PROCEEDINGS OF THE
43RD CONVENTION OF THE
ASSOCIATION OF LUNAR
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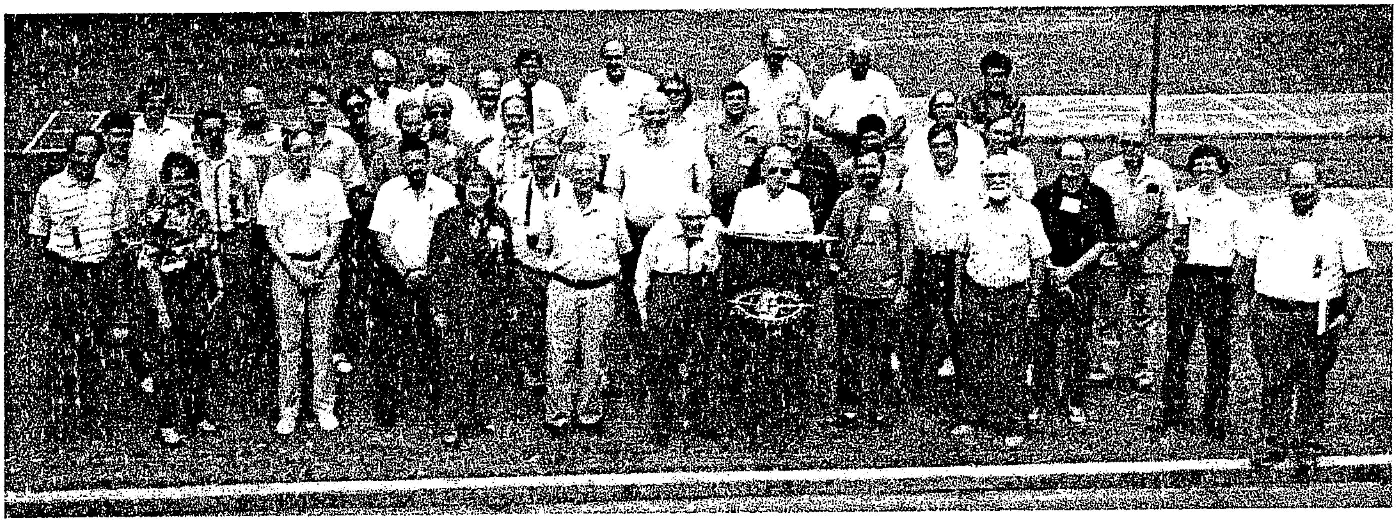
LAS CRUCES, NEW MEXICO, AUGUST 4-7, 1993



Program Chairman: David H. Levy

Edited by: John E. Westfall

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Preface

The Association of Lunar and Planetary Observers held its 43rd Convention in Las Cruces, New Mexico, on August 4-7, 1993. Approximately fifty members attended, many giving papers or workshops that made a success of this four-day gathering.

Several organizations and persons need to be thanked individually: The Astronomical Society of Las Cruces, the Astronomy Department of New Mexico State University (NMSU), the National Solar Observatory, Apache Point Observatory, Reta Beebe (NMSU), Jack Burns (NMSU), Stephen Edberg (JPL), Walter Haas, Cindy Jalife (the Planetary Society), David Levy, Scott Murrel (NMSU), Clyde Tombaugh, and Elizabeth Westfall.

The following *Proceedings* include all the papers or abstracts that have been submitted to the Editor. "Editing" is a generous term here; for the most part consisting of placing the papers in order and assigning page numbers—the papers following have been copied directly from the manuscripts supplied by their authors.

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Buried Gold - in that old SCT

JEFF BEISH

Association of Lunar and Planetary Observers

Introduction

My first "large aperture" telescope was a popular 8-inch Schmidt/Cassegrain (SCT), a big step from an old "Christmas Special" 60mm refractor and homebuilt 3½-inch reflector I was used to back in the early 1970's. While the SCT provided many hours of enjoyment its performance fell short of many of my friend's 6-inch and 8-inch Newtonians. My 6-inch f/4 Richest Field outpreformed the D8. We live and learn. After many years of observing and experimenting with various types of optical systems, I learned to appreciate the subtle differences in telescope designs. Yes, aperture plays an important roll in selecting a telescope; however, one should not forget that image contrast is also a very important ingredient in telescope performance.

In a reflecting telescope, the secondary mirror is a controlling factor in image contrast because it obstructs the optical light path causing light to scatter throughout the image field. This obstruction causes light from the center spot of the Airy disk to be scattered among the outer rings of the image and this is the real villain that causes the of loss in contrast. This fact is most often forgotten by commercial telescope makers and some home builders alike. Image contrast is lost by increasing the secondary obstruction -- the larger the secondary, the more contrast is lost -- <u>period!</u>

As a telescope builder and tinkerer my thoughts were on ways to increase the SCT's performance and in doing so I found some buried gold in an old Dynamax-8 (D8). The story begins a few years ago while camping and observing in the Everglades -- swatting mosquitoes and chasing away raccoons -- I dropped the telescope! With a loud thud the optics were, well, shall we say........realigned! This is what I subsequently learned about the Schmidt-Cassegrain telescope and how to increase its performance.

Reduced Central Obstruction

In the process of realigning the all of the optical components of the D8 the front corrector plate had to be removed and replaced several times. To save time the secondary baffle was intentionally left out and the secondary holder was loosened to make adjustments in centering. For the course optical centering and alignment, a bright star and/or a Cheshire eyepiece type alignment tool was used. While using Saturn's rings to fine tune the optics, I noticed something different about the images -- they appeared sharper and higher in contrast than before, even though the scope was not in perfect collimation! I could see Cassini's Division quite clear and more diffraction rings appeared in the off-focused star images. Also, the background field appeared darker.

The various components and distances within the telescope were measured and it was determined that the 2.75-inch diameter secondary baffle was a major contributor to the central obstruction (see Figure 1). The 2-inch secondary was found to be attached to an aluminum housing that was secured to the corrector plate with a ¼-inch overlap. Reducing the housing diameter from 2.5 inches to 2.25 inches left enough aluminum to safely secure the secondary and holder to the corrector plate. The corrector has a two-inch hole for this purpose (1.5 or 1.75 inch hole would be more than adequate). The increase in image quality was immediate. Looking around inside the D8, no logical reason was apparent for such a large baffle. Even my baffling calculations revealed no reason for it (no pun intended)!

While some direct light from the Moon did leak by the secondary into the image with the secondary baffle removed, it was easily eliminated by placing a glare stop near the end of this tube and lining the inside of the primary baffle tube with flocking paper. [redacted] Besides, those shinny SCT baffles do cause flares on photographs. While the image size is reduced a bit, it did not cause any apparent loss in image brightness, even on a photograph. The typical SCT baffle inside diameter is around 1.25-inches -- it seems some manufacturers falsely claim image sizes will fully illuminate a 35mm frame; however, how can it be larger than the I.D. of the rear end of the baffle? Maybe they design these scopes for day light use. Can you see someone carrying around a 14-inch telephoto!

The overall effect of this modification was to increase the contrast efficiency of the D8 by reducing the central obstruction from 35% to 28%. This produced a 41% increase in the contrast efficiency by increasing the Contrast Factor from 1.68 to 2.37 (where 0 is the lowest and 5.25 maximum). A 5.25 C_F is usually found in unobstructed telescopes (*Johnson*, 1956). The Contrast Factor (C_F) is illustrated in Figure 2 and can be found using the following equation:

$$C_F = 5.25 - 5.13(S/D) - 34.17(S/D)^2 + 51.1(S/D)^3$$

where S is the secondary mirror diameter,
and D is the primary mirror diameter.

If it were not for the 2.75-inch blackened area around the center hole in the primary, a 4% increase in light gathering power would have been realized as well. These results may appear to be small; however, the apparent increase in performance of the Schmidt-Cassegrain with this modification is obvious.

Additional Tips for Increasing Telescope Performance

1) It may come to a surprise to you, but those mosquito sprays that everyone uses in summer may be detrimental to the health of your mirror or corrector coatings. Watch out for those people who like to spray everything in sight! Other enemies to mirror coatings are; air pollution, chlorine vapors from swimming pools, and sea breezes containing salty air.

2) Most star diagonals that come with those popular SCT's are far too small, find a larger one. The D8 I once owned came with a 16mm aperture diagonal that proved much too small. Several dealers sell a 30-32mm aperture diagonal that works very good. I think the two inch stuff is a but too large for the usual 1" image diameters found in the SCT.

3) Keep your SCT primary from shifting by keeping it tight on the primary baffle tube hub/mirror cell. Of course, don't over tighten it. The primary mirror and "cell" slides up and down the primary baffle tube, I found some slop there too. Adding a little heavy grease in to sliding area will help this problem too. You might think about taking the focussing mechanism to a machinist

for reworking, they are much too loose for efficient focusing as they come from the factory. Much of the workmanship found in these SCT's is a joke, so don't be afraid to have them reworked or replaced by higher quality stuff and workmanship!

Another way to solve this problem is to lock the primary mirror in place and install a rack and pinion focuser. I drilled and tapped #10 holes in the small plate of the D8's back housing and drove screws up against the aluminum mirror housing/cell to lock the mirror in place. It also provide a method of slightly adjusting the f/2 primary collimation. The calculations reveal a back focus of 7.8 inches for the D8, probably near that for the C8 too.

4) The newer SCT's use a worm gear for polar rotation. To prevent the worm housing from getting too loose try some Loctite on each of the mounting screws that secures the worm housing components together. By the way, SCT's typically are out of balance so don't be afraid to add weights, a little extra weight will help dampen the excessive vibrations! The finder scope is only one cause for the unbalance. However, it is sometimes wise to off balance the R.A. axis of the mount in favor of the drive direction to lessen the backlash in drive gears.

5) Last but not least, be sure to mark everything for proper reassembly. I didn't the first time around and had to learn how to do all those optical testing procedures!

References

Johnson, Lyle T., "Improving Image Contrast In Reflecting Telescopes," *J.A.L.P.O.*, Vol. 18, Nos. 7-8, 142-146, July-August 1964.

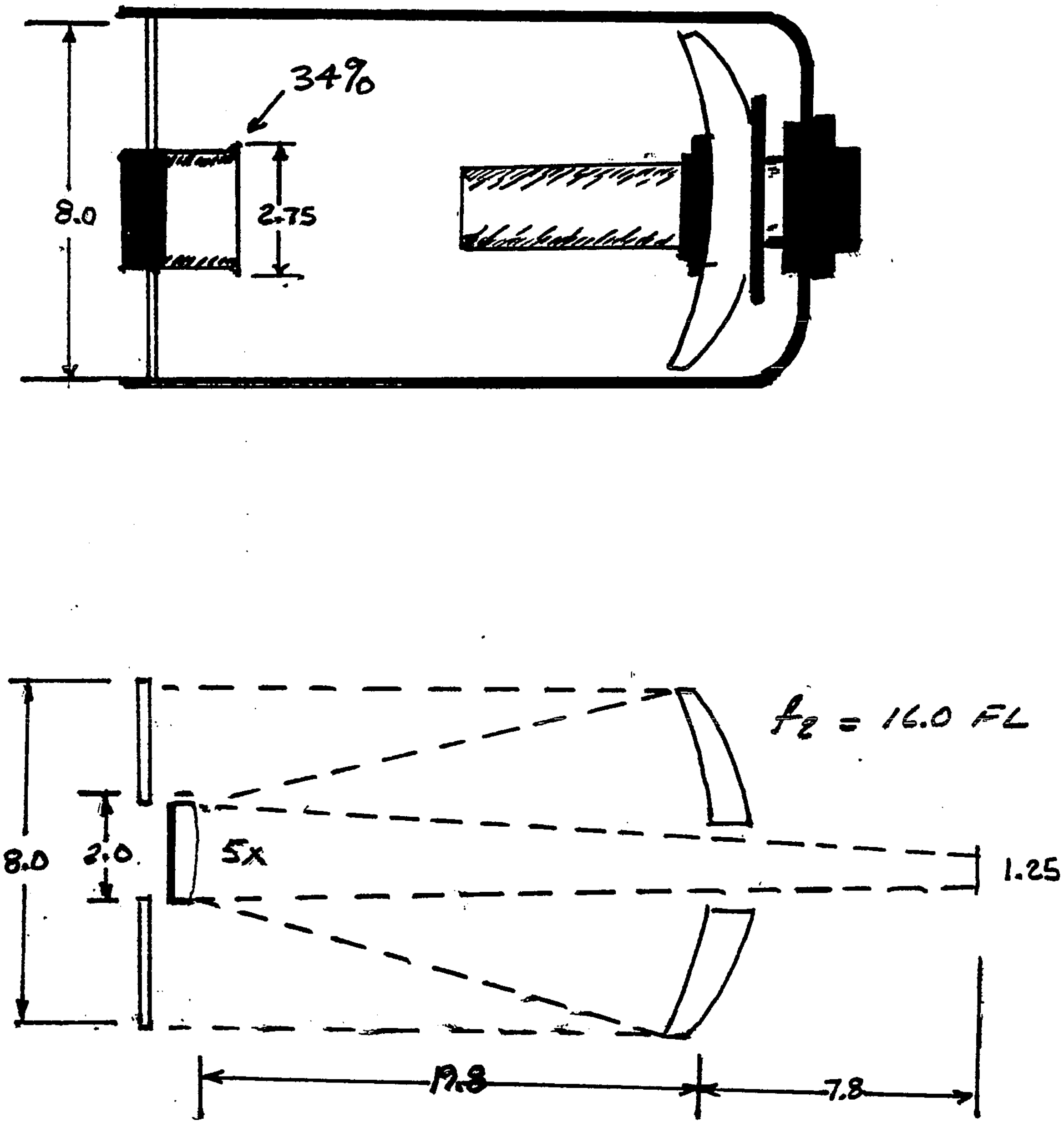

Figure 1. Top drawing shows the general design of the Dynamax-8 Schmidt-Cassegrain Telescope and the measured size of the secondary baffle housing. Bottom drawing indicates optical path and important measurements.

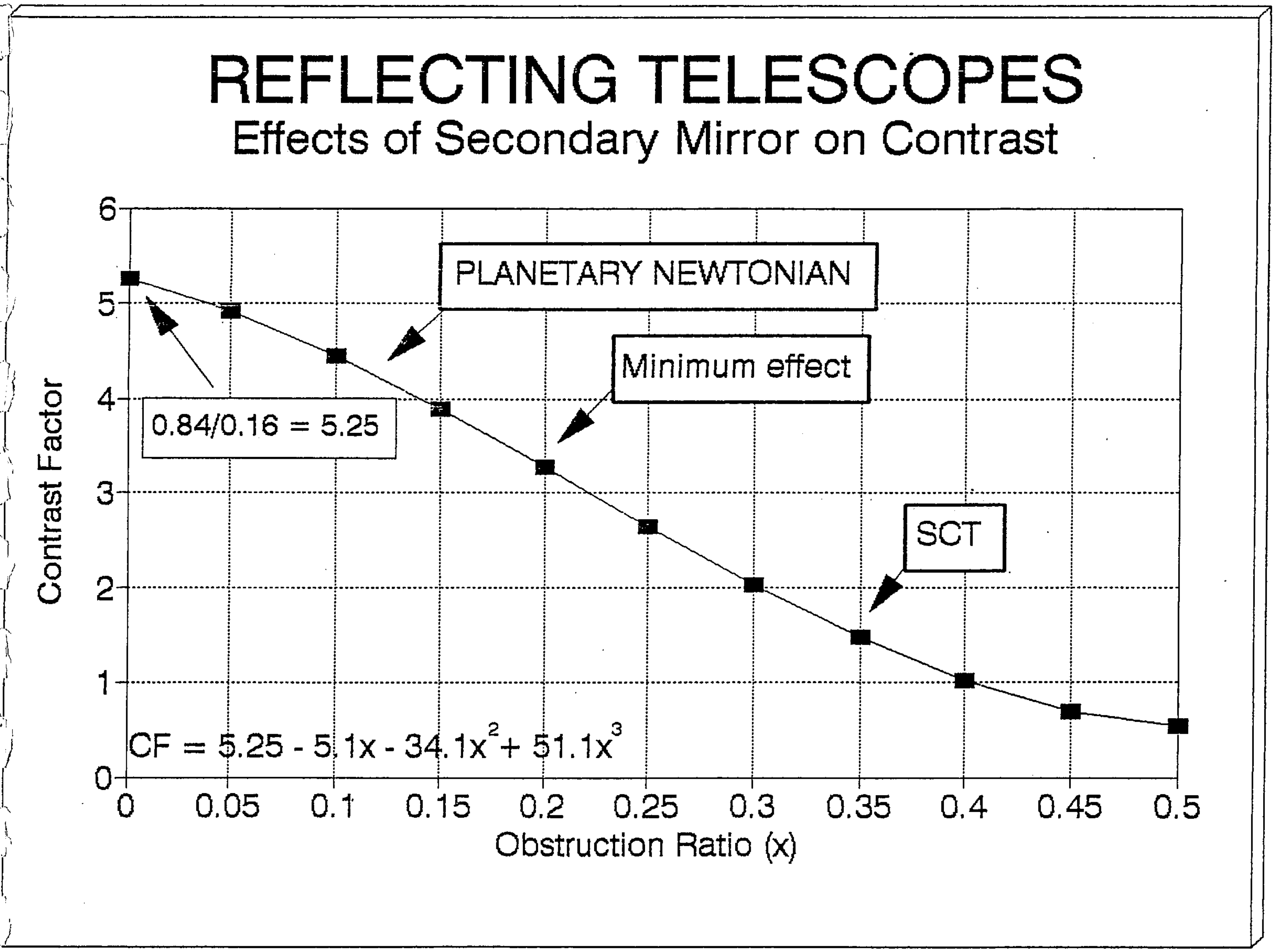

Figure 2. Graph of Contrast Factor C_F curve with relative comparisons with other telescope systems. Obstruction ratio is found by dividing the secondary mirror diameter by the primary mirror diameter. Calculated derived from ratio of the amount of light within the Airy disk to the light distributed throughout the outer rings. The unobstructed telescope ratio is 0.84/0.16.

THE ELEMENT OF FUN IN WHAT WE DO

By: Julius L. Benton, Jr.

A.L.P.O. Saturn, Venus, and Lunar (SAP) Recorder

ABSTRACT

Some observers seem to have overlooked the essential ingredient of fun in carrying out their observations. Many have the mistaken idea that pursuing research programs has to be a tedious and difficult task to be useful, while others have lost interest altogether in certain observing programs, feeling that they have exhausted all there is to do. A few people have even considered the heavens essentially changeless! These impressions were obtained during the author's recent visits to several local and regional astronomical societies. Discussion is presented on his efforts to try to renew some of the spirit of fun back into observing with the use of personal notes and examples of viable observing programs.

Not too long ago, I was invited to give a talk on lunar and planetary observing at a local astronomy club. I was filling in for the original speaker who had a schedule conflict, and his discussion was to have been solar eclipse expeditions. I had intended to describe useful visual observational programs that an amateur planetary astronomer could successfully undertake with the aim of generating information that could be useful to science.

In anticipation of this meeting, I had spent many hours planning what I would say, hoping that I might encourage a few people to start seriously following the Moon and brighter planets. The night of the meeting, I arrived early to arrange my slides and make final preparations for my program. Before the meeting started, there was the usual mingling with the attendees, which that night numbered forty or so. Outside the auditorium, several individuals were pointing to street lights and complaining about how light pollution was becoming increasingly troublesome at the club's remote observing site. A few people were also lamenting about the distance they always had to drive for observing sessions, let alone the cumbersome equipment that had to be carried and set up.

I quickly discovered that the majority of the members of the club were deep-sky enthusiasts, most of them owning Dobsonian telescopes ranging from 8 to 29 inches in aperture. The President of the organization added that almost all of the members had smaller refractors, but these had long ago been tucked away in the nearest closet when the "light-buckets" became popular. One gentleman related that he had essentially given up regular observing because he had "bagged" all of the Messier objects, had logged most of the more accessible NGC's, and had split all of the double stars within reach of his 16-inch Newtonian. He emphasized what he considered to be the futility of looking at the same old changeless things again and again, and he had all but made a decision to sell his 3-inch Unitron and the 16-inch because his telescopes couldn't now serve any useful purpose. Then there was the elderly lady and her daughter, who said they were afraid to observe away from their home because of the fear of being approached by unwelcome curiosity seekers, or perhaps worse. She said she was overwhelmingly convinced that nothing could be done from her well-lighted backyard. And not surprisingly, I witnessed numerous accounts of economic woes, chiefly centering on not being able to buy that larger instrument to permit detection of still fainter galaxies, nebulae, and star clusters. Finally, the sole individual I encountered who had been pursuing planetary observations insisted that he was unable to come with projects that would be considered worthwhile. The most disturbing thing I kept hearing was that people just weren't having fun anymore!

The flavor of the informal gathering prior to the actual meeting was all too familiar. In recent years, I had spoken before quite a number of similar astronomical societies, the majority of which were made up of deep-sky observers. Without exception, there was the same distress over the lack of dark skies, the growing inconvenience of distant travel, the exhausted observing lists of deep-sky objects, the changelessness of it all, and the persistent lack of fun. Club officers frequently told me about how their memberships were steadily dwindling, and how they were having problems establishing programs that were fun for their members. Some societies I had visited just last year no longer even existed.

When I began speaking about the A.L.P.O. and our various programs, which we all know deal exclusively with observing the Moon, planets, comets, meteors, and the Sun, I suddenly felt confronted with a virtual loss of something pertinent to say. After all, I was addressing an audience that appeared largely convinced that astronomy has become less attractive as a pastime because of the many circumstances cited above. No one seemed to enjoy what they were doing. The organized and well-conceived presentation I'd developed just didn't seem to fit in that night, and I decided to abandon my original, specialized theme to talk about the broader scope of watching the heavens and what astronomy meant to me as a veteran observer. It was abundantly clear that there was a growing crisis of the spirit among these otherwise dedicated enthusiasts. Yet, despite their obvious frustration, I could still sense that there was an underlying desire to continue their astronomical endeavors. Most of them had lost a sense of purpose and direction. I had no way of knowing what impact my words and experiences might have on them, but I felt compelled to give it a try.

At the outset, I reminded the group of those times when I was a youngster without a telescope. I recalled the experiences of pulling out a star map, a flashlight, and a small pair of binoculars, and heading out into the yard to learn the constellations and the brighter stars. Then I recounted the excitement of seeing my first meteor, witnessing a lunar eclipse, watching the motions of the brighter planets, and trying to pick out as many of the Messier objects as I could with my 7 X 50 binoculars. The thrill of discovery, coupled by my insatiable appetite to learn more about what I was seeing, led me to the acquisition of my original telescope. I put that diminutive Unitron 1.6-inch refractor through many paces, looking at everything I'd seen in binoculars over and over again, and then tackling new ventures. Quickly realizing that my little scope revealed almost nothing comparable to what the textbooks depicted so dramatically for galaxies and nebulae, I turned it onto the waxing crescent Moon at 75X. For months, I spent every clear night I could identifying all of the craters, mountain ranges, and other lunar features within reach of the small refractor. I took a lot of kidding at star parties about my tiny Unitron, but I sat in amusement as my fellow observers took a peak and found that they could see almost as much with it as they saw in their larger telescopes. And when the night was over, I was packed up and ready to go, usually helping them dismantle larger instruments that had dewed up much earlier in the night or had been shut down because seeing was uncooperative for those bigger apertures. With the passing of time, I had made many drawings of the Moon, done sketches of Saturn and its Rings, made colorful renditions of Jupiter, and recorded on paper my impressions of the changing phases of Venus and Mercury. And, I was having fun along the way.

One thing I stressed during my presentation was my realization that our solar system is anything but changeless. I told my listeners that, in all my years of observing, not once had I experienced boredom, regardless of whether I was using to my little Unitron or larger instruments I have owned. I explained how I had rapidly exhausted the standard observing lists of deep-sky objects such as galaxies, nebulae, and clusters in my earliest explorations, and I described how my interest in astronomy had evolved through various phases. My interest in planetary astronomy was a natural outcome of my stellar ventures. Because so many of the people attending the meeting had expressed feelings of discontent, I attempted to show them how, without their having to abandon deep-sky observing altogether, they could pursue some refreshing alternatives. I simply asked them to consider for a moment what lunar and planetary observing had to offer in hopes of restoring enthusiasm and pleasure back into their efforts.

I showed the group a series of color slides of Jupiter, all taken by amateur observers, calling attention to how the atmosphere of the planet exhibited metamorphosis with time during a single evening of observation. Next, I threw in examples of how long-term variances in the appearance of the Great Red Spot were coupled with the overall state of the Jovian atmosphere. Excitement grew when I moved to slides depicting the dramatic outburst of the Great White Spot on Saturn two years ago; these slides demonstrated how the feature had suddenly and unexpectedly modified an otherwise quiescent planet. Attention was then directed to the changing phases of Venus, and I explained how the Ashen Light had been periodically seen over the years. Many people were interested in how color filter observations showed curious, elusive markings in the clouds enshrouding the planet. I believe my constituents were beginning to see that amateur planetary observations involved monitoring variable phenomena at the surfaces or in the atmospheres of solar system objects, and sometimes these efforts could bring spectacular rewards. Not many individuals had even remotely considered that the Moon was among those bodies that presented evidence of visible transformation. The awe was apparent when I showed sequential drawings and slides depicting the changing aspect of Alphonsus, Plato, and Aristarchus-Herodotus with varying solar angle. I pointed out that observers throughout the years have seen changes on the Moon that were not always attributable to varying illumination, and I gave a few examples of bona fide Lunar Transient Phenomena (LTP).

By now, I could tell that I had not only captivated the attention of everyone, I had perhaps stirred enough of their interest where some might actually attempt this "new" field of observation! More importantly, I thought I might help rekindle the element of fun in what they were doing. I underscored the fact that lunar and planetary observing did not absolutely require the darkest or clearest skies, and I added that nearly anyone with a fairly unobstructed southern horizon (i.e., good access to the ecliptic) could do this kind of observing from the convenience, comfort, and safety of their home.

Noticing the clock on the wall, I could see that I had already run over my allotted time. I turned to the President to apologize, but he encouraged me to continue, at least if the audience desired for me to do so. The response was unanimous that they wanted me to continue, and I felt it was now pertinent to open the floor for questions. I was immediately inundated with the usual queries about instrumental prerequisites, how observing instructions could be obtained, who collected observations, how one could join the A.L.P.O., and so forth. One man interjected that it looked like planetary observing required a lot of hard work, but he could see how someone, if properly directed, could contribute interesting and useful scientific data. I agreed with him but explained that, while viewing the Moon and planets necessitates careful planning and execution, regular observers are rewarded with phenomena that occur unexpectedly. I welcomed anyone who thought they might like to get involved with lunar and planetary work to speak with me after the meeting.

This thing about having fun still concerned me. Before I closed, I could not help but say something about the philosophy of observing, why we really do what we do, and why pleasure and recreation in using our telescopes should be at the forefront of our undertakings.

Too many people, I explained, have the misconception that astronomy is worthwhile only if useful scientific results are being produced. I encouraged my listeners not to get caught up in believing that enjoying astronomy always requires expensive and imposing equipment, nor does it mean that participating in highly specialized programs is absolutely mandatory. I went back to the examples of my younger years when I had no telescope at all, and I told about finding plenty of fascinating things to do. I suggested that meteor observing, for instance, required only a good pair of eyes, fairly clear and dark skies, and a comfortable lawn chair. And, when it comes to telescope type and size, I said that the important thing is not what kind of instrument one has, but that it is used and enjoyed. I gave a further example of the basic requirements for enjoying astronomy by citing my experience some years ago of hiking the Appalachian Trail from Georgia to Maine (some 2,100 miles) carrying nothing but a backpack. In that adventure, which lasted nearly six months, I was stripped down to the bare essentials I needed for survival, with no telescope, no star maps, no binoculars, and no textbooks. But, that trek through the wilderness changed my life forever, taking me back to the roots of my existence and to the foundations of my interest in astronomy. Sitting alone on isolated mountains, seeing the skies like the ancients did eons ago, watching the Sun rise and set, chasing the waxing and waning Moon, and following the movement of the bright "wanderers" of our solar system reinforced and renewed my fascination with the night sky. Just like when I was a child, lying out on my lawn and looking up into the sky, the spirit of it all was the same. And, upon returning home from my hike, I frequently deviated from the observational routine of following Venus, Saturn, and the Moon, and cast aside my telescope, just sitting and enjoying the night sky. I sometimes get out my old Unitron 1.6-inch and reminisce. But, first and foremost, I keep the fun in what I'm doing.

While my evening audience of largely deep-sky enthusiasts were not all induced to pursue lunar and planetary observations, some told me they had decided to broaden their thinking a little and would explore their options for a continued enjoyment of astronomy. The elderly lady and her daughter, who I mentioned earlier, said they were going to make it a point to dust off their old 2.4-inch refractor, and it would be turned on the Moon the next clear night. And, I overheard the gentleman who was thinking of selling his smaller instrument tell a friend that he was going to give it a try on some of the planets that coming weekend. Several people said they were going to get rid of the encumbrances and start having fun observing again. I left the meeting feeling optimistic, certainly better than I did when I arrived.

I'm glad I abandoned my original theme that night, because it gave me an opportunity to share with others some of the things that I am convinced helps keeps me going in my astronomical pursuits. It is true that most of us in the A.L.P.O. enjoy our specialized pastimes, and as Section Recorders, the majority of us gain enrichment from helping others come aboard, participate in our programs, and contribute to our knowledge about the solar system. But, too many of us are guilty of getting so immersed in our work that we seldom stop to experience, and convey to others, the simple pleasures that launched us into this thing we call observing. For me, it was, and still is, preserving the essential element of fun in what I'm doing.

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JUPITER'S 1993 SEB DISTURBANCE

By: Phillip W. Budine, A.L.P.O. Jupiter Recorder

ABSTRACT

A synopsis of the history, qualitative observations, and rotation periods of Jupiter's 20th SEB Disturbance based upon observations by observers of the A.L.P.O. Jupiter Section. Comparison is made with previous SEB Disturbances. Changes in the SEB (South Equatorial Belt) and affects on the Great Red Spot are noted. Emphasis is on the drift rates and rotation periods for the SEB Disturbance phenomena.

What is an SEB Disturbance on Jupiter? It is more than just the appearance of any prominent marking in the SEB (South Equatorial Belt); such a disturbance is a sequence of characteristic events and activity that has been repeated in an amazingly similar manner in each of the twenty episodes so far.

Before an outbreak of a major disturbance, the interior of the South Equatorial Belt (or SEBZ) is clear and bright. The SEBn and SEBs are usually quite faint and featureless. The first sign of the eruption is a small dark spot or bright spot somewhere in between the two components of the SEB. Since this initial spot always appears suddenly and in nearly the same latitude, we might assume that it represents material that has risen to the visible surface, it begins to diffuse and is carried away by prevailing winds.

If the initial eruption were all that there was to a disturbance, then this dark matter would soon be carried away and diffused about the SEBZ until it was invisible. However, this is not the case. Spots continue to form near the longitude (II) of the initial eruption, and each in turn is diffused and torn apart by the different atmospheric currents. As a result, there is the SEBn Branch, advancing rapidly in a direction of decreasing longitude; the SEBZ Branch with dark patches and bright ovals advancing slowly in the direction of decreasing longitude; and the SEBs Branch of small dark spots moving rapidly in a retrograde direction with increasing longitude. The source and the following dark material in the zone remain stationary in System II. At the longitude of the initial outbreak new spots continue to appear.

In late 1992 and early 1993 the SEB was quite faint; the SEBs being almost inivisible and the SEBn faint and dusky. The SEBZ was quite featureless and light. The Red Spot was quite dark and a prominent orange color. All indications were that a SEB Disturbance would be forth-coming. As a matter of fact - your Recorder predicted an event would happen in the first few months of 1993 - I predicted this in mid-1992 using the three year cycle and Source Graph. By March, 1993 the SEB was faint with a bright interior zone and the RS was darkest it had been in years with a strong orange-pink color!

The first sign of any disturbance event was the observation of a dark spot on the south edge of the SEB near 17°(II) by Gomez of Spain on 1993 April 6; and by Richard Schmude, Jr. with a 14-in. reflector at Texas A & M University. On the following day (1993 April 7) David Fernandez of Spain recorded the dark spot connected to a EZ festoon and a small bright spot following the dark spot on the south edge of the SEBn. It should be noted that a dark projection had been seen near this longitude since last apparition. The features seen by Fernandez were seen near 17°(II) preceding the Red Spot. Fernandez was employing a 158mm refractor.

On 1993 April 9 the SEB eruption was underway! The eruption was first recorded and reported by Jose' Olivarez of the U.S.A. at 17°(II) with his new D & G F/12 8-inch refractor. A dark festoon was observed connecting the two components of the SEB. It was confirmed on the same date by James Tommey II with a 8-inch reflector and by New Mexico State University Observatory who recorded the event with a 889 nm filter - observation reported by Dr. Reta Beebe. Jose' called me and reported the event on the evening of April 9th.

The following day; 1993 April 10 the eruption was confirmed by Claus Benninghoven of Burlington, Iowa employing the 12-inch Alvan Clark Refractor of the John H. Witte, Jr. Observatory. Claus called me and your Recorder immediately sent a telegram to Cambridge of the event and confirmation! Claus's observation was also confirmed by Richard Schmude, Jr. During the next few days your Recorder was phoning active Jupiter observers around the country, mailing Bulletins on the event, and flashing the news on the Computer Networks.

Early observations indicated the SEB Disturbance was similar in it's early stages- in appearance- to the 1958 Event.

The 1993 Event started fortunately when Jupiter was well placed in the evening sky! This was not the case in 1990; when the eruption took place when Jupiter was in conjunction with the Sun. The 1993 event took place when Jupiter was less than a month past opposition (1993 March 30).

Early observations of the disturbance were received for the period: 1993 April 10- 1993 April 24 from the following A.L.P.O. observers: Olivarez, Benninghoven, Schmude, Mac Dougal, Haas, Parker, Carlino, Fernandez, Troiani, Aerts, Tommey, and Budine.

The developement of the disturbance was patterned much like the 1958 Classical Event. Bright spots and dark spots were observed moving along the SEBZ and S-SEBn in a direction of decreasing longitude. The source longitude remained fairly stationary in System II; usually between 15°- 21°(II). The source area continued to vent spot for the period: April 10 - May 24,1993.

Dark retrograding spots were observed moving along the SEBs from the source and under the Red Spot in a (+) increasing longitude direction. Intially, spots were seen between April 11 and May 8, 1993. These were mostly observed by Fernandez, Budine, and Miyazaki. Starting May 10 SEBs spots were observed by other observers including: Claus Benninghoven, Dan Troiani, Sam Whitby, and Don Parker.

The Great Red Spot which had been very Dark prior to the eruption and of a strong red-orange color was still prominent through the period: April 10-May 10, 1993. Budine observed the SEBs spots passing the RS on 1993 May 8. By 1993 May 17 the Red Spot had faded considerably - it's northern half was very faint!

Also, by this date a very bright oval had developed with a "concave" festoon running from the south edge of the SEBs to the north edge of the STB. This feature had the appearance similar to the preceding-end of a STrZ Disturbance. Claus Benninghoven and Isao Miyazaki had good observations of the marking from May 17 - June 15, 1993. The SEBs dark retrograding spots never got past the feature from May 19 - June 10th. Instead they moved in a deflected southerly direction in latitude to the STBn. A strip sketch by Benninghoven shows a possible deflected SEBs on the STBn near 43°(II) on 1993 May 17. A photo by Miyazaki on 1993 May 20 shows two SEBs dark spots in the STrZ festoon. Parker's excellent CCD images of 1993 June 3 shows a string of them ! Apparantly, the RS cyclonic vortex motion "caught" these dark SEBs spots!

Whitby had a good observation of the STrZ feature on 1993 June 23. By 1993 June 28 the feature was gone!

Adequate transits, photos, and CCD images were submitted by A.L.P.O. observers to obtain rotation periods of the important features in System II.

It should be noted that the 1993 SEB Disturbance was a "classical type". The Bright Streak SEB Disturbances of 1985 and 1986 are intermediate types and lack the dark SEBZ spots and dark SEBs retrograding spots!

The Red Spot was affected by the SEB Disturbance. It not only faded but it was also accelerated in a (+) increasing longitude direction. It started fading in mid-May. The Red Spot had moved in a increasing (+) longitude direction from 1992 Oct. 31 - 1993 July 07 from 037°- 046° (II) or (+1°.084 in 30 days) for a period of 9:55:42.

The SEB Disturbance - preceding branch had appearance and venting similar to the 1958 and 1964 events. The dark spots and bright spots were advancing along the SEBZ and S-SEBn. The rotation periods of these spots were as follows (also, see SEB Disturbance Table): The preceding branch Spots No. 1 and main branch No. 2 were moving at -51°.4 and -95°.5 for periods of: 9:54:30 and 9:53:30 respectively. Nine other spots are listed in the table. The SEBs spots had drifts and periods of: +70°.0 and +85°.0 for 9:57:17 and 9:57:37.

In comparison the 1958 Event had a period of 9:54:02 for the preceding branch and 9:57:53 for the SEBs. The 1964 Event had a period of 9:54:34 for the preceding branch and 9:58:02 for the SEBs spots. The 1993 Event was moving at 9:51:47 in System I for the preceding branch.

The STr Event which was first seen by Miyazaki and Benninghoven on 1993 May 17 had a drift of -11°.7 with a rotation period of 9:55:25. It was first seen by Claus at 069°(II).

<u>Late - Breaking SEB Disturbance Summary</u>: By late in the apparition the main preceding branch had advanced to a longitude of 152°(II) with a drift of -94°.6 and a period: 9:53:32. One SEBZ feature No. 9 was at 123°(II) by 1993 July 12. With a drift -97°.4 and period: 9:53:28.

The first two SEBs spots were moving at +67°.3 and +71°.3 with periods of 9:57:13 and 9:57:19 respectively. Other SEBs spots were observed late in the apparition. The Red Spot was at 47°(II) and long-enduring STB oval FA was nearing conjunction with the RS as of 1993 July 24.

The SEB was prominent, wide, and dark in most longitudes.

The System III rotation period for the radio emissions from Jupiter indicate a period of 9:55:29.711. Using this period for the source the projected longitude for the System II eruption was 14°(II). The SEB Disturbance began at a longitude of 17°(II)!

Jupiter observers should be alert for the following phenomena or events as Jupiter nears conjunction with the Sun. Also, the planet should be observed in the morning sky -as soon as possible- after conjunction.

* Changes in the RS appearance and rotation period.

* The STrZ should be monitored for any STrZ Disturbances.

*The coming conjunction of FA and the RS should be observed.

*The SEB should be monitored for any secondary outbreaks.

Your Recorder would like to thank all A.L.P.O. observers who contributed valuable observations making this report on the 1993 SEB Disturbance possible. The events in this paper give another example of how the Giant Planet is always full of surprises for the active amateur!

July, 1993, Synopsis of Drift and Rotation Periods

(Prepared July 15, 1993, by Phillip W. Budine)

Feature and Long. Sys.	Time Span (1992-1993)	Long. Range	Drift Rate	Rot. Period
STB (II):				
Oval BC	Nov.29-Jun.22	037° - 323°	-10°.9	9:55:26
Oval DE	Nov.29-Jun.22	057 - 340	-11.3	9:55:25
Oval FA	Dec.16-Jun.23	151 - 070	-12.9	9:55:23
Dp No. 1	Jan.17-Apr.10	231 - 186	-16.1	9:55:19
Dc No. 2	Jan.17-Feb.05	243 - 236	-11.7	9:55:25
Df No. 3	Jan.17-Jun.02	254 - 235	- 4.2	9:55:35
Dc No. 4	Jan.28-Mar.28	144 - 116	-14.0	9:55:21
Df No. 5	Feb.02-Mar.28	147 - 123	-13.3	9:55:22
Df No. 7	Feb.28-Mar.30	081 - 071	-10.0	9:55:27
Dc No. 8	May 10-Jun.15	019 - 007	-10.0	9:55:27
STrZ (II):				
RSp	Nov.29-Jun.15	027° - 036°	+ 1°.364	9:55:42
RSc	Oct.31-Jul.07	037 - 046	+ 1.084	9:55:42
RSf	Nov.29-Jun.15	050 - 056	+ 0.909	9:55:42
Dc No. 1 (Little RS)	Apr.06-Jun.22	329 - 336	+ 2.7	9:55:37
Dc No. 2	May 18-Jun.23	069 - 055	-11.7	9:55:25
SEBs (II):				
Dc No. 1	May 27-Jun.22	027 - 000	-30.0	9:55:00
Dc No. 2	Jan.17-Feb.04	300 - 342	+70.0	9:57:17

SEB Disturbance (1993), (SEBZ, S-SEBn), (II):

Feature and Long. Sys.	Time Span (1992-1993)	Long. Range	Drift Rate	Rot. Period
Dp No. 1	Apr.09-Apr.21	017°- 341°	-51°.4	9:54:30
Dp No. 2	Apr.16-Jun.16	019 - 188	-95.5	9:53:30
Wc No. 3	Apr.23-Jun.24	017 - 241	-64.8	9:54:12
Wc No. 4	Apr.28-Jun.17	021 - 285	-56.5	9:54:23
Wc No. 5	May 08-May 15	021 - 009	-60.0	9:54:19
Dc No. 6	May 07-May 17	337 - 310	-90.0	9:53:38
Dc No. 7	Apr.24-May 29	019 - 315	-53.3	9:54:28
Dc No. 8	May 08-Jul.01	344 - 199	-80.6	9:53:51
Dc No. 9	May 14-Jun.07	308 - 234	-92.5	9:53:34
Dc No. 10	May 24-Jun.17	336 - 292	-55.0	9:54:25
Wc No. 11	May 17-May 27	021 - 008	-46.7	9:54:37

SEBs (Dist.), (II):

Dc No. 1	Apr.11-Apr.24	023°- 051°	+70°.0	9:57:17
Dc No. 2	Apr.19-Apr.24	029 - 046	+85.0	9:57:37

Feature and Leng. Sys.	Time Span (1992-1993)	Leng. Range	Drift Rate	Rot. Period
NEBs-EZn (I): (Note: OL - features are all De's):				
OL-1(83)	Oct.28-Jun.28	046°- 055°	+1°.1	9:50:31
OL-1(91)	Nov.29-Jun.28	152 - 143	-1.3	9:50:28
OL-6(91)	Dec.20-Jul.06	210 - 200	-1.5	9:50:28
OL-4(86)	Dec.20-Jun.27	235 - 235	0.0	9:50:30
OL-8(91)	Dec.20-Jun.27	271 - 267	-0.6	9:50:29
OL-5(88)	Dec.20-Jun.02	294 - 306	+2.2	9:50:33
De No. 5	Jan.06-Jun.03	082 - 081	-0.2	9:50:30
We No. 6	Jan.25-Jun.28	069 - 070	+0.2	9:50:30
We No. 7	Feb.04-May 10	230 - 231	+0.3	9:50:30
De No. 8	Nov.28-Jun.16	330 - 331	+0.2	9:50:30
De No. 9	Feb.04-Jun.06	220 - 221	+0.2	9:50:30
NEBn-NTrZ (II):				
We No. 4	Dec.16-Jun.12	276°- 244°	-5°.4	9:55:33
We No. 6	Jan.17-May 14	259 - 229	-7.7	9:55:30
We No. 8	Dec.20-Feb.28	020 - 016	-1.7	9:55:38
De No. 9	Dec.20-May 27	027 - 023	-0.8	9:55:40
De No. 10	Feb.09-Jun.08	072 - 077	+1.3	9:55:42
De No. 17	Mar.06-Jun.11	085 - 086	+0.3	9:55:41
De No. 18	Oct.25-Jun.15	278 - 235	-5.5	9:55:33
NTBs (I):				
De RMS No. 1	Jan.19-Feb.04	303°- 277°	-52°.0	9:49:20
De RMS No. 2	May 14-Jun.15	200 - 138	-56.4	9:49:14

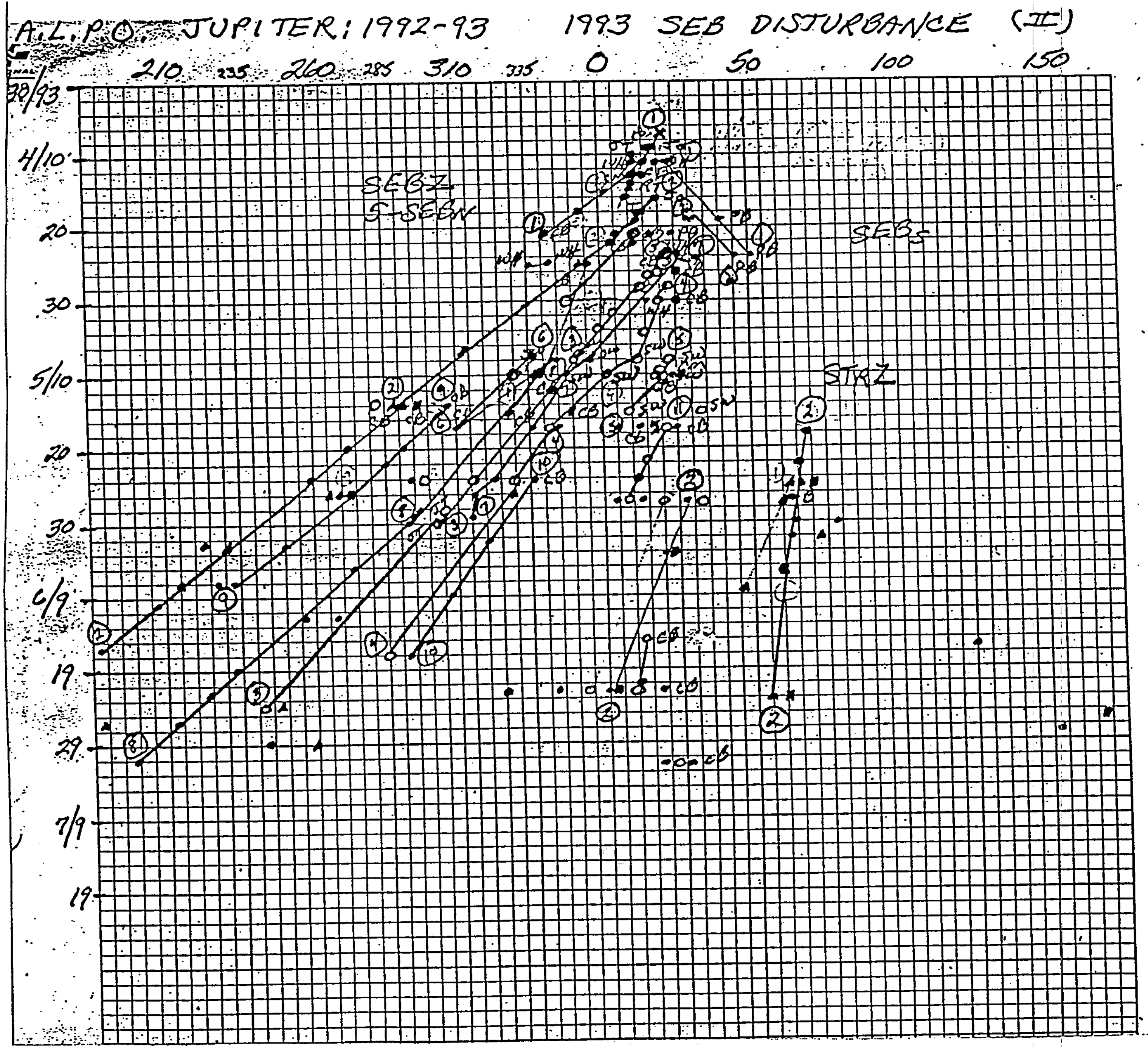
Notes:

BC was in conjunction with the RS on 1992 Nov. 29 at 037°(II).

DE was in conjunction with the RS on 1993 Jan.10 at 038°(II).

FA was nearing conjunction with the RS as of 1993 Jul. 15.

The report above on Rotation Periods is based on observations received by 1993 Jul. 15. The following observers contributed observations (transit timings, photos, CCD images, slides, disc drawings, strip sketches, and notes): Claus Benninghoven, Jose' Olivarez, Phillip Budine, Craig MacDougal, Isao Miyazaki, Daniel Troiani, Samuel Whitby, James Tommey II, Detlev Niechoy, Richard Schmude, Mark Bosselaers, Gross Horst, Wim Cuppens, Erwin Verwichte, Aerts Leo, Gus Johnson, Walter Haas, Don Parker, Mike Morrow, Robert Hays, Jr., Randy Tatum, Daniel Joyce, Mike Mattei, David Fernandez, Reta Beebe, Dan Boyar, Lawrence Carlino, and Jan Vantomme.


A.L.P.O. JUPITER: 1992-93 1993 SEB DISTURBANCE (II)

SEB Disturbance (1993), (SEBZ, S-SEBn), (II):

Feature and Long. Sys.	Time Span (1992-1993)	Long. Range	Drift Rate	Rot. Period
Dp No. 1	Apr.09–Apr.21	017°– 341°	–51°.4	9:54:30
Dp No. 2	Apr.16–Jun.16	019 – 188	–95.5	9:53:30
Wc No. 3	Apr.23–Jun.24	017 – 241	–64.8	9:54:12
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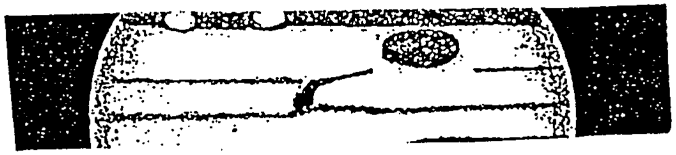
Wc No. 5	May 08–May 15	021 – 009	–60.0	9:54:19
Dc No. 6	May 07–May 17	337 – 310	–90.0	9:53:38
Dc No. 7	Apr.24–May 29	019 – 315	–53.3	9:54:28
Dc No. 8	May 08–Jul.01	344 – 199	–80.6	9:53:51
Dc No. 9	May 14–Jun.07	308 – 234	–92.5	9:53:34
Dc No. 10	May 24–Jun.17	336 – 292	–55.0	9:54:25
Wc No. 11	May 17–May 27	021 – 008	–46.7	9:54:37

SEBs (Dist.), (II):

Dc No. 1	Apr.11–Apr.24	023°– 051°	+70°.0	9:57:17
Dc No. 2	Apr.19–Apr.24	029 – 046	+85.0	9:57:37

APR 7



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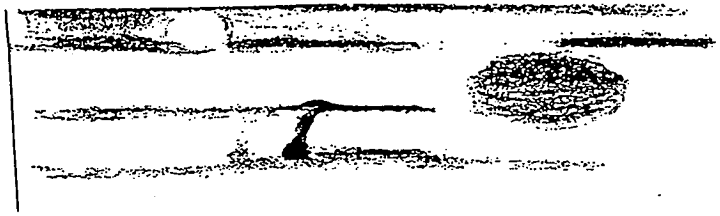

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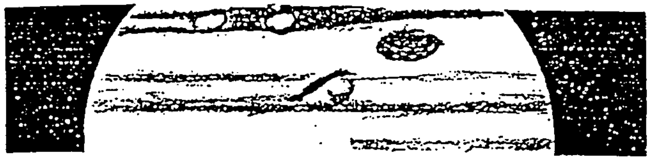

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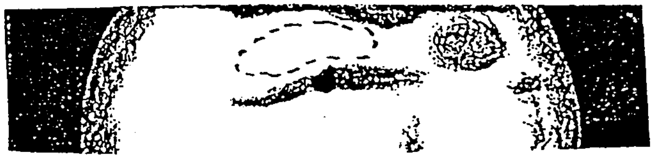

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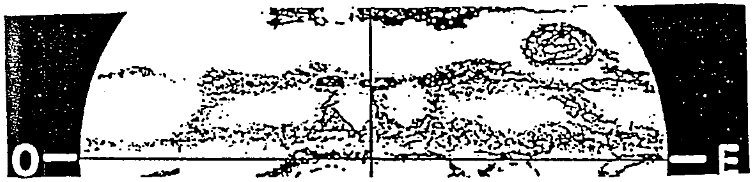

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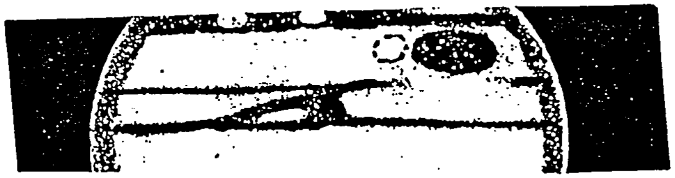

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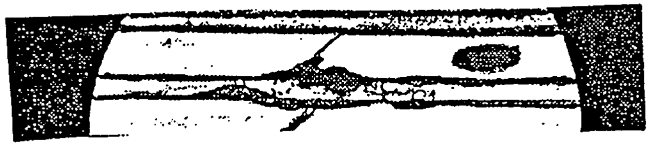

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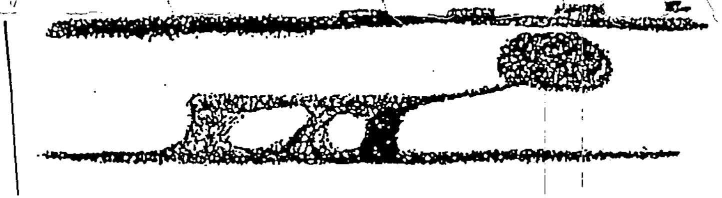

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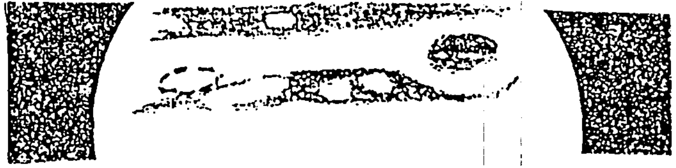

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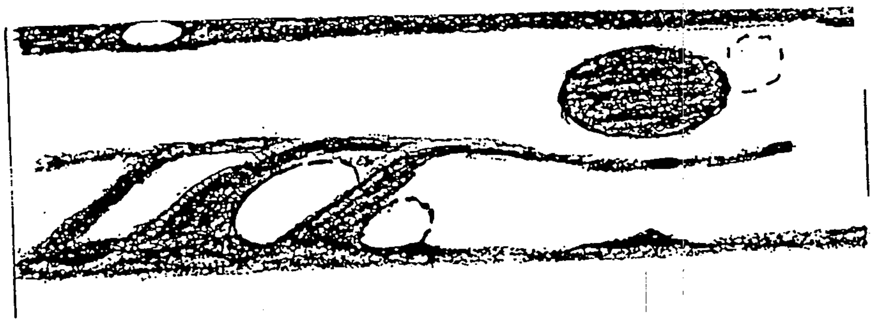

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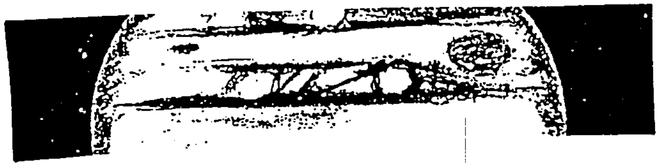

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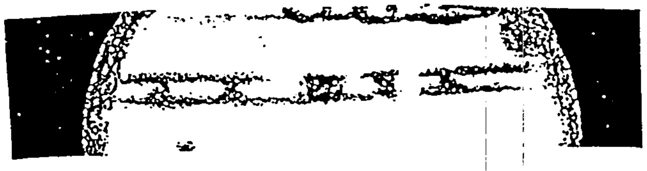
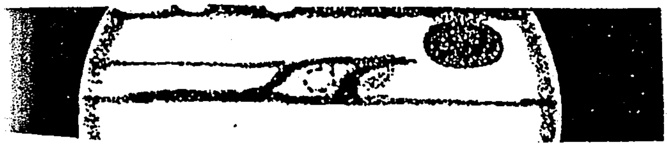


MAY 8

ASSOCIATION OF LUNAR AND PLANETARY OBSERVERS
ALPO
Founded In 1947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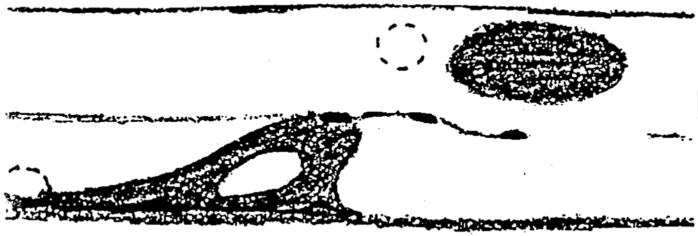
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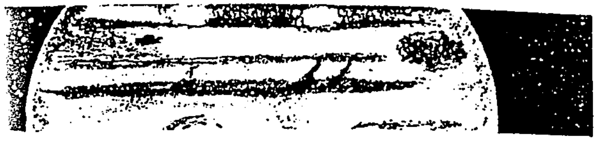
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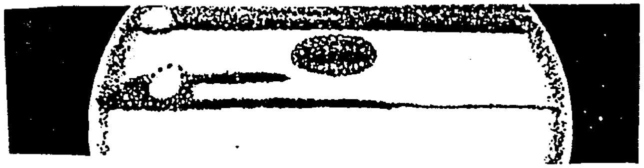
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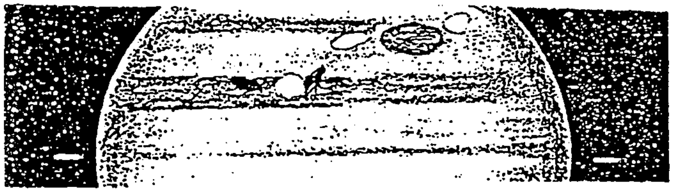
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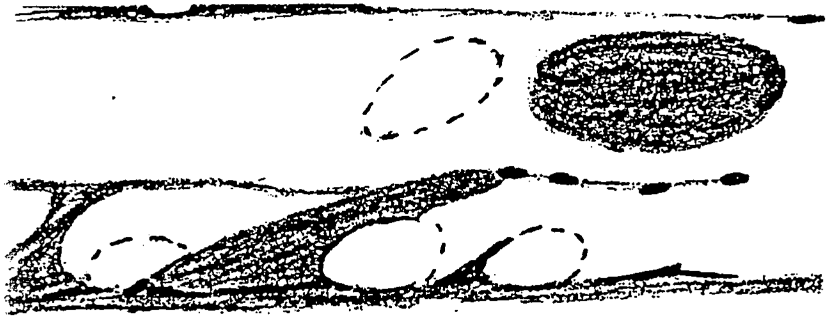
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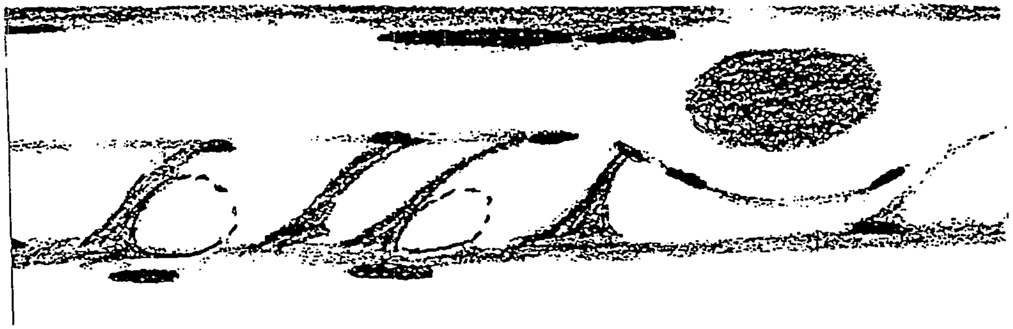
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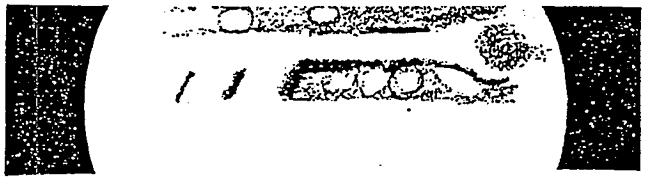
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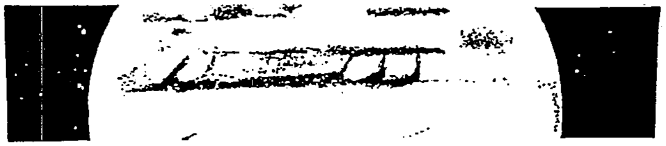
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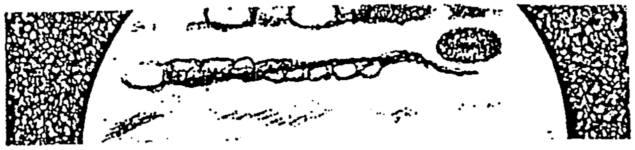
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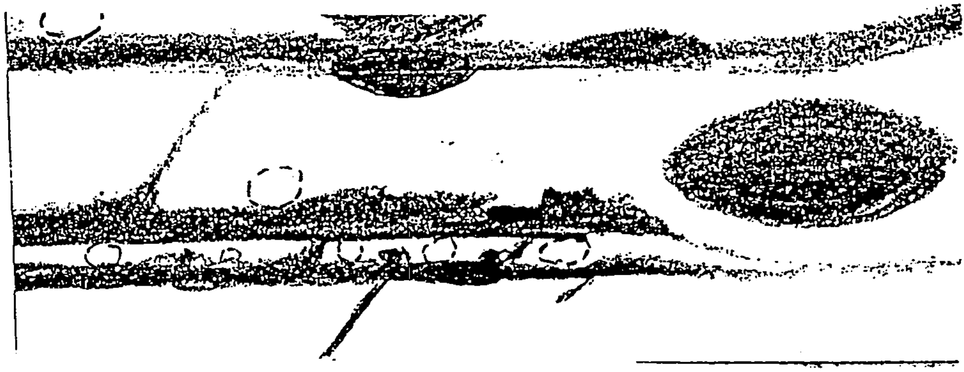
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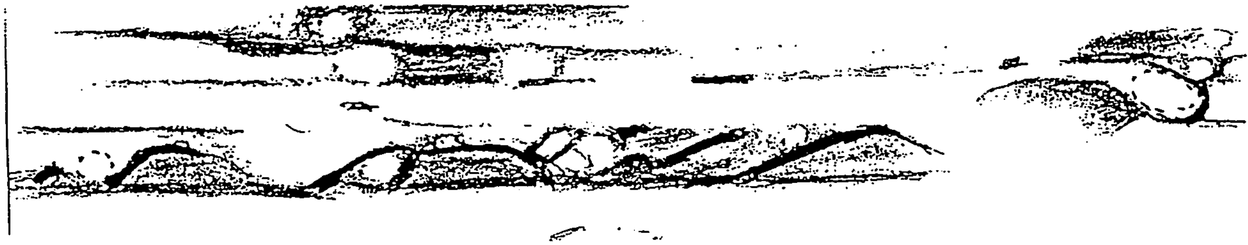

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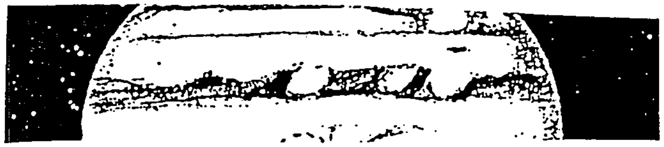

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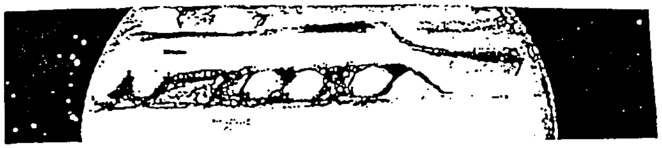

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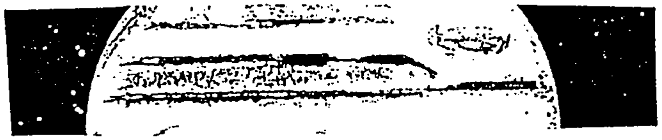

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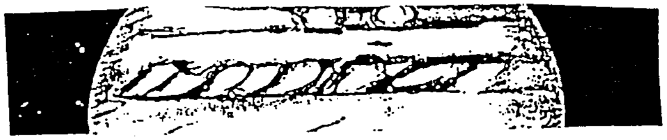

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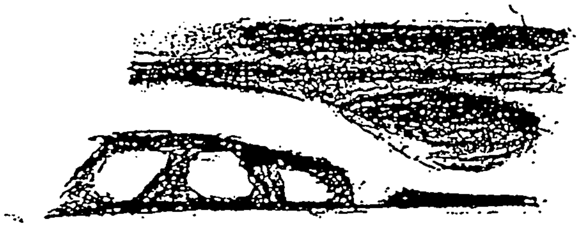

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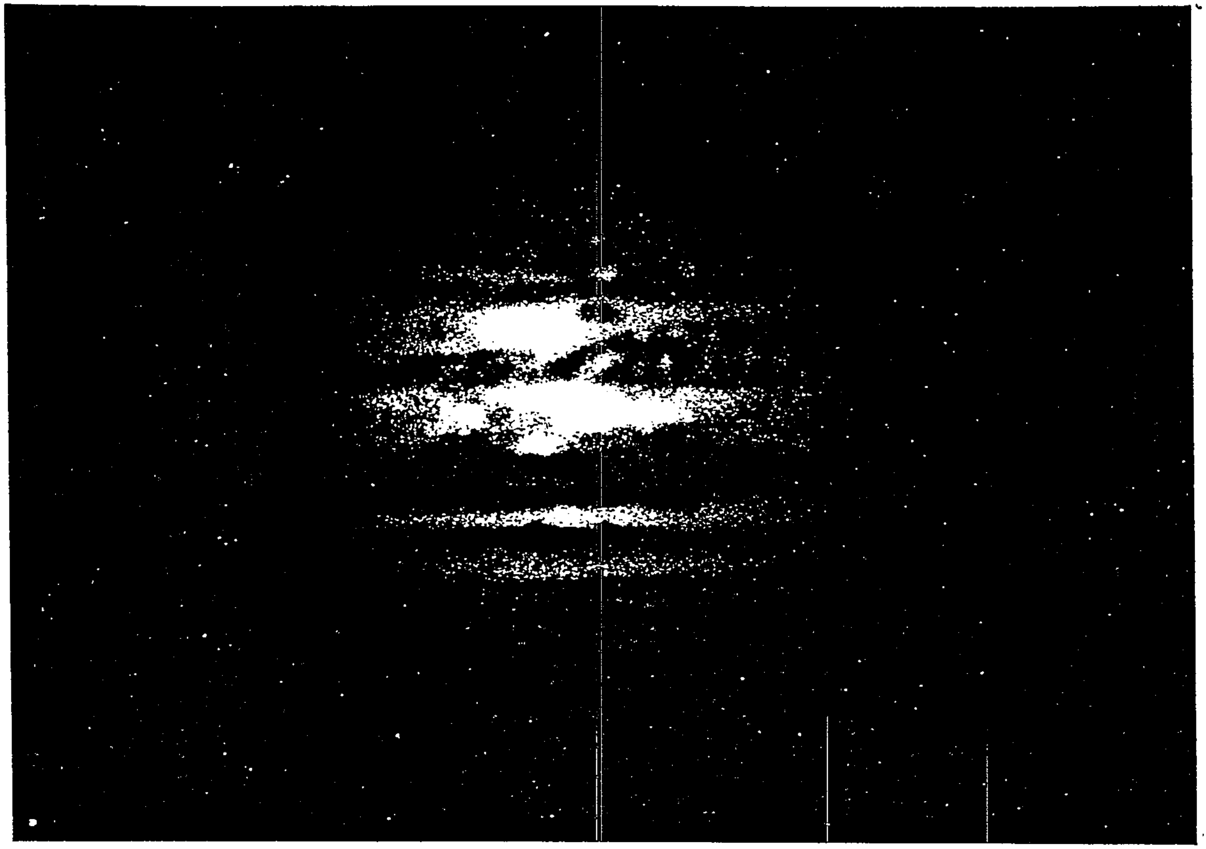


Photo of Jupiter and the 1993 SEB Disturbance by Isao Miyazaki on 1993 May 12 at 13:18 U.T. with a 40-cm Refl. CM1 - 216°.5 and CM2 - 335°.2.

AN OUTLINE OF THE HISTORY OF THE A.L.P.O.: 1947-1993.

Walter H. Haas, Founder, A.L.P.O.

(Abstract; full paper appeared in J.A.L.P.O., Vol. 37, No. 2 [Oct., 1993], pp. 49-53.)

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

DON'T MISS A NEAR MISS!

Richard E. Hill

(Abstract)

A description of methods used to measure the appulses of asteroids to bright stars, the reduction of the data, and significance to astrometry.

USING THE CCD FOR PLANETARY ASTRONOMY

Richard E. Hill

(Abstract)

Discussion of the minimal calibrations, both in observation and reduction, necessary for proper CCD observing so that images can be used photometrically and in multi-color work.

ASTRO-VIDEO WORKSHOP

Daniel P. Joyce, Daniel M. Troiani

(Abstract)

The advent of CCD equipment has augmented Solar-System imagery technique to unprecedented levels. Detail of hitherto unheard-of refinement is not only attainable, it is verifiable. Often, video systems can penetrate otherwise untenable seeing conditions. Although the best cameras are high-sensitivity black-and-white models, some off-the-shelf color camcorders can provide surprising results. Images can also be used in conjunction with conventional sketches. Computer-mounted frame-grabbers can translate video into the computer for processing. Converting computer imagery back to video, whether the image originated in video or the alternative CCD method, is also feasible. Even conventional photographs can be faithfully translated to computer format via the video CCD camera.

Craig MacDougal

AN OVERVIEW OF RECENT STUDIES IN VISUAL PERCEPTION FROM A PLANETARY ASTRONOMER'S VIEWPOINT

For years visual astronomers have been honing their skills and (mostly) passing on their knowledge to the next generation of astronomers. This started in the days of Galileo, and continued unabated until the development and widespread use of the photograph as a replacement for the eye. In planetary astronomy however, the eye still had a considerable advantage to the photograph. The length of exposure times allowed fine details to be blurred by the atmospheric seeing. Plus, the astute observer could stay at the eyepiece and wait for that moment of "good air" and transfer to paper what he/she saw in that fleeting moment. Now with the advent of the CDD, the may no longer have the advantage. However, this new piece of technology will not stop many of us from sitting at the telescope with a sketchbook at hand. After all for most of us, it's FUN.

Even if the days of sketching for scientific studies are numbered, it is still important to understand the process of *perception* that goes into the making of a sketch. This knowledge not only helps us to make better sketches, but it can be applied to the interpretation of past sketches. In the astronomical community, most of this knowledge has been gained by strictly empirical means. Meanwhile, the medical profession has been doing studies on visual perception but, of course, without an emphasis on what happens while gazing at Jupiter at 200X. I have done a brief scan of some recent findings, looking for results that would be of interest to planetary observers.

At the back of the eye is the retina, which contains two types of receptors: rods and cones. Cones are the high resolution receptors and also detect colors. They are found on all of the retina but especially the center of the retina, which is called the fovea. The fovea is made up of cones exclusively. The cones work best with a good bit of light, and are not very useful in dim light. The rest of the retina is dominated by rods which work with quite a bit less light, but cannot register color. The rods are the low resolution receptors, plus their actually density falls off dramatically from the center. Thus, one would rightly expect our resolution to drop off as we get more into our peripheral vision. However many studies, using differing methods, show that our perceived resolution drops off even FASTER than the physical density of rods. This is apparently an effect of how the visual system processes the images coming from the eye. It would seem that even though averted vision (ie: looking off to one side a bit to make use of the low-light sensitive rods) is quite useful to the astronomer, significant resolution will be lost if one looks off to the side more than just enough to get the image away from the fovea.

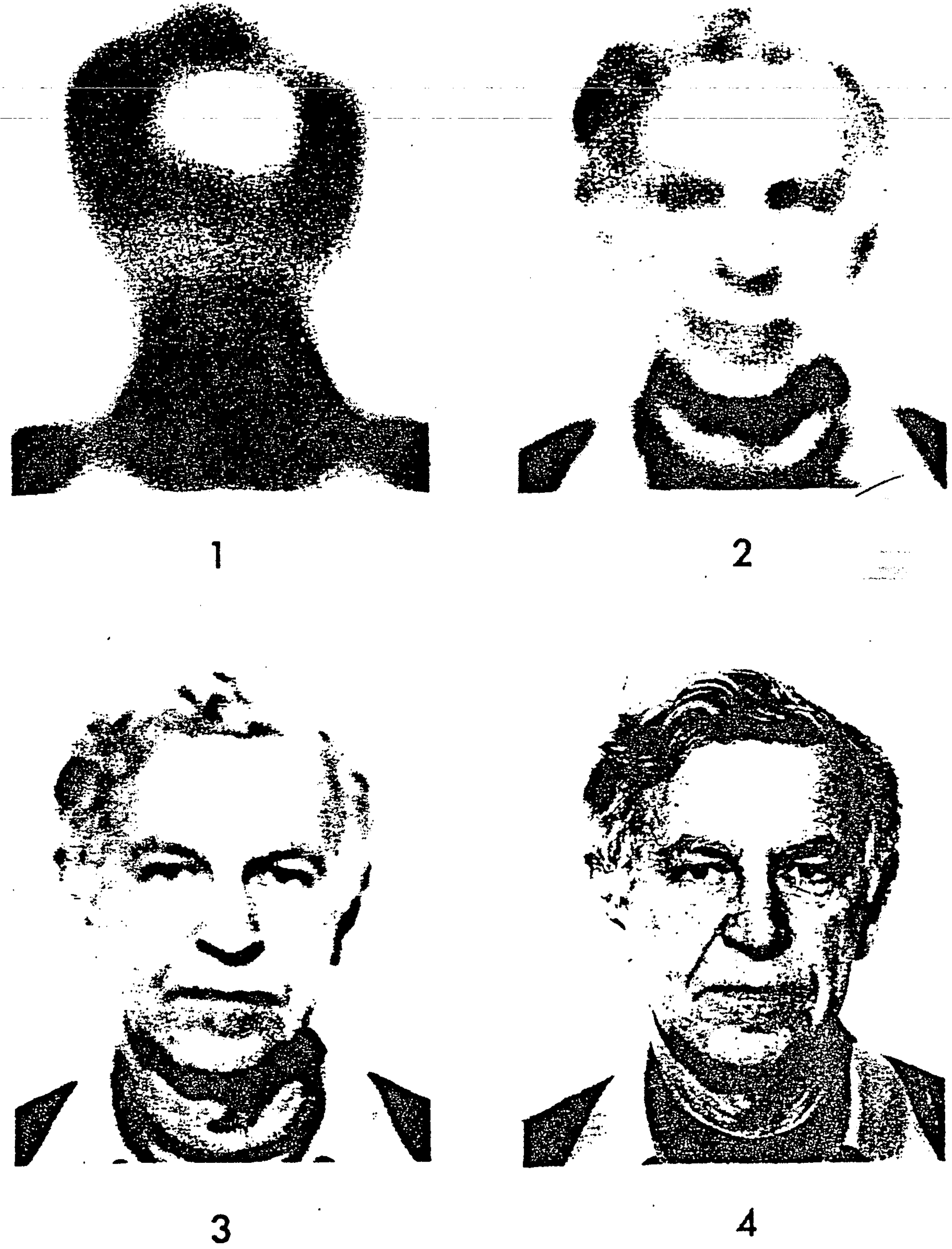
So now we see that the eye has physically defined low, and high resolution areas. However, it has also been found that the brain processes the high and low resolution aspects of an image differently. In right-handed people, the right hemisphere of the brain deals more with the low resolution information, while the left hemisphere works with the high resolution information. This dichotomy was determined by two basic types of studies. One type worked with people who had some kind of damage to their visual centers on one side or the other. The other type of study used "regular" people, and presented images to one side, or the other of their field of vision. (In each eye, the left side of the field of vision is sent to the right hemisphere of the brain, and visa versa.) It has also been noted that the right hemisphere does not need as strong a signal (ie: dimmer image) and reacts faster to the signal than the left hemisphere. Thus, the rough outlines of things on Mars are spotted almost immediately, while the finer details require a bit more of a look. This could help explain why bad seeing of the "fast" kind can obliterate fine details, while details can sometimes be wrenched from a night of bad seeing of the "slow" variety. This also helps to explain why, in even good seeing, it takes a few moments of study before the finer details become apparent.

Extensive studies are being done in the area of object and face recognition. Face recognition studies seem to be a perfect analog for the planetary astronomer since, like a planet, an individual face contains more and more detail as it is seen with better and better resolution. Figure 1 gives an example of the kinds of face representations used in these studies. It is the same face at low through high resolutions. If the subject had already been shown photographs at number 4 resolution and then had to pick out that face from a set of low resolution photographs, resolution number 2 was usually sufficient to make that judgment. However, when the subject was shown a face at number 2 resolution, and then later had to pick out that face from a set of faces at number 2 resolution, the success rate was very low. In astronomy the experienced Mars observer, for example, may be able to pick out Solus Lacus under adverse conditions because he/she has seen it in greater detail before. The less experienced observer might miss it alltogether. Some knowledge of what the object is *supposed* to look like helps in identification of low resolution views. However, herein lies a pitfall for the experienced observer. If the observer remembers what a feature looked like under better conditions, he/she may place details on a sketch that are not really visible, merely remembered. Having said that, it should be noted that these face studies indicate that the high resolution details of a face are not remembered particularly well. When shown faces that look very similar at resolution 4, and asked to identify them later, performance dropped off dramatically after just a short amount of time. However, when shown faces that look similar at a lower resolution, the success rate was not nearly as dependent on the amount of time that had lapsed. Thus it seems that high resolution information is not remembered very well at all. For a planetary observer, it would thus seem VERY important to finish one's sketch at the eyepiece, and resist any temptation to make any adjustments in the morning, no matter how well one thinks they remember what the planet looked like the night before.

Before we leave these "face" studies there are two other findings that will probably come as no surprise to experienced observers. The first is that if the lighting angle on the face was changed, recognition and matching was impaired dramatically at all resolutions. Lunar observers have known for a long time how drastically different the same area can look under different solar altitudes. It would seem that the ongoing study of Transient Lunar Phenomenon should strive to closely match the sun angle in "before" and "after" observations when identifying an event. The second concerns a particular class of subject who has suffered damage to the right hemisphere, and has lost the ability to identify the faces of persons that he/she knows. If the subject had also, before the damage, been very familiar with a class of objects (furniture, birds, firearms) through their job or as a hobby, they could not identify these objects any better than they could familiar faces. It seems that the process for discriminating very similar objects is set apart from the ability to say "That's a chair. That's a bird. That's a gun." When you tell others that seeing Jupiter is like seeing the face of an old friend, you now have scientific backing.

Finally, there are some studies in what's called OBJECT CONSTANCY that may be of interest here. We all know what a tennis shoe looks like. But think of the actual image that forms at our retina when we look at a shoe. It could be very different depending on whether we are looking at it head on, or from above, or maybe the shoe is upside down on the floor. How do we always *know* that it's a shoe. That's what the study of Object Constancy is about. Current theory holds that we somehow store a 3 dimensional representation of objects after just a few looks that allow us to identify these objects from ANY angle. Of interest to visual astronomers is the idea that we automatically assign an up-down left-right framework to any scene that is ambiguous. When looking at your dining room, up and down is pretty obvious, especially when something rolls off of the table. When looking through the eyepiece, up is not so clear cut, but according to this, our mind *arbitrarily* picks which way is up. Using equilateral triangles, the researchers asked subjects to, quickly as possible, say whether a triangle was "pointing" up, down, left or right. Look at figure 2a. Almost all would agree that those 3 triangles are pointing left. Now look at the triangles of 2b. Are they pointing to the upper left, or to the right? Because one side of each triangle could be extended to form one straight line connecting all three, that can form an impression of a common "base" and thus, DOWN. Figure 2c, and 2d show a similar effect using circles (which have no principle axis) to help define "up". When sketching the deserts of Mars, or the cloud belts of Jupiter, our minds are apparently making these kinds of judgments all the time, and with little conscious control. This "up-down" bias for individual features can creep in while we are trying to commit what we see onto paper. Thus distortions can happen because we may be unconsciously trying to make all of the features have a common "down". This effect can hopefully be minimized by making the mental effort to relate each feature to a *global* framework. For example, decide how far it is from the apparent center of the disk to the limb, and at what position angle. For larger features, make that determination for each "corner" or "side" or whatever. Two other observing hints come to mind in light of these findings. First, one should try to always orient sketch to the same way it appears in the eyepiece. If south appears to be at the upper left in the eyepiece, then tilt the paper if you want south to appear at the top in the sketch. Secondly, don't change the orientation in the eyepiece while in the middle of a sketch. If using a star diagonal in a refractor, don't rotate it until you're done. With a scope in a German equatorial mount, the same field rotation happens when you rotate the tube in its cradle. Of course, a BIG change in orientation can happen when you make the shift from the west side of the pier to the east side as the planet in question passes the local meridian.

These are just a couple of findings from an admittedly quick search of the current literature. As time permits, I hope to delve into the research a further to see if there are other discoveries that are germane to visual astronomers. I may even find the answer for one my favorite "paradoxes": Why can I see Cassini's division so easily in my 15cm Newtonian? With the rings open at a wide angle the past few years, it certainly has been the best time to see it, HOWEVER at its best, the division is only .6 arcseconds wide. Remember that Dawes' limit for a 15cm scope is .7 arcseconds. Why can I still see it in even awful seeing? When I find out, I'll be sure to tell you.


1
2
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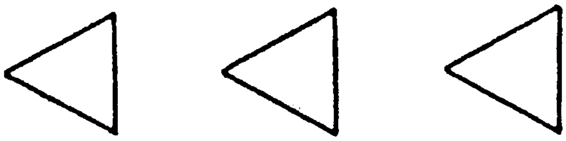
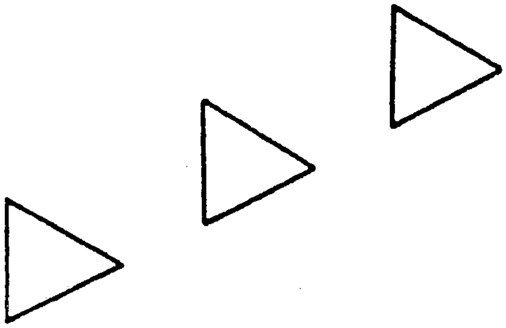
4

Fig. 1

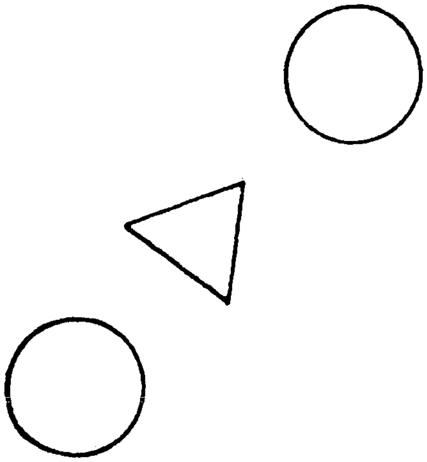
6



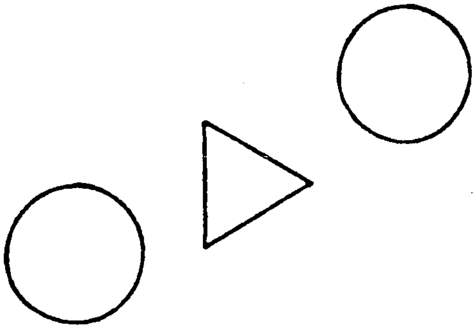
A. Axis-aligned triangles



B. Base-aligned triangles



C. Axis-aligned configuration



D. Base-aligned configuration

Fig. 2

An Occultation of a Star by Jupiter's Satellite Callisto on December 17, 1977

By: Michael Mattei

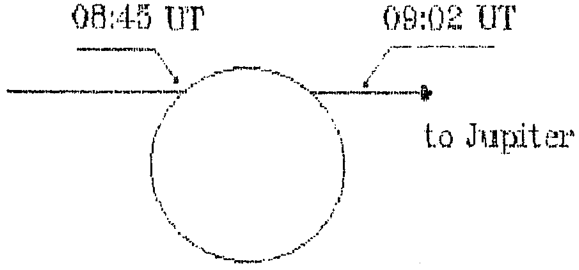
Callisto the fourth satellite of Jupiter had occulted a 9th magnitude star on December 17, 1977.

On December 17, 1977 while observing with a friends 14 inch Celestron telescope, I was about to end this observing session for the night when I decided to take one last look at Jupiter before turning in for the night. The time was about 08:00 U.T. After having a short look at the planet I noticed that one of its satellites looked like it was going to pass in front of another satellite. It was so close that I though it worth while to stay up to watch it. It appeared that they would merge in about an hour. A short time after I began the observation I began to realize that the other object did not look like the other satellites, it did not have the same color, and I guessed it to be a star. The star appeared to be about 9th magnitude and was going to pass behind the satellite Callisto. The telescope a 14 inch (35.5cm) Schmit Cass with an eyepiece to give 240 power was employed. A diagonal gave a reversed image so that East and West were reversed but North and South were correct in the field. (See diagram). As the star came closer to the limb of the satellite it became more difficult to see because of the brightness of the satellite. The star passed behind Callisto at 08:45 U.T., and reappeared again. At 09:02 U.T. I could see that the star was well clear of the satellite. The sky was clear, but Jupiter was entering trees near the end of the event.

By running the time of the event through Jeff Beish's Impac program Jupiter is located at R.A. 06:08, Dec +23:09, at an elevation of 42 degrees at the beginning of the observation, and places Jupiter in Gemini at the time.

However I was not able to confirm which star was occulted as the program does not present all ninth magnitude stars. A more sophisticated program may show which star was occulted.

Occultation Dec 17, 1977 of a star by J4



Celestron 14
240x

HIGHLIGHTS OF THE 1992-1993 APPARITION OF JUPITER

By Jose Olivarez, ALPO Jupiter Recorder

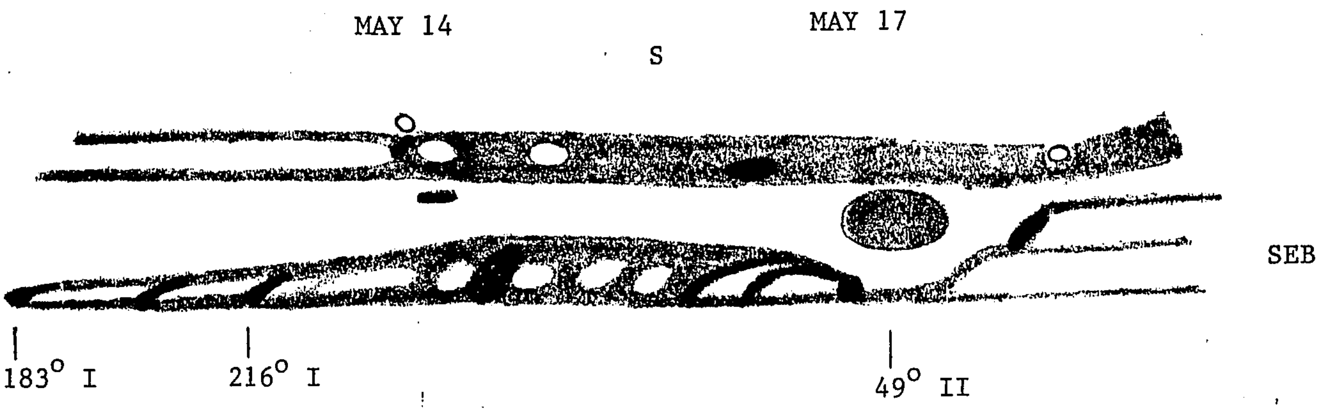
The number one highlight of the 1992-93 apparition of Jupiter was the South Equatorial Belt Disturbance that developed on April 7-9, 1993. Unlike other recent SEB Disturbances, this one began near the beginning of the 1993 evening opposition of Jupiter and permitted the viewing of the entire event. Also, unlike the 1990 SEB Disturbance which developed while Jupiter was in solar conjunction and which was enveloped in a dusky orangy veil during most of its active period, the 1993 SEB Disturbance was clear and its many rapidly developing white spots, dark spots, and festoons were clearly observed and followed.

Earlier in the apparition, activity in the North Equatorial Belt and the NEBn - NTrZ region was observed. The NEB developed white spots and rifts which were especially active in March, 1993. Other bright and dark features that developed at the latitude of the NEBn-STrZ were followed by the ALPO Jupiter observers from December 1992 through June, 1993.

Two small dark features that also attracted wide attention were a "Baby Red Spot" in the South Tropical Zone and a very dark "STrZ feature" that developed immediately following the Great Red Spot. The "Baby Red Spot" mimicked the Great Red Spot in both shape and color. It occupied the same latitude as the GRS in the South Tropical Zone and was observed from March through June at longitude 329 ° - 336 °II. The dark "STrZ feature" changed rapidly from a spot to an arc associated with an oval and was well observed through June 3, 1993.

Two Rapidly Moving Spots that appeared on Jupiter's North Temperate Belt Current "C" were followed. The first Rapidly Moving Spot was observed from January 19 - February 4, 1993. Its drift rate was -52°/30 days and yielded a rotation period of 9 hr. 49 min. 20 sec.. The second Rapidly Moving Spot was observed from May 14-June 15, 1993. Its drift rate was -56.4°/30 days and yielded a rotation period of 9 hr. 49 min. 14 sec. .

The Long Enduring South Temperate Belt Ovals "BC", "DE" and "FA" are about 8 degrees in length. "BC" and "DE" were in conjunction with the Great Red Spot around December 20, 1992. "FA" was in conjunction with the Great Red Spot around August 1, 1993. The three ovals are small white rotating cyclones that have existed on Jupiter for 53 years.



A STRIP SKETCH OF JUPITER SHOWING THE SEB DISTURBANCE
ON MAY 14 and 17 , 1993 UT

10-inch Reflector
150X - 178X
Seeing 7 on May 14th

Jose Olivarez
1469 Valleyview Court
Wichita, Kansas 67212 USA

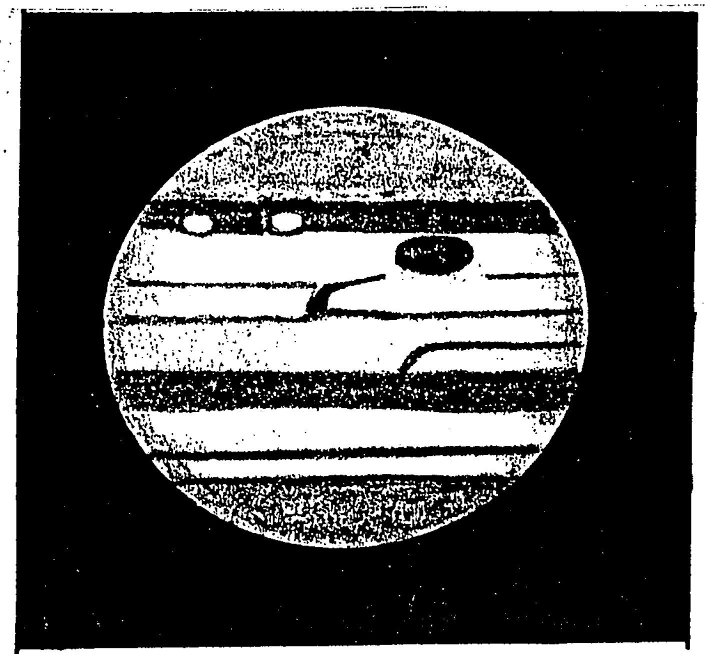
First Observation of the
outbreak of the 1993 SEB
DISTURBANCE in the U. S. A.

April 9, 1993 UT

3-inch D & G Refractor

Longitude of outbreak
at 17° (II) .

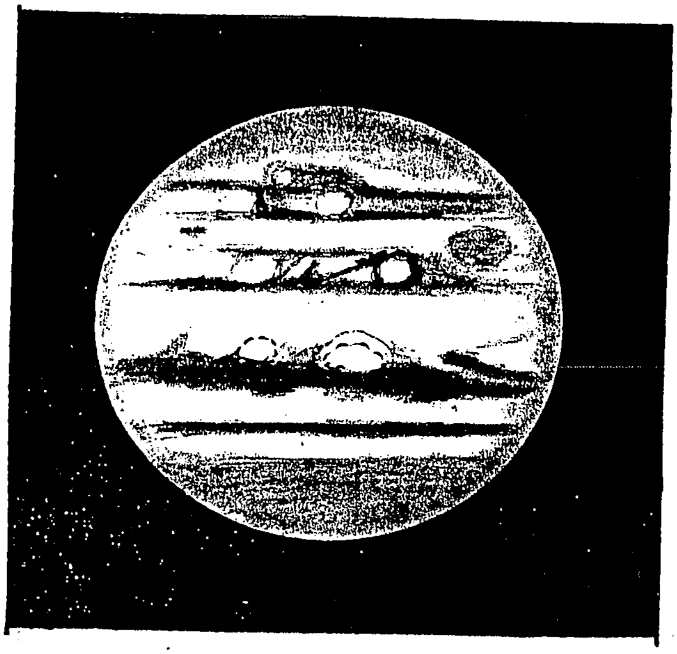
Jose Olivarez, Observer



Filter__________________

DATE (UT) APRIL 9, 1993

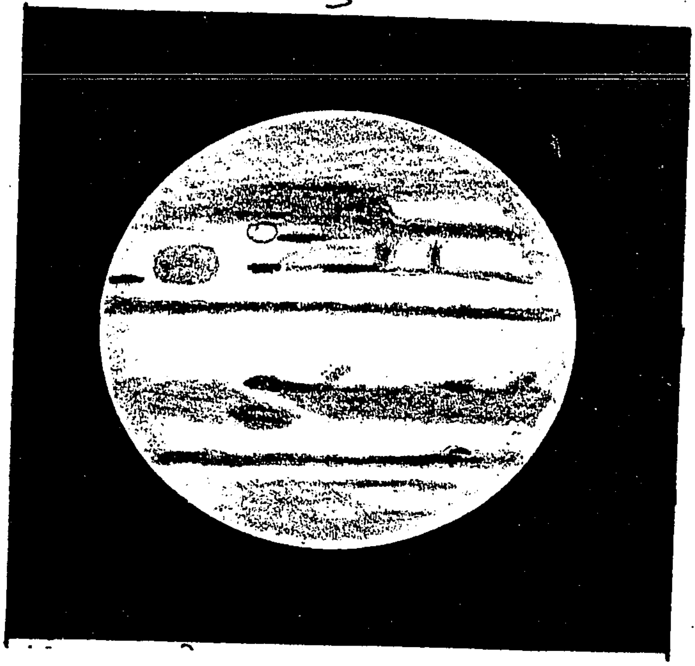
JUPITER
March 28, 1993 3;30 U.T.
8-inch Reflector 192X
Seeing - 6 Trans. 4,5
Observer- Claus Benninghoven
CM I = 309° CM II = 54°



JUPITER
April 30, 1993 at 4:12 UT
8-inch Reflector 236X & 192X
Seeing - 5 Trans. - 5
Observer - Claus Benninghoven
CM I = 148.7° CM II = 1.8°

JUPITER
May 23, 1993 at 0:25 UT
6-inch Reflector 205X
Seeing- 6 Trans.- 5
Observer- Samuel R. Whitby
CM I = 42° CM II = 81°

P



JUPITER
June 28, 1993 at 0:40 UT
6-inch Reflector 205X & 310X
Seeing - 8 Trans.- 4
Observer- Samuel R. Whitby
CM I = 332° CM II = 96°

ALPO
JUPITER SECTION
BUDINE
OLIVAREZ

THE MARTIAN ATMOSPHERE IN 1992-1993: A NEW SLANT

Donald Parker, Jeffrey Beish, Daniel Troiani, and Carlos Hernandez

(Abstract)

Despite the small apparent size of Mars in 1992-1993, the A.L.P.O. Mars Section has received several hundred high-quality observations. New CCD imagery enabled planetary observers to study the Martian atmosphere in greater detail than ever before. These electronic tricolor images revealed subtle cloud details not readily observed by visual or standard photographic methods.

In addition to the standard drawings and images, a number of micrometer measurements of the North Polar Cap were submitted; their significance will be discussed.

Getting Children Interested in Astronomy

Richard W. Schmude, Jr.
Texas A&M University

The author has found three ways to heighten children's interest in astronomy. These three are: allowing children to look through a telescope on Halloween (Oct. 31); giving slide shows and producing astronomy related television programs. Each of these three methods are discussed along with results.

Observation on Halloween

The author has allowed children to observe the moon and Saturn through a telescope on Halloween. It is felt that Halloween is good time to introduce people to astronomy because:

1. Large numbers of people are out in the evening
2. Halloween is just after the time change and so it gets dark early
3. It is still relatively warm

In 1987, I set up a 2.4 inch refracting telescope near my apartment and allowed the trick-or-treators to take a look at the moon as part of their treat. Most of them were impressed. In 1990, I allowed people to look through my 10 inch telescope which was pointed at the Moon. (A deep blue filter was used because the the brightness of the full moon.) Again, the children and their parents were quite impressed. In 1992, youngsters, dressed in a variety of costumes and their parents were treated with views of the moon and Saturn through a 10 inch telescope on Halloween. Most of the 75 people who stopped by were impressed and many of them had questions and several fruitful discussions went on during this time. This prompted my room mate and I to write a letter to Sky and Telescope.[1]

It is my hope that there will be more telescopes out on Halloween. This is an inexpensive way to increase public interest in Astronomy.

Giving Slide Shows

The author has given slide shows to children in the 6-12 age range. These shows have consisted of an oral presentation supported by slides (about 2 slides per minute). The presentations have generally gone well with members of the audience asking questions during and after the presentation. One problem which I have encountered is that children have a limited attention span and can begin talking to one another. I have found that one way around this is to periodically ask questions to the audience. Having them do an activity also helps.

In two of my presentations, the children (in groups of 2-4) were allowed to assemble their own telescopes from kits sold by Learning Technologies, Inc-(advertised in Sky & Telescope); these kits were 4.00$ in 1992.

My overall impression is that slide shows combined with a small activity is an effective way to teach youngsters about astronomy.

Producing Television Programs

I have been able to give four live television presentations and produce two more programs for the Public Access Television Channel in Los Alamos, New Mexico. The six programs covered all 9 planets; five of them were given at a level for 10-12 year olds. The programs consisted of many color slides (about 1-2 slides were shown per minute) and small demonstrations. In one program, video of the surrounding countryside was also edited in. The station manager along with a few friends helped me produce these programs. Press releases were made for several of the programs and all were listed in the local TV guide. The general public enjoyed the programs.

Conclusions

In conclusion, three methods have been attempted to interest young people in astronomy. Of the three methods, the easiest is setting up a telescope on Halloween and allowing people to view the moon or any other celestial object of interest. Slide shows can be effective especially when combined with small activities. It is possible for most people to produce their own television program if there is a Public Access Television Station nearby.

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[1] R. W. Schmude, and W. Winkler, Sky & Telesc. 86 (No. 4) p. 6 (1993).

WIDEBAND PHOTOMETRY OF URANUS AND NEPTUNE IN 1993: PRELIMINARY RESULTS

R. W. Schmude, Jr.-*A.L.P.O. Remote Planets Recorder*

Abstract

A total of 165 photometric measurements of Uranus and Neptune were made between April 21 and July 11, 1993. Based on these measurements, average normalized magnitudes for Uranus are: B(1,0)=-6.57±0.02; V(1,0)=-7.16±0.02; R(1,0)=-7.03±0.02 and I(1,0)=-5.84±0.03 while the corresponding values for Neptune are: B(1,0)=-6.48±0.02; V(1,0)=-6.92±0.02; R(1,0)=-6.60±0.02 and I(1,0)=-5.50±0.04. Small discrepancies (~0.02 mag.) in the magnitudes of the comparison stars used in 1991, 1992 and 1993 account for most of the year-to-year differences in magnitude measurements of Uranus and Neptune.

Introduction

An SSP-3 solid state photometer along with Johnson B, V, R and I filters were used for all Uranus and Neptune measurements; the photometer and filters are discussed elsewhere. [1,2] The 36 cm (14 inch) Schmidt-Cassegrain telescope at Texas A&M University Observatory was used for all photometric measurements. The focal length of this telescope is 391 cm (154 inches) and the photometer aperture is 1.0 mm; the angular diameter of the photometer aperture, when attached to the 36 cm telescope, is 54 arc-seconds. All Uranus measurements had an integration time of 30 seconds which meant that the respective signal-to-noise ratio for the B, V, R and I filter measurements was around 80, 200, 100 and 35. The integration time for almost all of the Neptune measurements was 60 seconds which resulted in approximate signal-to-noise ratios of 20, 45, 20 and 7 for the B, V, R and I filter measurements respectively.

The primary comparison star for the 1993 Uranus and Neptune measurements was 50-Sgr. This star was selected because it lies near both Uranus and Neptune and is not listed as a variable or a suspected variable. [3,4] The author measured the R and I magnitudes of 50-Sgr using ν_2-Sgr as a comparison star. Magnitudes of 50-Sgr and ν_2-Sgr are listed in Table 1.

Photometric Measurements

The photometric measurements of Uranus are listed in Table 2 and those of Neptune are listed in Table 3. The fourth column in these tables lists the air mass of the comparison star subtracted from the air mass of the planet, the fifth column lists the measured magnitude, corrected for atmospheric extinction, and the sixth column lists the normalized magnitudes. As in previous reports, the phase angle is taken to be 0° for all measurements. This assumption introduces an error of less than 0.01 magnitudes. Average, normalized magnitudes are listed in Table 4 for both planets.

The B, V and R magnitudes in Table 4 are similar to those measured in 1989, 1991 and 1992. [1,5-8] It must be pointed out though that different comparison stars were used in each of these years and so uncertainties of at least 0.02 magnitude are present due to the uncertainties in the star magnitudes. To eliminate this uncertainty, the author has measured the magnitudes of the comparison stars used in the 1991, 1992 and 1993 oppositions taking 50-Sgr as the standard. Preliminary results indicate small inconsistencies of 0.02 magnitudes in the star magnitudes. It is felt that any multi-year photometric study should include measuring the relative magnitudes of the comparison stars in much the same way as has been done at Lowell Observatory. [9]

Visual Studies

Figure 1 shows drawings of Uranus (A, B) and Neptune (C). All drawings were made by the author using the 36 cm telescope at Texas A&M University Observatory. Limb darkening was evident on both Uranus and Neptune. On May 15, dark areas were strongly suspected on Uranus while on June 23, under almost perfect seeing conditions, only a single dark area, near the preceding edge of the disc, was sighted. According to I.A.U. circular #5820, a dark spot was present on infrared images of Uranus taken on May 30, 1993 through a 180 cm telescope. It is not known whether the dark spot could be distinguished in visible light. On June 23, both dark and bright areas were suspected on Neptune; however the disc was relatively dark and it is felt that a larger aperture than 36 cm is needed for visual studies of Neptune.

Uranus usually had a yellowish color with a greenish hue during early 1993. Neptune generally had little color except on May 14 (8:40 U.T.) when it had a strong blue color.

The 8X50 finderscope on the 36 cm telescope was used in making 10 visual magnitude estimates of Neptune between June 1 and July 11, 1993. The average normalized magnitude is $V_{vis}(1,0)=-6.9$ with a standard deviation of 0.2 magnitudes. The comparison stars used (and respective magnitudes in parentheses) are SAO 188234 (+7.9); SAO 188219 (+6.0) and SAO 188252 (+7.1).

Conclusion

A total of 165 photometric measurements of Uranus and Neptune were made between April 21 and July 11, 1993. Average values of the normalized magnitudes for Uranus are: $B(1,0)=-6.57\pm0.02$; $V(1,0)=-7.16\pm0.02$; $R(1,0)=-7.03\pm0.02$ and $I(1,0)=-5.84\pm0.03$ while the corresponding magnitudes for Neptune are: $B(1,0)=-6.48\pm0.02$; $V(1,0)=-6.92\pm0.02$; $R(1,0)=-6.60\pm0.02$ and $I(1,0)=-5.50\pm0.04$. Visual studies indicate that Uranus may have had some albedo irregularities in May and June of 1993. The color of Uranus was generally yellow with a greenish hue. A normalized magnitude of Neptune is reported as $V_{vis}(1,0)=-6.9$.

Acknowledgements

I would like to thank Danny Bruton and Rob Lindenschmidt for assistance in gathering some of the data.

Table 1: Comparison stars and their respective magnitudes used in this study.

Star	R.A.	Dec.	B	V	R	I
50-Sgr	$18^h55.1^m$	$-22°40.3^m$	+6.81	+5.59	+4.65	+4.04
ν_2-Sgr	$19^h26.3^m$	$-21°46.6^m$	---	---	+4.04	+3.38

Table 2: Summary of Photometric measurements of Uranus made between April 21 and July 11, 1993.

Date (1993)	Filter	Comparison Star	Δ Air Mass	X_{meas} +	X(1,0) -
April					
21.416	B	50-Sgr	+0.132	6.357	6.542
21.418	V	50-Sgr	+0.127	5.745	7.154
21.427	B	50-Sgr	+0.106	6.346	6.553
21.429	V	50-Sgr	+0.102	5.747	7.152
21.437	B	50-Sgr	+0.111	6.347	6.552
21.439	V	50-Sgr	+0.110	5.734	7.165
21.452	B	50-Sgr	+0.066	6.343	6.556
21.454	V	50-Sgr	+0.063	5.742	7.157
26.418	B	50-Sgr	+0.029	6.350	6.540
26.420	V	50-Sgr	+0.031	5.726	7.165
26.433	B	50-Sgr	+0.029	6.348	6.543
26.434	V	50-Sgr	+0.026	5.728	7.163
26.451	B	50-Sgr	+0.006	6.334	6.557
26.452	V	50-Sgr	+0.010	5.738	7.153
26.464	B	50-Sgr	-0.030	6.334	6.557
26.466	V	50-Sgr	-0.026	5.738	7.153
May					
3.398	B	50-Sgr	-0.006	6.326	6.552
3.400	V	50-Sgr	-0.008	5.715	7.163
3.431	B	50-Sgr	-0.040	6.324	6.554
3.433	V	50-Sgr	-0.039	5.712	7.166
3.434	R	ν_2-Sgr	-0.022	5.844	7.034
3.436	I	ν_2-Sgr	-0.021	6.98	5.90
3.462	B	50-Sgr	-0.003	6.309	6.569
3.464	V	50-Sgr	-0.002	5.715	7.163
3.458	R	ν_2-Sgr	+0.006	5.852	7.026
3.460	I	ν_2-Sgr	+0.005	7.07	5.81
13.393	B	50-Sgr	-0.007	6.300	6.561
13.395	V	50-Sgr	-0.007	5.699	7.162
13.422	B	50-Sgr	-0.015	6.314	6.547
13.423	V	50-Sgr	-0.014	5.708	7.153
13.425	R	ν_2-Sgr	-0.019	5.836	7.025
13.427	I	ν_2-Sgr	-0.020	7.02	5.84

Table 2. Continued.

Date (1993)	Filter	Comparison Star	Δ Air Mass	X_{meas} +	X(1,0) -
May					
14.368	B	50-Sgr	-0.125	6.326	6.535
14.369	V	50-Sgr	-0.115	5.707	7.154
14.372	R	50-Sgr	-0.123	5.869	6.992
14.374	I	50-Sgr	-0.113	7.027	5.83
14.391	R	50-Sgr	-0.030	5.841	7.020
14.392	I	50-Sgr	-0.023	6.986	5.88
15.317	B	50-Sgr	-0.023	6.208	6.650
15.319	V	50-Sgr	-0.036	5.654	7.204
15.321	R	50-Sgr	-0.035	5.819	7.039
15.323	I	50-Sgr	-0.025	7.04	5.82
15.342	B	50-Sgr	-0.005	6.267	6.591
15.343	V	50-Sgr	0.000	5.664	7.194
15.345	R	50-Sgr	-0.004	5.823	7.035
15.347	I	50-Sgr	+0.001	7.01	5.85
15.371	B	50-Sgr	0.000	6.273	6.585
15.372	V	50-Sgr	+0.002	5.673	7.185
15.374	R	50-Sgr	+0.005	5.803	7.055
15.375	I	50-Sgr	+0.010	7.01	5.85
15.415	B	50-Sgr	+0.009	6.294	6.564
15.417	V	50-Sgr	+0.008	5.687	7.171
15.418	R	50-Sgr	+0.009	5.842	7.016
15.420	I	50-Sgr	+0.009	7.02	5.84
15.431	R	50-Sgr	+0.013	5.825	7.033
15.432	I	50-Sgr	+0.013	7.03	5.83
June					
1.278	B	50-Sgr	-0.088	6.249	6.557
1.280	V	50-Sgr	-0.078	5.644	7.173
1.302	B	50-Sgr	-0.152	6.223	6.562
1.304	V	50-Sgr	-0.138	5.660	7.143
1.306	R	50-Sgr	-0.136	5.789	7.025
1.309	I	50-Sgr	-0.141	7.01	5.81
1.329	B	50-Sgr	-0.063	6.254	6.560
1.331	V	50-Sgr	-0.062	5.658	7.162
1.333	R	50-Sgr	-0.057	5.788	7.038
1.334	I	50-Sgr	-0.057	7.02	5.81

Table 2: Continued.

Date (1993)	Filter	Comparison Star	Δ Air Mass	X_{meas} +	X(1,0) -
June					
1.366	B	50-Sgr	-0.014	6.257	6.572
1.368	V	50-Sgr	-0.011	5.671	7.161
1.370	R	50-Sgr	-0.010	5.798	7.035
1.372	I	50-Sgr	-0.008	7.00	5.83
1.383	R	50-Sgr	+0.012	5.822	7.014
1.384	I	50-Sgr	+0.013	7.00	5.84
23.274	B	50-Sgr	-0.017	6.217	6.596
23.276	V	50-Sgr	-0.014	5.642	7.171
23.288	B	50-Sgr	-0.001	6.237	6.576
23.290	V	50-Sgr	-0.003	5.640	7.173
24.224	B	50-Sgr	+0.138	6.206	6.607
24.226	V	50-Sgr	+0.133	5.645	7.168
24.238	B	50-Sgr	+0.076	6.259	6.554
24.242	V	50-Sgr	+0.076	5.654	7.159
July					
10.283	B	50-Sgr	+0.022	6.236	6.572
10.288	V	50-Sgr	+0.022	5.648	7.160
11.216	B	50-Sgr	+0.015	6.250	6.558
11.218	V	50-Sgr	+0.012	5.642	7.166
11.236	B	50-Sgr	+0.010	6.232	6.576
11.239	V	50-Sgr	+0.006	5.641	7.167

Table 3: Summary of photometric measurements of Neptune made between April 21 and July 11, 1993.

Date (1993)	Filter	Comparison Star	Δ Air Mass	X_{meas} +	X(1,0) -
April					
21.444	V	50-Sgr	+0.013	7.873	6.911
21.456	V	50-Sgr	+0.001	7.853	6.931
26.424	B	50-Sgr	-0.080	8.316	6.462
26.427	V	50-Sgr	-0.079	7.853	6.925
26.438	B	50-Sgr	-0.052	8.303	6.475
26.440	V	50-Sgr	-0.056	7.860	6.918
26.448	B	50-Sgr	-0.031	8.334	6.444
26.449	V	50-Sgr	-0.027	7.844	6.934
26.455	B	50-Sgr	-0.053	8.292	6.486
26.457	V	50-Sgr	-0.049	7.873	6.905
May					
3.393	B	50-Sgr	-0.048	8.302	6.468
3.396	V	50-Sgr	-0.055	7.845	6.925
3.420	B	50-Sgr	-0.051	8.321	6.449
3.422	V	50-Sgr	-0.053	7.836	6.934
3.425	R	ν_2-Sgr	-0.041	8.124	6.646
3.427	I	ν_2-Sgr	-0.044	9.20	5.57
3.454	B	50-Sgr	-0.036	8.279	6.491
3.456	V	50-Sgr	-0.035	7.829	6.941
3.450	R	ν_2-Sgr	-0.049	8.165	6.605
3.452	I	ν_2-Sgr	-0.040	9.25	5.52
4.394	B	50-Sgr	-0.046	8.324	6.446
4.396	V	50-Sgr	-0.047	7.850	6.920
4.418	B	50-Sgr	-0.033	8.306	6.464
4.420	V	50-Sgr	-0.032	7.906	6.864
13.388	B	50-Sgr	-0.039	8.272	6.487
13.390	V	50-Sgr	-0.042	7.826	6.933
13.412	B	50-Sgr	-0.039	8.300	6.459
13.415	V	50-Sgr	-0.040	7.833	6.926
13.417	R	ν_2-Sgr	-0.047	8.163	6.596
13.419	I	ν_2-Sgr	-0.049	9.38	5.38
13.445	B	50-Sgr	-0.024	8.327	6.432
13.447	V	50-Sgr	-0.022	7.884	6.875
13.449	R	50-Sgr	-0.020	8.210	6.549

Table 3: Continued.

Date (1993)	Filter	Comparison Star	Δ Air Mass	X_{meas} +	X(1,0) -
May					
14.358	B	50-Sgr	-0.114	8.289	6.469
14.360	V	50-Sgr	-0.111	7.857	6.901
14.363	R	50-Sgr	-0.120	8.183	6.575
14.365	I	50-Sgr	-0.116	9.27	5.49
14.386	R	50-Sgr	-0.056	8.170	6.588
14.388	I	50-Sgr	-0.056	9.28	5.48
15.308	B	50-Sgr	+0.020	8.186	6.571
15.310	V	50-Sgr	+0.003	7.791	6.966
15.313	R	50-Sgr	+0.001	8.098	6.659
15.315	I	50-Sgr	+0.001	9.13	5.63
15.333	B	50-Sgr	+0.003	8.246	6.511
15.335	V	50-Sgr	+0.002	7.811	6.946
15.337	R	50-Sgr	-0.003	8.133	6.624
15.339	I	50-Sgr	-0.003	9.23	5.53
15.363	B	50-Sgr	-0.010	8.257	6.500
15.365	V	50-Sgr	-0.013	7.814	6.943
15.367	R	50-Sgr	-0.015	8.123	6.634
15.369	I	50-Sgr	-0.013	9.26	5.49
15.406	B	50-Sgr	-0.016	8.274	6.483
15.408	V	50-Sgr	-0.019	7.829	6.928
15.410	R	50-Sgr	-0.019	8.192	6.565
15.413	I	50-Sgr	-0.021	9.24	5.52
15.426	R	50-Sgr	-0.022	8.189	6.568
15.428	I	50-Sgr	-0.023	9.31	5.45
June					
1.292	B	50-Sgr	-0.123	8.264	6.477
1.294	V	50-Sgr	-0.119	7.828	6.913
1.296	R	50-Sgr	-0.119	8.126	6.615
1.299	I	50-Sgr	-0.127	9.31	5.43
1.320	B	50-Sgr	-0.073	8.272	6.469
1.322	V	50-Sgr	-0.074	7.831	6.910
1.324	R	50-Sgr	-0.072	8.123	6.618
1.326	I	50-Sgr	-0.074	9.27	5.47
1.358	B	50-Sgr	-0.040	8.252	6.489
1.360	V	50-Sgr	-0.038	7.822	6.919

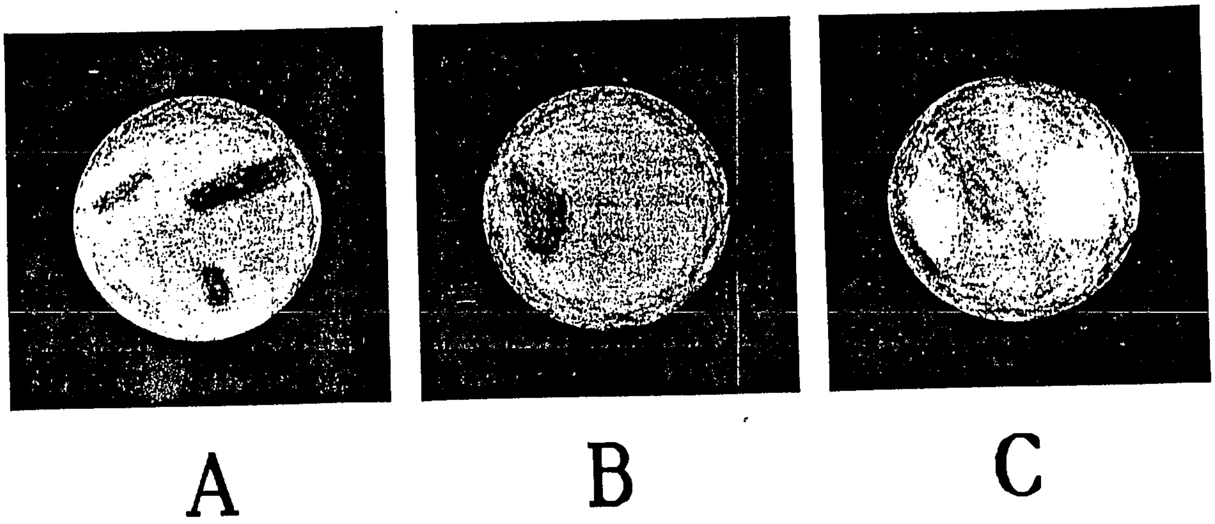
Table 3: Continued.

Date (1993)	Filter	Comparison Star	Δ Air Mass	X_{meas} +	X(1,0) -
June					
1.362	R	50-Sgr	-0.039	8.144	6.597
1.364	I	50-Sgr	-0.038	9.26	5.48
1.378	R	50-Sgr	-0.024	8.132	6.609
1.380	I	50-Sgr	-0.024	9.25	5.49
23.269	B	50-Sgr	-0.052	8.196	6.531
23.272	V	50-Sgr	-0.052	7.786	6.941
23.283	B	50-Sgr	-0.034	8.210	6.517
23.285	V	50-Sgr	-0.038	7.791	6.936
July					
11.222	B	50-Sgr	-0.073	8.254	6.469
11.224	V	50-Sgr	-0.071	7.793	6.930
11.242	B	50-Sgr	-0.059	8.274	6.449
11.244	V	50-Sgr	-0.056	7.803	6.920

Table 4: Average values of the normalized magnitudes of Uranus and Neptune based on 1993 measurements. The number of data sets, [#], are given in brackets and the standard deviations are in parantheses below the normalized magnitudes.

Parameter	Uranus	Neptune
B(1,0) [#]	-6.565 [29] (0.023)	-6.479 [24] (0.031)
V(1,0) [#]	-7.165 [29] (0.013)	-6.923 [26] (0.021)
R(1,0) [#]	-7.028 [14] (0.015)	-6.603 [15] (0.031)
I(1,0) [#]	-5.839 [14] (0.026)	-5.495 [14] (0.060)

Figure 1: Drawings of Uranus and Neptune made through the 36 cm Schmidt-Cassegrain telescope at Texas A&M University Observatory.
A) (Uranus), May 15, 1993, 10:31-10:49 U.T., 325 & 530X, seeing=8;
B) (Uranus), June 23, 1993, 5:31-5:43 U.T., 530X, seeing=9;
C) (Neptune) June 23, 1993, 5:49-6:06 U.T., 530X, seeing=9.



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CCD OBSERVATIONS OF P/SHOEMAKER-LEVY 9 (1993e)

Jim Scotti

(Abstract)

Periodic Comet Shoemaker-Levy 9 (1993e) was discovered on 1993 March 25 by Carolyn Shoemaker on films taken on March 24 by herself, Gene Shoemaker, and David Levy using the 0.46-m Schmidt telescope at Palomar. The comet's unusual appearance was immediately evident, but the resolution of the Palomar 0.46-m Schmidt telescope did not allow its true nature to be seen. The author, who was at the Spacewatch 0.9-m telescope on Kitt Peak, was contacted by one of the discovers, David Levy, during the evening of March 25 local time (March 26 UT). CCD images were then obtained under poor seeing conditions which showed a narrow train of nuclei about 47 arcseconds long composed of at leave five individual nuclei. Also visible were dust trails extending from both ends of the nuclear train and tails extending more than an arcminute from the nuclear train. Further observations have been made of this comet with the same telescope, showing more than 11 individual nuclei. Higher-resolution images, including Hubble Space Telescope images, show as many as about 20 individual nuclei. Some results from these observations will be presented in this paper along with some speculation on the potentially spectacular future events surrounding this comet's probable impact with Jupiter in July, 1994.

LUNAR SURVEYING WITH A CCD CAMERA

John E. Westfall

INTRODUCTION

CCD Cameras are admired for their photometric accuracy, their prodigious dynamic range, and their ability to detect faint objects and subtle shadings. We do not hear much about their *metric* properties—their potential for the measurement of positions and quantities related to positions. This paper describes the results of an experiment in the measurement of a lunar CCD image in order to calculate the positions, diameters, and elevations of features, along with an assessment of the accuracy of those results.

PROCEDURE

The CCD camera the writer uses is typical of amateur CCD units; a Lynxx MC camera with 165X192 pixels occupying a square area in the focal plane 2.64 mm on a side. When used with his 28-cm "C11" Schmidt-Cassegrain and a 2X Barlow lens, each pixel represents about 1 square km on the Moon.

The image selected for this experiment showed the area of the crater Plinius under morning lighting, and was taken with a 0.20-second exposure on 1994 DEC 20 at 02h 16m UT. The geometrical parameters for the exposure were: Colongitude = 347°.27, selenocentric solar latitude = +0°.69, topocentric librations = 3°.09 E/5°.76 N. The "raw" image, calibrated with flat and dark fields, but not otherwise enhanced, is shown in *Figure 1.*

This image was chosen because its lighting was low enough for features to cast measurable shadows, the seeing had been fairly good, the image included five measured points listed in the "Unified Lunar Control Network" (see reference in *Table* 2), and the region is covered by the *Lunar Orthophotomap* series, which has 100-meter contours. Finally, the camera was so aligned during the exposure that the minor axes of the rectangular pixels were parallel to the direction the shadows were cast, allowing about 16 percent finer resolution when measuring shadow lengths; it was also possible to measure shadow lengths in terms of only one dimension of the array.

A long focal length must be used to make each pixel's "footprint" on the Moon's surface small so as to increase the precision of the measurement. One problem with making lunar position measurements on small-format CCD images is that this makes each image's "footprint" small as well, as is shown in *Figure 2*. This means that it is difficult to find an adequate number of previously-measured "control points" in the frame. There appear to be three ways to circumvent this conflict:

- Use a shorter focal length. This will increase the lunar area covered but will also increase the pixel size and reduce the precision of the measurements.
- Mosaic adjoining frames. This must be done very precisely and the component frames must have identical orientations and be taken within a few minutes of each other or the solar lighting and the topocentric librations will have changed significantly.
- Obtain a larger-format CCD. This is the only solution that does not compromise accuracy, but it is expensive monetarily and in terms of computer memory.

The Lynxx-format image was exported to Adobe *Photoshop* as a PICT-format file. Once in *Photoshop*, the image was enlarged by a factor of 5.000X horizontally and 5.818X vertically, the different ratios correcting for the non-square pixels. This enlargement made it possible to measure pixel rows and columns to greater precision; now about 200 meters. No further modification was applied to this image before it was measured. In particular, it was felt that such processes as non-linear contrast enhancement and unsharp masking would affect the positions of shadow edges and thus degrade the elevation measurements. However, a separate enhanced image was created, to be used for feature identification but not measurement, and is shown here as *Figure 3*.

The pixel columns (X) and rows (Y) of the 5 control points and 61 other features shown in *Figure 4* were then measured. Many features were selected to form pairs; such as peaks and the ends of their shadows, in order to compute elevations; or the opposite rims of craters, in order to compute their diameters. The most difficult step was to estimate the edges of the shadows, which were blurred over several pixels. The writer considered the beginning or end of a shadow as being the pixel whose brightness was one-half that of the surrounding sunlit terrain.

The next step was to convert the image positions into the selenographic rectangular coordinates ξ and η. The first method tried was the standard procedure used to measure photographs, as described by D.W.G. Arthur ("Contributions to Selenography No. 4. Selenographic Positions from Photographs." 1955). Here, one uses multiple regression to find X and Y as linear functions of ξ and η (as well as ζ, the vector toward Earth at mean libration). Then one inverts the equations, finding ξ and η as functions of X and Y. It was at this stage that the standard procedure broke down; extrapolating from the small lunar area being measured to find the apparent lunar radius gave significantly different ξ– and η-radii, making the equations insoluble.

Instead, the writer tried direct multiple regression of ξ and η as functions of X and Y in the following form:

$$(1) \qquad \xi = A + BX + CY; \eta = D + EX + GY.$$

For this particular image, in its enlarged Photoshop format, and for the five control points, the coefficients were found to be:

$$A = +0.30638; B = +0.00011710 \pm .00000151; C = +0.00000012 \pm .00000234;$$

$$D = +0.32285; E = -0.00000049 \pm .00000079; F = -0.00012937 \pm .00000122.$$

These values imply that one pixel column equals 203 meters on the Moon, and one row is 225 meters. The third coordinate, ζ, was found by assuming that the sums of the three squared coordinates totaled to 1.000000 lunar radius. In other words, this was a two-dimensional *selenographic* solution because two images at different librations would be needed to determine three-dimensional positions. The rectangular coordinates were converted into latitude (β) and longitude (λ) by the formulae:

$$(2) \qquad \sin \beta = \eta; \ \sin \lambda = \xi / \cos \beta$$

The distance, d, between any two points, i and j, was found by the formula:

$$(3) \qquad d_{ij} = R\surd[(\xi_i - \xi_j)^2 + (\eta_i - \eta_j)^2 + (\zeta_i + \zeta_j)^2],$$

where R is the local lunar radius, here taken as the mean radius vector of the five control points, or 1735.666 km. This distance allowed the diameters of craters and the lengths of shadows to be computed. Given the length of a shadow, converted to selenocentric arc, θ, and the elevation of the Sun at the shadow tip, α, the relative elevation between a peak and its shadow tip, H, was found using the expression:

$$(4) \qquad H = R \{[\cos(\alpha + \theta)/\cos \alpha] - 1\}.$$

RESULTS

The measured and computed positions of the 61 points measured are given in *Table 1*, and can be used as a framework for mapping of the area. More important here, though, is the accuracy of the results. The regression fit described above had root-mean-square residuals of ±0.000738 lunar radius in ξ and ±.000384 in η; when combined giving about ±1.44 km uncertainty. *Table 2* gives more detailed information on the differences between the positions found in this study and previous values. These results appear accurate enough to use for mapping the Moon at medium scales of 1:2,000,000 or smaller. They also appear accurate to about ±0°.03 selenocentric angle, and so can reliably used to compute solar altitudes for height calculations.

Another use for CCD measures is to measure the diameters of craters, although probably Lunar Orbiter photographs would be more accurate, at least for smaller craters. On the other hand, CCD-based crater diameters can be compared with those from other sources as another means of assessing accuracy. Such comparisons are shown in *Table 3*, giving a root-mean-square difference of ±.1.08 km, comparable to the positional uncertainty. There appears to be a tendency for the CCD diameters to be underestimates (by 0.78 km on the average), but for the larger differences to be associated with the larger diameters.

The final form of feature parameter calculated was relative elevation; the height of a peak above the tip of its shadow. *Table 4* gives these results and compares them with those found from other sources. The question is *which* other source. The "LAC" elevations were calculated from shadow-length measurements on earthbased photographs and are often considered unreliable, so in most instances the writer compared the CCD elevations with those shown on the Lunar Orthophotomaps, whose elevations were based on stereo photogrammetry from lunar orbit. Nonetheless, the Lunar Orthophotomap elevations are expressed by a rather coarse 100-meter contour interval, with only occasional spot elevations given to 1-meter precision. Another comparison problem is that the shadow-tips often fell on steep slopes where a small positional error would create a large elevation error. For studies of other areas, it is unfortunate that the Lunar Orthophotomaps are hard to find and cover only a fraction of the lunar nearside.

Bearing the above in mind, it appears that the CCD elevations frequently are too low; averaging about 6±4 percent below the admittedly approximate Lunar Orthophotomap values. The root-mean-square difference is ±23 percent (the mean absolute difference is ±18 percent). These errors are large enough to warrant further study. It is clear that the Sun angle, which ranged from 6°.04 to 10°.86, was often too low for the smaller craters so that the shadows of their east wall rims often fell on their inner west walls, rather than on their floors. The chief problem, though, was the "softness" of the shadow edges. It is tempting to use unsharp masking to sharpen them before they are measured. This procedure was tested by drawing a brightness profile across the central peak of Plinius on both an unenhanced and a sharpened image, as shown in *Figure 5*, with the resulting profiles shown in *Figure 6*. The unsharp masking resulted in a much more clearly defined shadow boundary. However, the apparent shadow length was increased from 16 pixel columns to 20, which would make the peak about 25 percent higher than the unenhanced-image measurement, which happened to agree closely with the Lunar Orthophotomap.

CONCLUSIONS

I have several recommendations regarding the use of CCD images to measure lunar positions, crater diameters, and elevations.

- Every measurement was a single measurement only, rather than the mean of a series. Accuracy should be improved if the coordinates of every point were measured several times and the means of the series used.

- The positional results appear encouraging, although it would be desirable to use a larger-format CCD chip, and preferably one that has square pixels. The larger format would allow more of the Moon to be imaged in one frame. The larger area would include more control points and thus allow a better first-degree regression fit. It would also allow a second-degree or higher regression fit, which would be desirable everywhere, and would probably be necessary in areas closer to the limb.
- A more accurate procedure for determining the lengths of shadows needs to be found. Despite the possible exaggeration of shadow length found in the experiment, unsharp masking should not be rejected out of hand. The writer used the maximum sharpening possible in Photoshop, and this saturated both the sunlit (100 percent) and the shadow (0 percent) areas. This undoubtedly caused some loss of information, and a smaller amount of sharpening might be able to make the shadows better defined but still have their correct lengths.
- It is important to have the proper solar elevation for certain types of features. A very low Sun angle is needed for domes, ridges, and "saucer" craters. For the depths of large craters, the wall shadow should fall on the floor. For small, hemispherical-floored craters, the wall shadow should fall near the *center* of the floor.
- Obviously, the sharper the original image, the better, as always encouraging the use of the best optics and the sites and moments of best seeing. It would also be useful to experiment with taking several images in short succession, and then using the averaged result for measurement.

There is always room for improvement and further experiment, but this single test shows that amateur CCD images *work* for measuring positions, diameters, and elevations on the Moon. Such measurement in the past usually implied using glass plates or large-format film with a measuring engine, and was thus rarely done by amateurs. This is why, for example, we have no elevations for most of the Moon's peaks, domes, and ridges; as well as no depths or rim heights for most of the small craters. Now that CCD cameras can be used for these measurements, this need not be the case for much longer.

Table 1. Positional Measurements from CCD Image Plinius.93DEC20.0216.

Point	Pixel						
No.	Col.	Row	ξ (Xi)	η (Eta)	Longitude	Latitude	Description
			+	+	+°	+°	
1	84	283	.316250	.286197	19.272	16.630	On E rim Tacquet
2	67	283	.314260	.286205	19.146	16.631	Shadow-tip of Pt. 1
3	55	283	.312854	.286211	19.057	16.631	On W rim Tacquet
4	197	378	.329494	.273852	20.035	15.894	Center Tacquet B
5	223	376	.332538	.274098	20.229	15.908	On W rim Tacquet B
6	193	376	.329025	.274112	20.007	15.909	Shadow-tip of Pt. 5
7	168	378	.326098	.273866	19.820	15.894	On E rim Tacquet B
8	140	378	.322819	.273880	19.612	15.895	Shadow-tip of Pt. 7
9	436	419	.357486	.268430	21.784	15.571	Center Crater SLC 13256
10	429	248	.356646	.290556	21.884	16.891	Promontorium Archerusia (Pk.)
11	395	248	.352664	.290573	21.627	16.892	Shadow-tip of Pt. 10
12	348	305	.347167	.283222	21.222	16.453	Peak (unnamed)
13	327	305	.344708	.283232	21.065	16.453	Shadow-tip of Pt. 12
14	313	322	.343071	.281039	20.945	16.322	Peak (unnamed)
15	266	322	.337567	.281063	20.594	16.324	Shadow-tip of Pt. 14
16	264	373	.337339	.274466	20.537	15.930	Peak (unnamed)
17	161	355	.325276	.276845	19.786	16.072	Center Tacquet BA
18	178	355	.327266	.276836	19.912	16.071	On E rim Tacquet BA
19	164	355	.325627	.276843	19.808	16.072	Shadow-tip of Pt. 18
20	150	355	.323988	.276850	19.704	16.072	On W rim Tacquet BA
21	134	355	.322114	.276858	19.586	16.073	Shadow-tip of Pt. 20
22	74	389	.315092	.272489	19.116	15.812	Peak (unnamed)
23	49	389	.312165	.272501	18.932	15.813	Shadow-tip of Pt. 22
24	139	424	.322708	.267929	19.570	15.541	Peak (unnamed)
25	104	424	.318609	.267946	19.311	15.542	Shadow-tip of Pt. 24
26	294	511	.340869	.256598	20.651	14.868	Peak (unnamed)
27	264	511	.337356	.256613	20.429	14.869	Shadow-tip of Pt. 26
28	513	408	.366501	.269816	22.372	15.653	Peak (unnamed)
29	483	408	.362988	.269830	22.146	15.654	Shadow-tip of Pt. 28
30	432	449	.357021	.264551	21.729	15.340	Peak (unnamed)
31	462	448	.360534	.264666	21.954	15.347	Plinius δ (peak)
32	579	431	.374233	.266808	22.849	15.474	On W rim Plinius
33	561	431	.372125	.266817	22.713	15.475	Shadow-tip of Pt. 32
34	681	446	.386179	.264817	23.608	15.356	Plinius β (central peak; N of 2)
35	665	446	.384305	.264825	23.487	15.357	Shadow-tip of Pt. 34

(Continued)

Table 1—Continued.

Point	Pixel						
No.	Col.	Row	ξ (Xi)	η (Eta)	Longitude	Latitude	Description
			+	+	+°	+°	
36	672	456	.385126	.263528	23.531	15.280	Plin. unnamed cen. pk.; S of 2)
37	654	456	.383018	.263537	23.394	15.280	Shadow-tip of Pt. 36
38	752	403	.394488	.270345	24.189	15.685	On E rim Plinius
39	691	403	.387344	.270375	23.724	15.687	Shadow-tip of Pt. 38
40	764	468	.395901	.261930	24.219	15.185	On E rim Plinius
41	709	468	.389460	.261957	23.800	15.186	Shadow-tip of Pt. 40
42	681	810	.386222	.217727	23.311	12.576	Center Ross D
43	699	810	.388330	.217718	23.445	12.575	On E rim Ross D
44	676	810	.385637	.217729	23.273	12.576	Shadow-tip of Pt. 43
45	662	810	.383997	.217736	23.169	12.576	On W rim Ross D
46	653	810	.382944	.217740	23.101	12.576	Shadow-tip of Pt. 45
47	379	694	.350844	.232882	21.147	13.467	On E rim Tacquet C
48	370	694	.349790	.232886	21.081	13.467	Shadow-tip of Pt. 47
49	272	579	.338301	.247811	20.438	14.348	On E rim Tacquet A
50	241	579	.334671	.247827	20.209	14.349	Shadow-tip of Pt. 49
51	221	579	.332329	.247836	20.062	14.350	On W rim Tacquet A
52	208	579	.330806	.247843	19.966	14.350	Shadow-tip of Pt. 51
53	168	605	.326125	.244499	19.654	14.152	Peak (unnamed)
54	144	605	.323315	.244511	19.477	14.153	Shadow-tip of Pt. 53
55	495	613	.364418	.243304	22.068	14.082	Center Crater SLC 13264
56	196	700	.329416	.232195	19.796	13.426	Peak (unnamed)
57	175	700	.326957	.232205	19.642	13.427	Shadow-tip of Pt. 56
58	85	775	.316427	.222547	18.939	12.859	Peak (unnamed)
59	61	775	.313616	.222558	18.765	12.859	Shadow-tip of Pt. 58
60	40	681	.311146	.234729	18.668	13.576	Peak (unnamed)
61	23	583	.309143	.247416	18.606	14.325	Peak (unnamed)

Table 2. CCD-Based Positions Compared With Other Sources

	CCD Measurement			Comparison Position				
Description	ξ (Xi)	η (Eta)	ζ (Zeta)	ξ (Xi)	η (Eta)	ζ (Zeta)	Difference	Source
	+	+	+	+	+	+	km	
Tacquet	.314494	.286334	.905045	.314999	.286602	.904503	1.85	ULCN
Plinius A	.398043	.224404	.889497	.398652	.224706	.889365	1.20	ULCN
Tacquet C	.349790	.232886	.907420	.349586	.232835	.907434	0.37	ULCN
Al-Bakri	.335490	.247823	.908862	.335063	.247556	.909840	1.91	ULCN
Plinius β	.386296	.264558	.883620	.385806	.264317	.883286	1.11	ULCN
Plinius δ	.360534	.264666	.894409	.3608	.2642	.8944	0.9	CCSP
Ross D	.386222	.217727	.896341	.3863	.2177	.8963	0.2	CCSP

CCSP = Arthur, D.W.G. *Consolidated Catalog of Selenographic Positions.* Lunar and Planetary Laboratory Communication No. 11, 1962. This gives ξ, η coordinates only; ζ has been computed assuming a radius of 1.000000.

ULCN = Davies, Merton E.; Colvin, Tim R.; & Meyer, Donald L. "A Unified Lunar Control Network: The Near Side." *J. Geophys. Res.*, *92*, No. B13, Dec. 10, 1987, 14177-14184. This gives *selenodetic* (3-dimensional) coordinates

Differences in kilometers assume a lunar radius of 1735.666 km.

Table 3. CCD-Based Crater Diameters Compared With Other Sources

Feature	CCD-Based Diameter	Comparison Diameter	CCD-Comp. Difference	Comparison Source
	km	km	km	
Al-Bakri	11.04	12.4	-1.36	Pike
Plinius	40.22	42.1	-1.88	Pike
Ross D	8.19	9.07	-0.88	SLC
Tacquet	6.24	7.00	-0.76	Pike
Tacquet B	11.95	12.14	-0.19	SLC*
Tacquet BA	6.04	5.63	+0.41	SLC

Pike = Pike, Richard J. *Geometric Interpretation of Lunar Craters.* U.S.G.S. Professional Paper 1046-C. 1980.

SLC = Arthur, D.W.G.; Agnieray, Alice P.; Horvath, Ruth A.; Wood, C.A.; & Chapman, C.R. *The System of Lunar Craters, Quadrant I.* Comm., L.P.L., v. 2, No. 30. 1963.

* = Geometric mean of major and minor axes.

Table 4. CCD-Based Relative Elevations Compared With Other Sources.

Point No.	Description	CCD-Based Elevation	Comparison Elevation	CCD-Comp. Difference	Source & Notes
		m	m	m	
1	Tacquet, E depth	411	480	-69 (-14%)	LAC 42 (a)
5	Tacquet B, W rim height	831	~ 1150	-319 (-28%)	LTO60B1
7	Tacquet B, E depth	732	~ 900	-168 (-19%)	LTO60A2
10	Promontorium Archerusia	1157	1416	-259 (-18%)	LTO42C4 (b)
12	Peak (unnamed)	664	800	-136 (-17%)	LTO42C4
14	Peak (unnamed)	1419	1400	+19 (+1%)	LTO42C4
18	Tacquet BA, E depth	374	400	-26 (-6%)	LAC42 (c)
20	Tacquet BA, E rim height	414	~350	+64 (+18%)	LTO42D3
22	Peak (unnamed)	588	~950	-362 (-38%)	LTO60A2
24	Peak (unnamed)	879	900	-21 (-2%)	LTO60A2
26	Peak (unnamed)	883	800	+83 (+10%)	LTO60B1
28	Peak (unnamed)	1086	1190	-104 (-9%)	LTO60B1
32	Plinius, W rim height	690	750	-60 (-8%)	LTO60B1
34	Plinius β (central peak)	665	670	-5 (-1%)	LTO60B1
36	Plinius cent. pk., S of 34	741	900	-159 (-18%)	LTO60B1
38	Plinius, E depth	2636	2250	+386 (+17%)	LTO60B1 (d)
40	Plinius, E depth	2394	2450	-56 (-2%)	LTO60B1 (d)
43	Ross D, E depth	946	1000	-54 (-5%)	LTO60B1 (e)
45	Ross D, E rim height	361	300	+61 (+20%)	LTO60B1
47	Tacquet C, E depth	286	650	-364 (-56%)	LTO60B1 (f)
49	Al-Bakri, E depth	888	1050	-162 (-15%)	LTO60B1 (g)
51	Al-Bakri, W rim height	357	300	+57 (+19%)	LTO60A2 (h)
53	Peak (unnamed)	617	500	+117 (+23%)	LTO60A2
56	Peak (unnamed)	553	880	-247 (-28%)	LTO60A2
58	Peak (unnamed)	553	370	+183 (+49%)	LTO60A2

Notes: (a) 1100m on LTO42D3.
(b) 660m on LAC42.
(c) 730m in LCD.
(d) 3200m on LAC42.
(e) 1100m on LAC60; 1730m in LCD.
(f) 810m in LCD.
(g) 1100m on LAC60; 1000m in LCD.
(h) 230m on LAC60.

LAC = *Lunar Astronautical Chart* (1:1,000,000; usually 300-m contour interval; some spot heights).

LCD = Arthur, D.W.G. "Lunar Crater Depths from Orbiter IV Long- Focus Photographs." *Icarus*, v. 23, pp. 116-133. 1974.

LTO = *Lunar Topographic Orthophotomap* (1:250,000; usually 100-m contour interval; some spot heights at 1-meter precision).

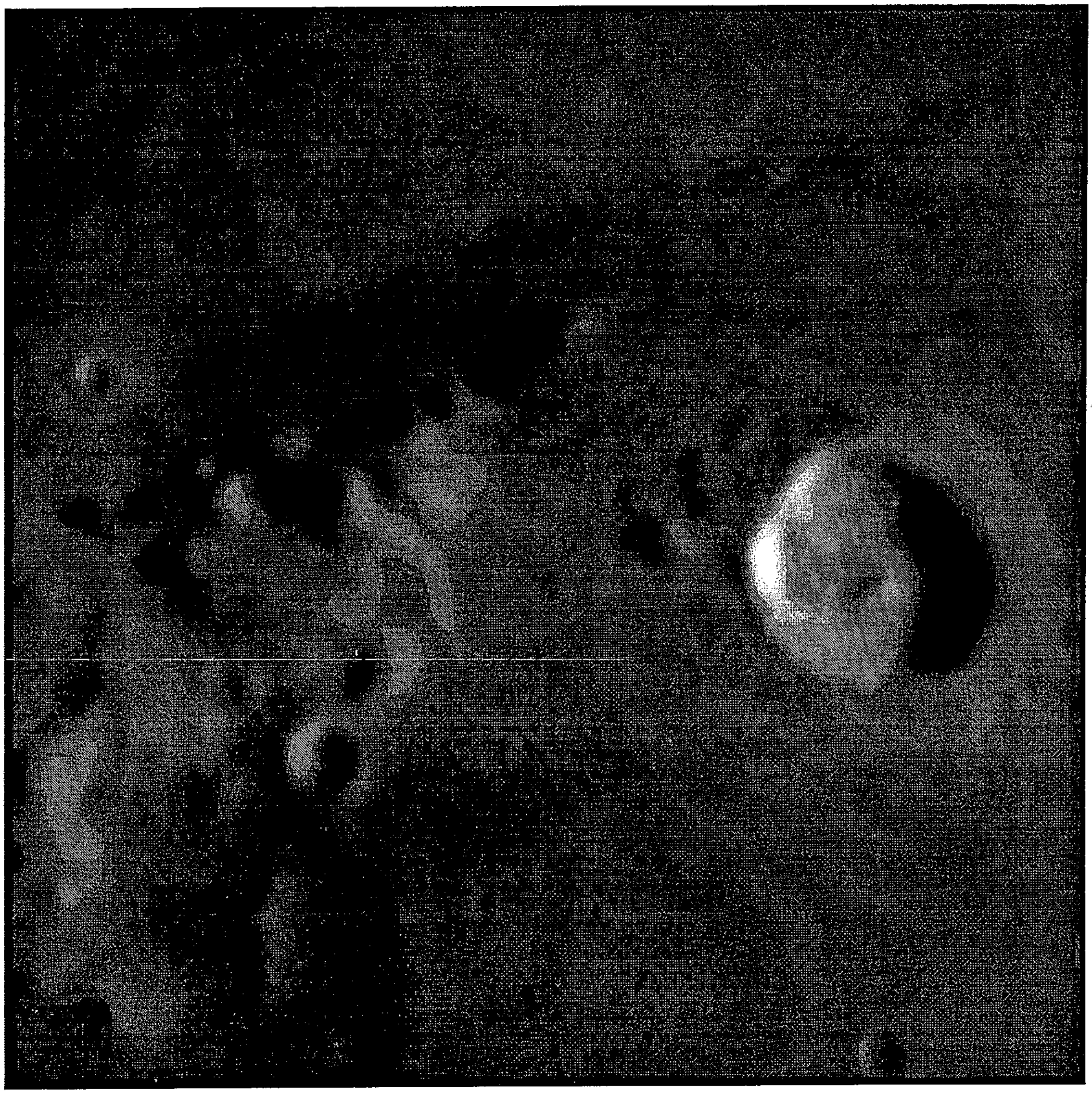
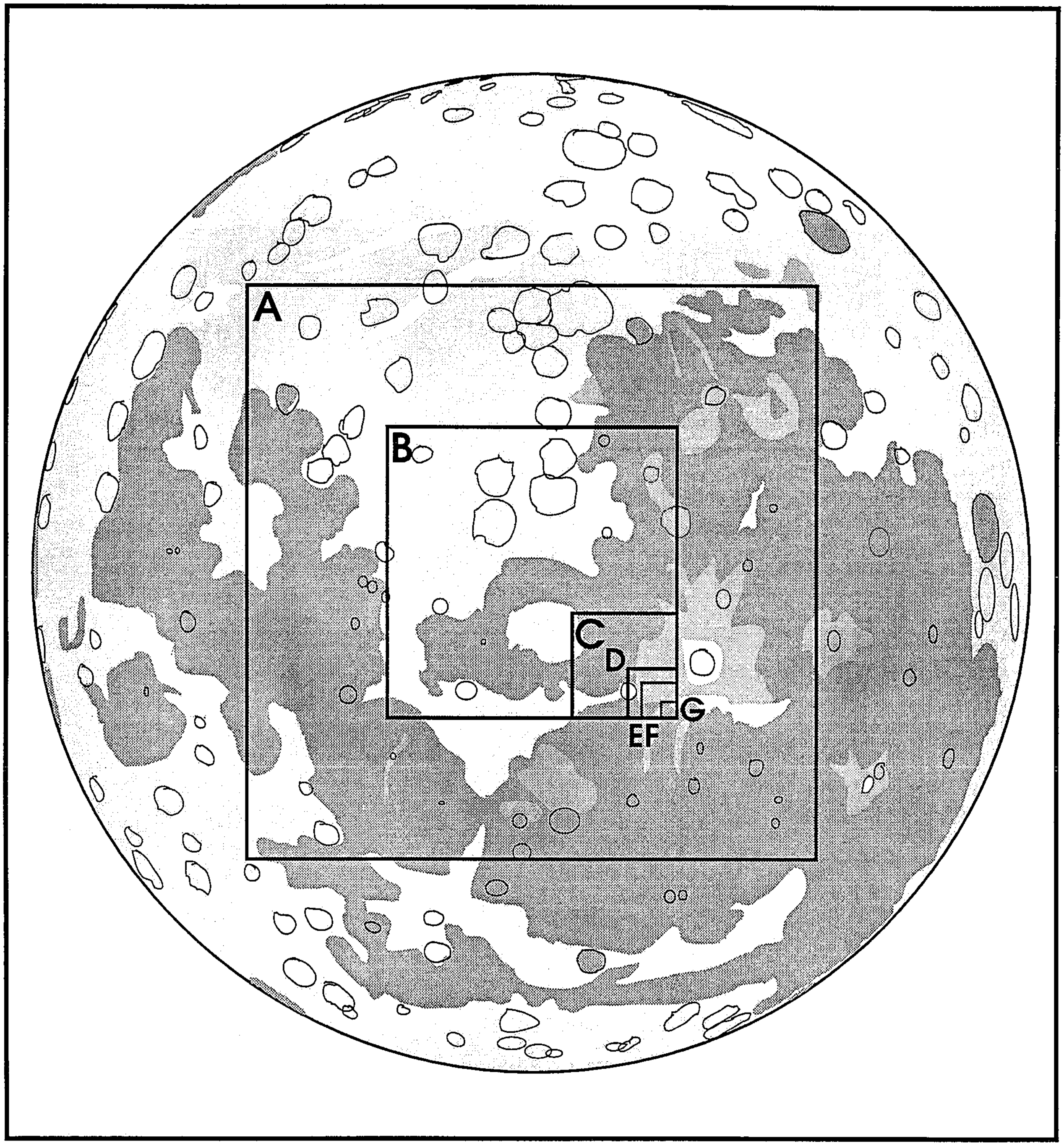


Figure 1.

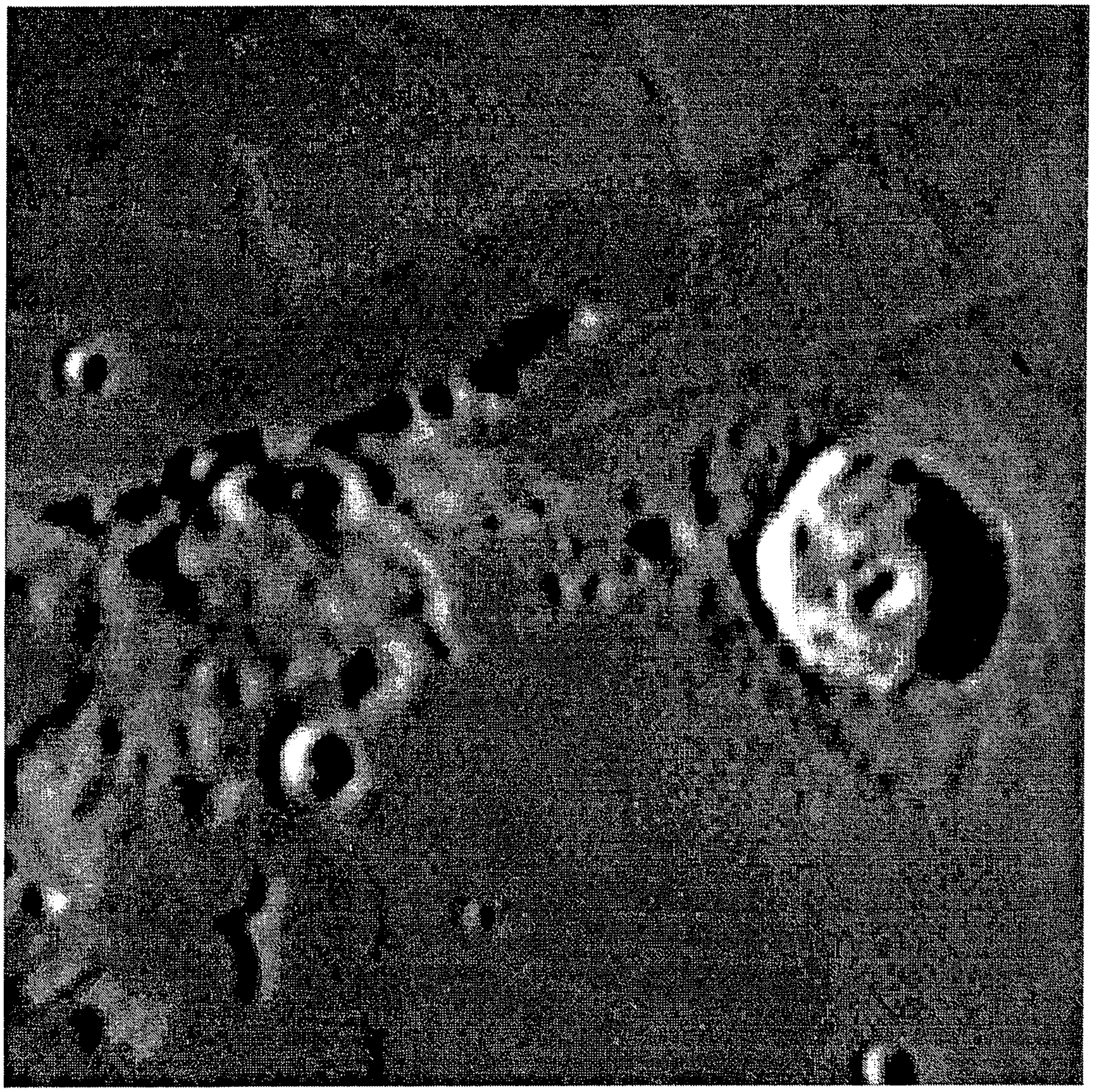
CCD Lunar Image Coverage

TC211 Sensor, 192 X 165 pixels, 2.64-mm square array size.



	Sample Telescope	Side Covered	Area Covered	Pixel Size
A	Comet-Catcher (f/3.64, 51-cm FL)	1994 X 1994 km	3,975,000 sq km	11.20 km
B	C-90 (f/10, 100-cm FL)	1014 X 1014 km	1,028,000 sq km	5.70 km
C	C-11 (f/10, 279-cm FL)	363 X 363 km	131,600 sq km	2.04 km
D	C-11 (f/21.4, 598-cm FL)	170 X 170 km	28,750 sq km	0.95 km
E	C-11 (f/29, 810-cm FL)	125 X 125 km	15,650 sq km	0.70 km
F	51-cm Refr. (f/16.8, 853-cm FL)	119 X 199 km	14,110 sq km	0.67 km
G	51-cm Refr. (f/36, 1826-cm FL)	55.5 X 55.5 km	3,081 sq km	0.25 km

Figure 2.



PLINIUS & VICINITY.
1993 DEC 20, 02h16m UT. 28-cm Sch.-Cass., f/21,
0.20 sec. No filter. North at top. Colong. 347°.27, Solar
Lat. = +0°.69. Topocentric Librations = 3°.09 E/ 5°.76 S.

Figure 3.

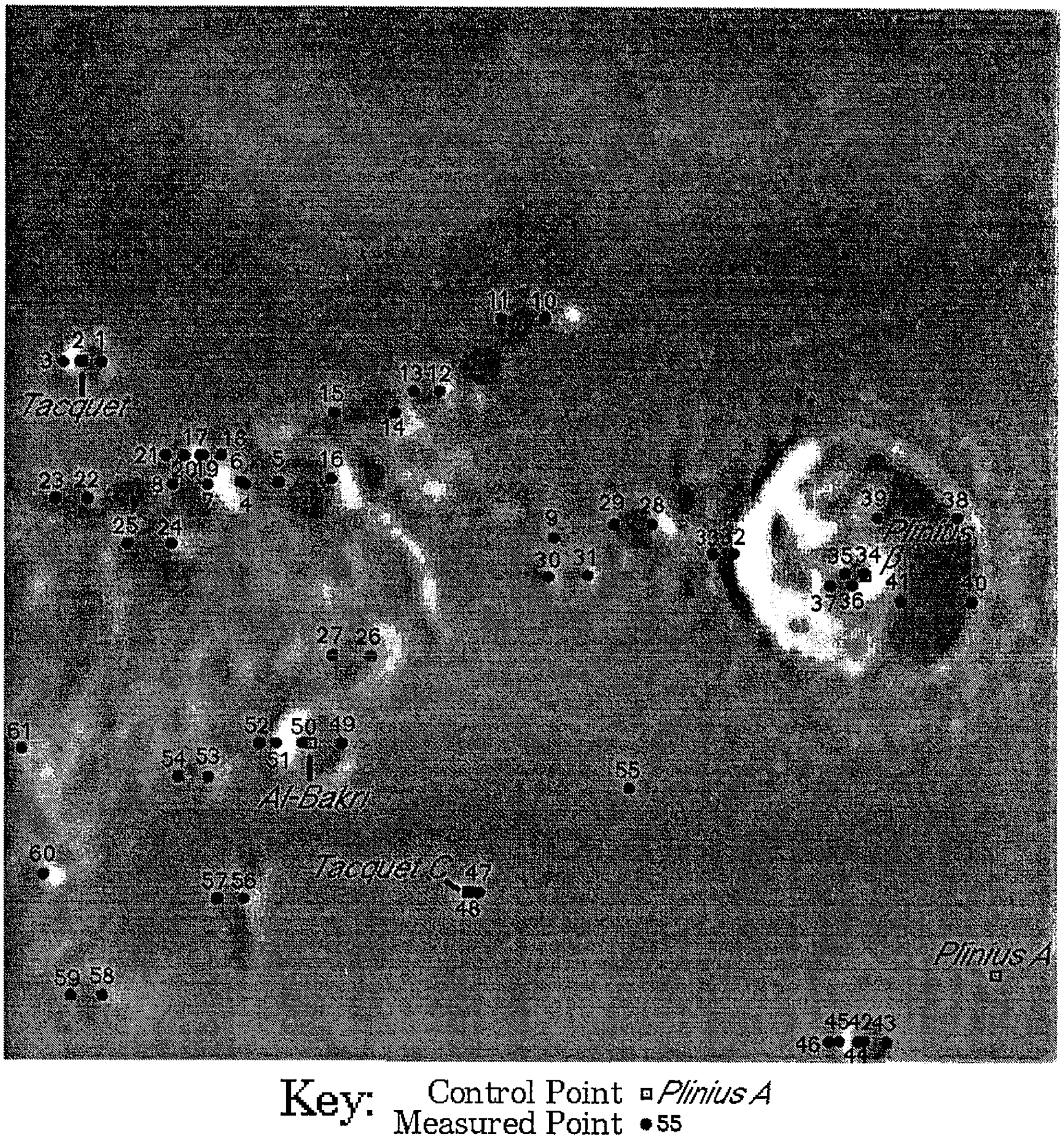
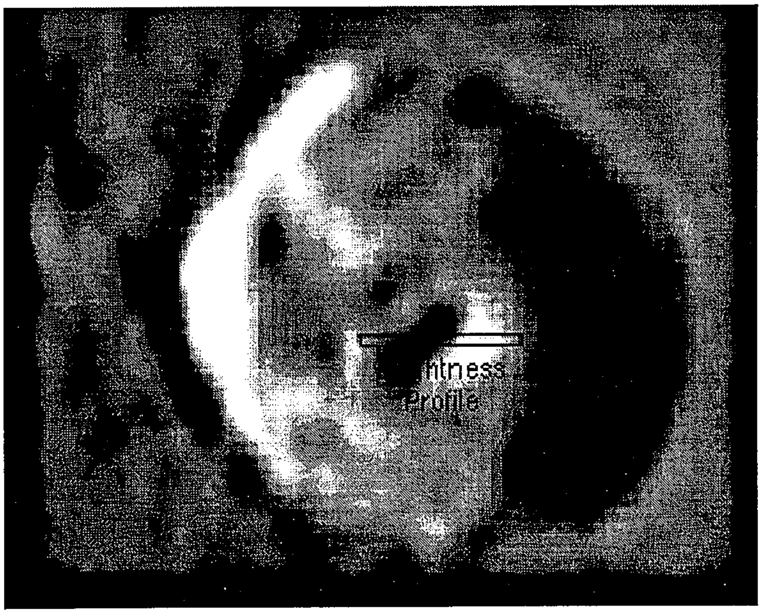

Tacquet
Al-Bakri
Tacquet C
Plinius
Plinius A
Key: Control Point □ Plinius A
Measured Point ● 55

Figure 4.

Raw Image (Calibrated)



Unsharp Masking

Figure 5.

East-West Image Density Profiles Across Central Peak of Plinius

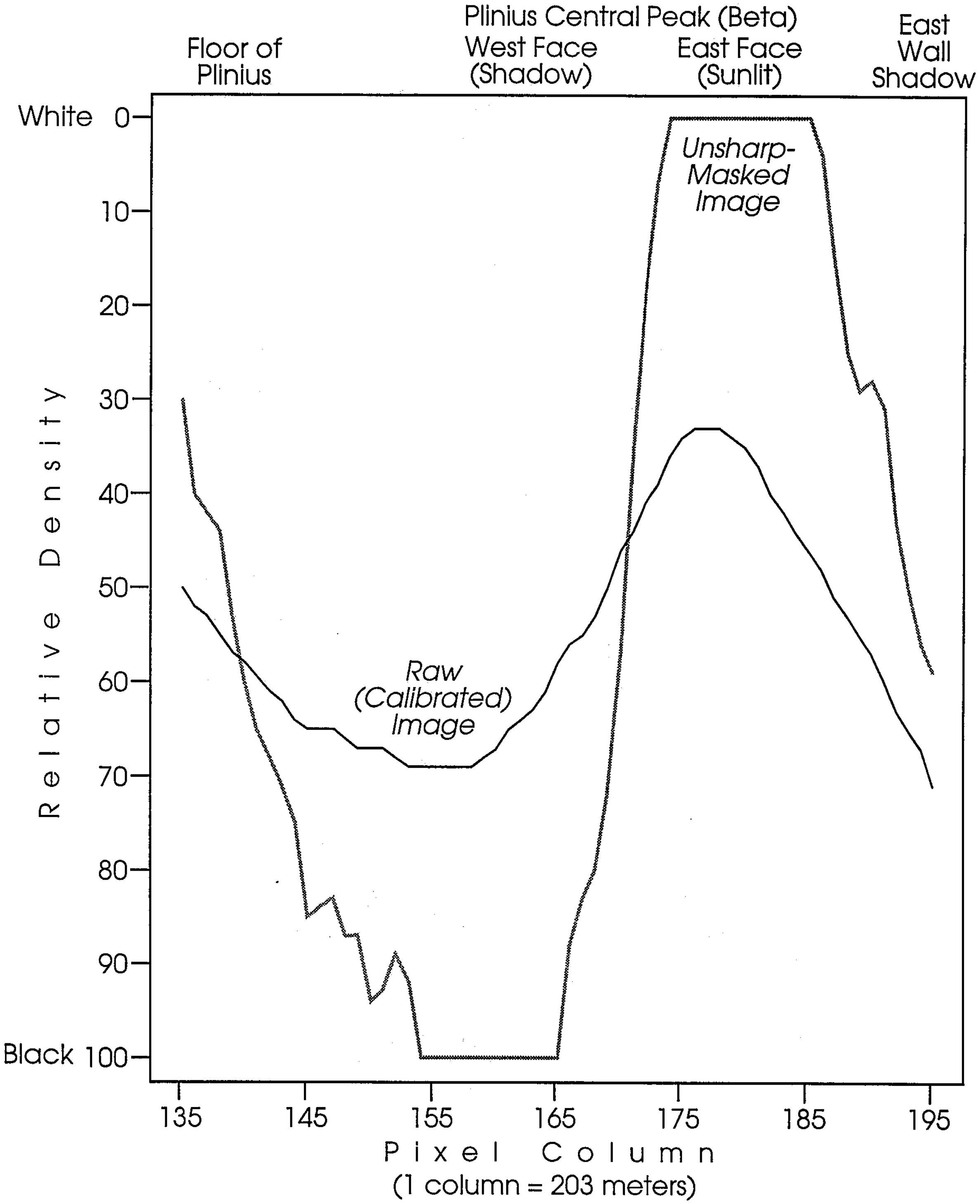


Figure 6.

AN A.L.P.O. OF THE PAST.

Joseph Zurlinden

(Abstract)

Throughout the southwestern region of the United States there exist a number of archaeological sites which were inhabited by Native Americans. Some of these sites included structures which formed alignments with the Sun and/or Moon on certain days of the year associated with rituals or other activities important to the people occupying these regions. Recently, a known site close to Las Cruces, New Mexico, has been discovered to possibly have a similar function. The author's investigation of this site is the subject of this paper.