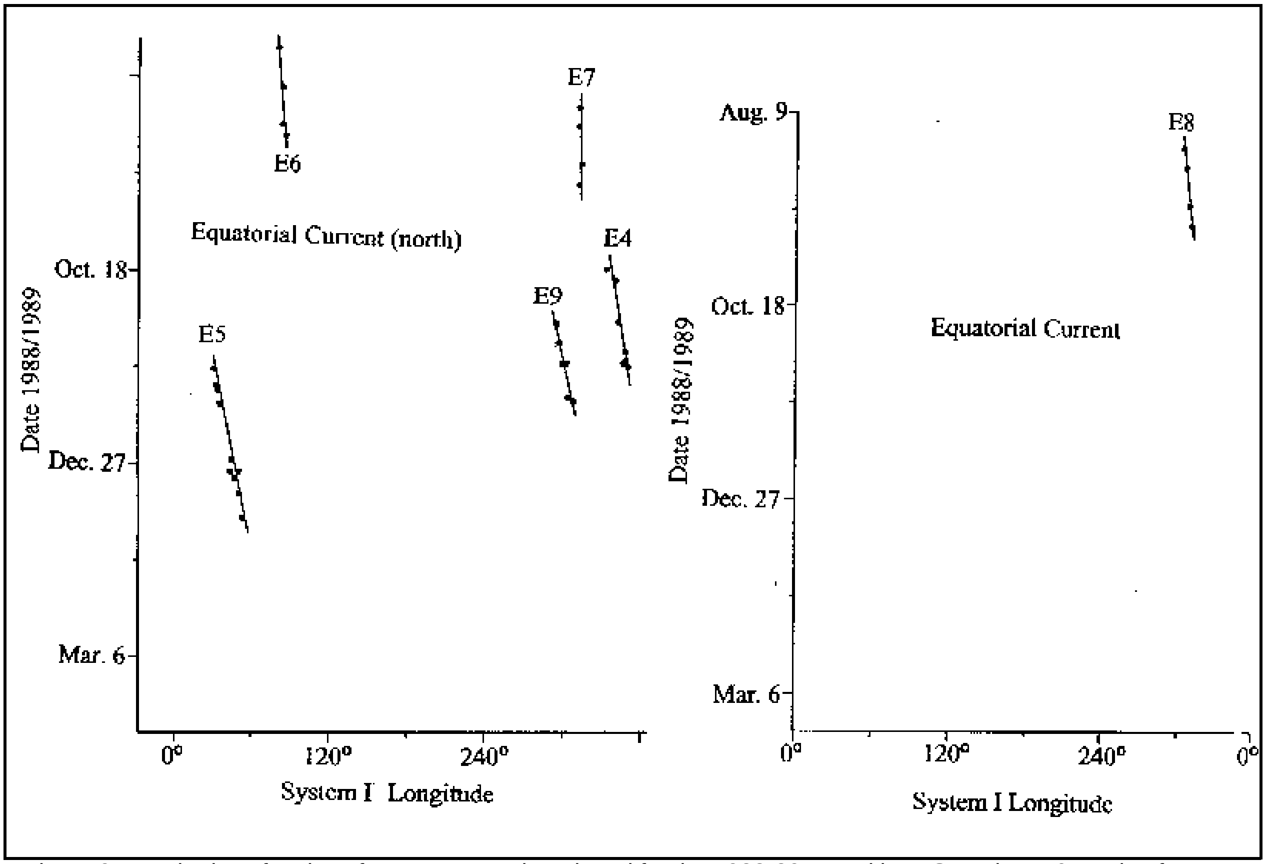

Figure 9: Longitudes of various features on Jupiter plotted for the 1988-89 apparition. See Figure 6 caption for symbol meanings.

Table 10: Average Drift Rates, Rotation Periods and Wind speeds for Several Currents on Jupiter During the 1988-89 Apparition

Current	Feature(s)	Drift Rate (deg/30 day)			Rotation Period	Wind Speed m/s (Sys. III)
		Sys I	Sys II	Sys III		
SS Temp. Cur.	B1,B3,B4,B5	200.0	-28.9	-20.9	9h 55m 01s	7.8±0.3
S Temp. Cur.	Ovals BC, DE,	219.4	-9.5	-1.5	9h 55m 28s	0.6±0.3
	FA, C1, C2					
S Trop. Cur.	GRS	229.8	0.9	8.9	9h 55m 42s	-4.0±0.3
S Trop. Cur.	C1	231.5	2.6	10.6	9h 55m 44s	-4.8±0.3
S Eq. Cur.	S1,S2	*				
Eq. Cur.	E4-E7,E9	9.4	-219.5	-211.5	9h 50m 43s	101.0±0.8
Eq. Cur.	E8	6.7	-222.2	-214.2	9h 50m 39s	102.9±0.5
N Trop. Cur.	N1-N6	227.6	-1.3	6.7	9h 55m 39s	-3.1±0.3
NN Temp. Cur.	G1-G3	230.2	1.3	9.3	9h 55m 43s	-3.5±0.3
NNNNN Temp. Cur.	I1-I3	240.6	11.7	19.7	9h 55m 57s	-5.8±0.2

*Drift rates of 37.5 and 12.4 degrees/30 days (system II) were measured.No average value is reported due to the large difference between the drift rates of S1 and S2.

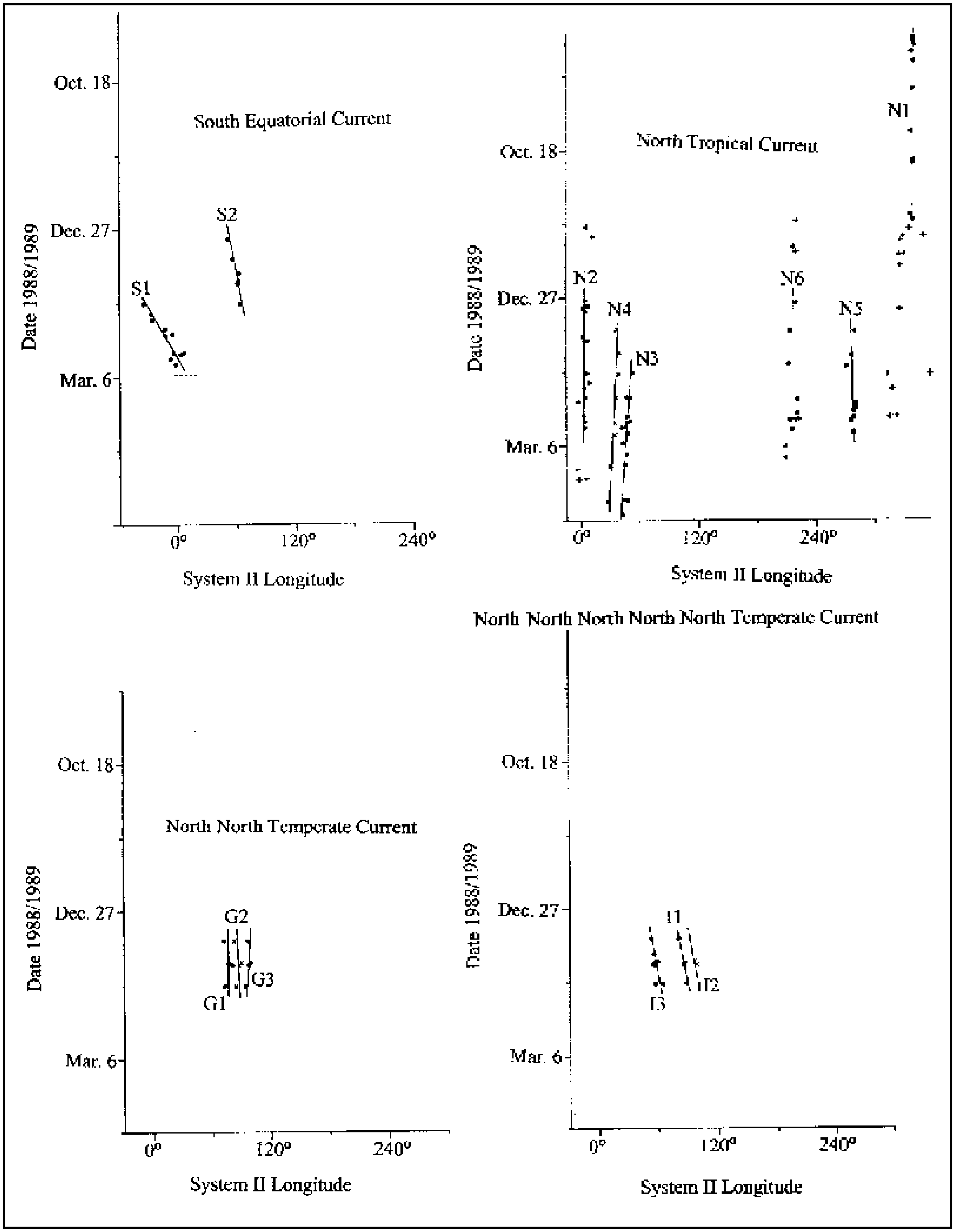

Figure 10: Longitudes of various features on Jupiter plotted for the 1988-89 apparition. See Figure 6 caption for symbol meanings.

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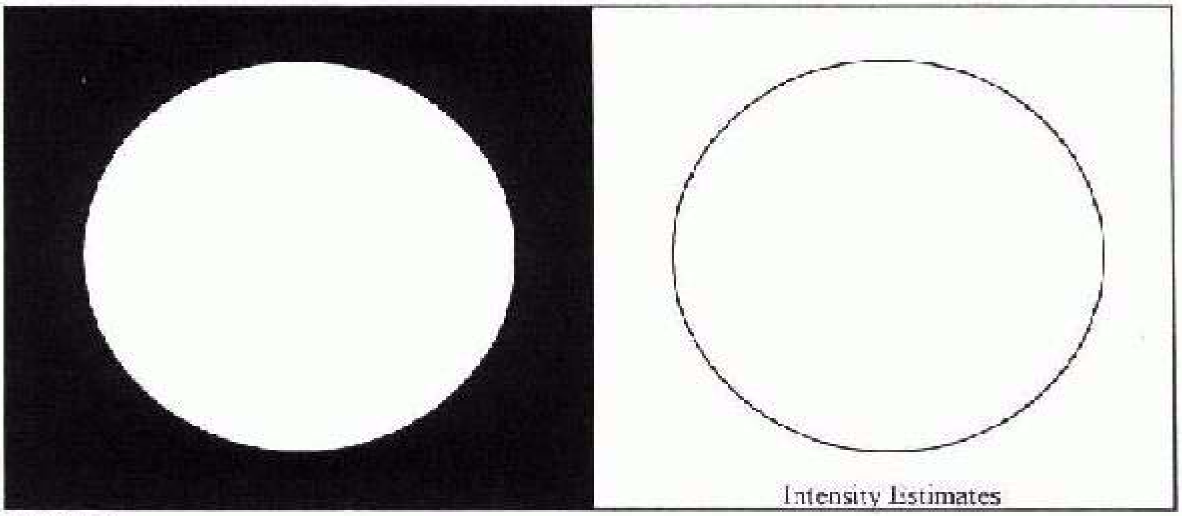

Date (UT): ____________________________
Time (UT): ____________________________
CMI= _______ ° CMII= _______ ° CMIII= _______ °

Begin (UT): - End (UT):
Telescope: _______ f/____ (in. / cm. ; RL / RR / SC)
Magnification: _______ x _______ x _______ x
Filters: ________________________ (W / S)
Transparency (1-6): ____ (Clear / Haze / Int. Clouds)
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- **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.

ALPO Resources (continued)

Schmude, Jr. 31 pages. Price: $4 for the United States, Canada, and Mexico; $5 elsewhere.

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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.

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- **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").
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- **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*.
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- **Minor Planets (Derald D. Nye):** *The Minor Planets 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 Planets Bulletin" to 10385 East Observatory Dr., Corona de Tucson, AZ 8564I-2309.

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- **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

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