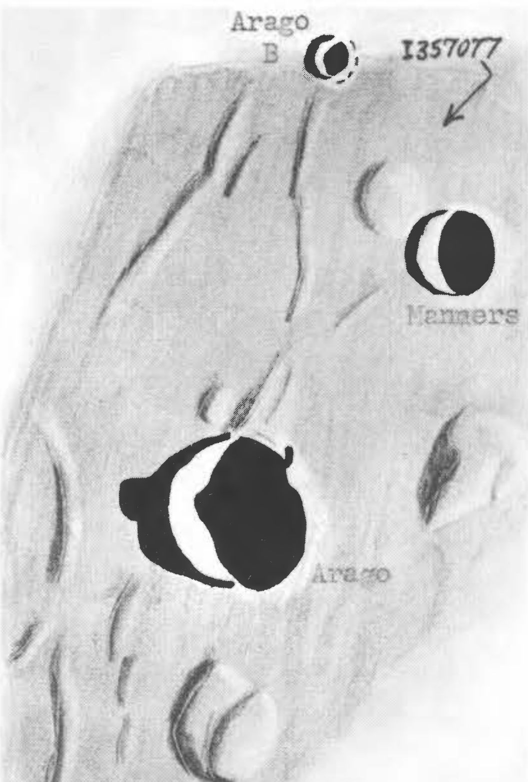
See also pg. 187


# The Strolling Astronomer

The Journal Of The Association Of Lunar And Planetary Observers

**Volume 18, Numbers 9-10** — **September-October, 1964**
**Published May, 1965**


Drawing showing three lunar domes in Arago-Manners region. Made by John E. Westfall on October 26, 1964 at 5 hrs., 30 mins. - 5 hrs., 55 mins., Universal Time. 4-inch refractor, 180X, 220X, and 500X. Seeing 4, transparency 4 on usual scales. Colongitude 155.2 degrees. Lunar south at top, lunar west (IAU sense) to right. Note the irregular shapes and complex summits of the two large domes north and west of Arago. The very low dome bordering Manners requires more study, especially with large apertures. See also pages 179 - 182 of this issue.


**THE STROLLING ASTRONOMER**
Box AZ
University Park, New Mexico
88070
Residence telephone 524-2786 (Area Code 505)
in Las Cruces, New Mexico

ASSOCIATION OF LUNAR & PLANETARY OBSERVERS
ALPO
Founded In 1947

**IN THIS ISSUE**

# MARS - IS IT HABITABLE FOR MAN?

By: Joel W. Goodman

As a professional biologist and an amateur astronomer, I have been deeply interested in the challenging possibilities of the existence of life--perhaps even intelligent forms of life--elsewhere in the universe. There are even now highly imaginative attempts to search for structured radio signals which might in reality be messages from civilizations far beyond our Solar System.

In this context, the planet Mars has long inflamed the mind of man. From the description of "canali" in 1877 by Schiaparelli, which word in English carries a connotation of artificial waterworks he probably never intended, through the involved hypotheses of Percival Lowell, down to the present day, we have never entirely abandoned the idea that Mars may be inhabited by intelligent beings. This despite the weight of accumulated evidence to the contrary. Now, with Mariner IV approaching Mars, the irrefutable answer may be near at hand.

There seems little doubt that astronauts will some day set foot on the planet. How will they fare in the Martian environment? Let us cast a critical eye first on the requirements of man---the factors that determine habitability, and then on the parameters of Mars, based upon our knowledge at this time, in order to evaluate how closely they satisfy the requirements for human sustenance. In this discussion we shall be concerned only with the natural conditions which prevail at the surface of the planet. There is little question that Man will some day be capable of transporting the materials with which he can establish an enclosed "artificial" environment suitable to his needs. This, however, has no direct bearing on the congeniality of the native Martian environment.

The basic requirements for the maintenance of human life can be considered within the provinces of temperature, light, gravity, water, and atmosphere. While other factors such as the mineral composition of the surface of the planet and the presence or absence of a magnetic field are by no means negligible, a liberal degree of variability in these will not seriously impair survival. The five elements designated above, on the other hand, are qualitatively and quantitatively much more critical.

Temperature. Essentially the entire world's population lives in regions where the mean annual temperature is between 0° C and 30° C. This distribution is principally due to the dependence of important food crops and the propagation of herbaceous and woody plants upon temperatures between 10° C and 30° C. There are numerous instances of organisms which can tolerate higher or lower temperatures. Some algae live in water at 85° C; and ducks have survived for 16 days at -40° C, though not in a reproductive or even physically active state. However, neither Man nor his crops are quite so adaptable. As tolerable extremes, mean daily temperatures of -10° C and 40° C at the coldest and hottest seasons, respectively, appear reasonable.

Light. A certain minimum level of radiation in the region of the electromagnetic spectrum between 380 mu and 760 mu must be indigenous to the surface of the planet. This is the domain of photobiology which encompasses the vision of all terrestrial animals, the bending of plants toward light, and all known photosynthetic processes by which plants and certain bacteria transform radiant energy into chemical energy. The upper and lower limits are dictated by the threshold required for photosynthesis and by inhibition of plant growth by excessive amounts of light, an effect called "solarization".

Maximum illumination at the surface of the Earth is about 15 lumens/cm$^2$. Humans can see well enough to avoid obstacles at an illuminance as low as $10^{-9}$ lumens/cm$^2$, and they can tolerate with some discomfort about 50 lumens/cm$^2$. However, green plants require at least 0.02 lumens/cm$^2$, and their growth is retarded above about 30 lumens/cm$^2$. The latter values, then, comprise the practical limits. The importance of green plants, it should be stressed, is not merely as a source of food and energy but more importantly as a source of oxygen, the necessity for which will be emphasized later. The photosynthetic generation of oxygen probably accounts for the entire quantity of this gas in our atmosphere, and the vegetation now on the Earth could produce this quantity in a matter of several thousand years.

Water. Man and his entire ecology are utterly dependent on water. Living things are, in point of fact, more water than anything else; and the absence of water vapor would cause rapid desication and concomitant death. Furthermore, a habitable planet must possess large open bodies of liquid water, for without seas there can be no precipitation and hence no supply of fresh water. While complete inundation of a planet's surface would obviate the survival of terrestrial life forms no other restrictions can be applied.

Atmosphere. The atmospheric requirements of Man can be completely specified in terms of component gases and their partial pressures. As far as we know, the only essential ingredients of a breathable atmosphere are oxygen and minor amounts of water vapor. Nitrogen and carbon dioxide, while not directly essential for respiration, are needed for photosynthesis and for the synthesis of organic compounds.

The minimum tolerable level of oxygen is an inspired partial pressure of about 60 millimeters of mercury. This represents the partial pressure of the gas in the lungs and corresponds to a total barometric pressure of 107 mm. Hg. since absorption and dilution occur enroute to the lungs. Below this total pressure bubbles form at body temperature, and gaseous swelling has been observed in Man and animals. A partial inspired pressure for oxygen of 60 mm. Hg. corresponds to an elevation of about 21,000 feet above sea level on the Earth. Men who venture above this altitude, such as the climbers of Mount Everest, must carry a source of oxygen with them.

There is also a maximum tolerable oxygen level, and this lies at a partial pressure of about 400 mm. Hg., almost three times the amount at sea level on the Earth. Higher partial pressures are toxic and may produce blindness as well as other dysfunctions. Degeneration of the retinas of infants maintained in incubators, a condition known as retrolentil fibroplasia, was found to be caused by excessive oxygen tensions.

There are only certain diluents that may be mixed with oxygen in a breathable atmosphere, and each has an upper limit of inspired partial pressure beyond which narcosis is produced. It would be tedious to enumerate all possible constituents; but carbon dioxide deserves special mention because it is both necessary, as stated previously, and highly dangerous. It has a strong affinity for hemoglobin, readily displacing oxygen which is normally transported from the lungs to other tissues by this protein pigment. The partial pressure of carbon dioxide at the Earth's surface is about 0.2 mm. Hg. While exact tolerable limits have not been determined with certainty, they may loosely be placed at 0.05 and 7.0 mm. Hg.

Gravity. Human beings can tolerate accelerations of up to approximately 5 g. in a sitting position for two minutes without special protection. For indefinite periods, however, the gravitational load should not exceed 1.5 g. Our frames have evolved in a 1.0 g. milieu and simply are not built to withstand pressures much in excess of this. On the other hand, there is no conclusive evidence that a certain level of gravity is required for normal physiologic function. In fact, it can be inferred on the basis of experimentation that physical activity in reduced gravitational fields requires less time and energy than in a field of 1.0 g.

Having considered the conditions that a planetary environment must fulfill in order to support human life, let us now proceed to an inspection of the environment of Mars. Mass and age are intrinsic parameters that largely shape the environment of a planet. In addition, there are positional characteristics including distance from the primary star, orbital eccentricity, inclination of the plane of the equator to that of the orbit, and relationships with other planets. Rate of rotation is an important outgrowth of these. While Mars is similar to the Earth with respect to several of these properties, the two planets differ widely with respect to most of them. The comparative statistics are shown in Table 1.

The ambient temperature at the surface of Mars is dictated largely by its distance from the Sun, which is some 50 per cent greater than that of the Earth. Despite this, radiometric measurements indicate temperatures of about 30° C for the equatorial maria, which are about 8° warmer than the adjacent desert areas. This figure refers to points for which the Sun is on the meridian when the planet is near perihelion. However, the diurnal temperature variation is very large because the tenuous Martian atmosphere permits a great deal of heat to radiate away at night. Measurements near the morning limb record temperatures some 50° to 60° cooler than at the meridian. Extrapolating this gradient back to the night side, which is, of course, not directly observable, we infer that temperatures may well plummet to -70° to -100° C after midnight even at equatorial latitudes. This, despite the fact that the period of rotation of Mars is almost identical with that of the Earth. It should also be remembered that the measured values refer to the surface temperature. The rarified atmosphere, which provides little conductivity, suggests that temperatures even a few feet above the surface must be considerably lower.

In addition, there is a very considerable seasonal variation in temperature due to the eccentricity of the planet's orbit. This fact is manifested by differences in size and sublimation rate of the two polar caps. The southern cap, which forms when Mars is near aphelion and vaporizes when it is near perihelion, becomes larger and diminishes more rapidly than does the northern cap.

While it is quite possible that robust organisms from the Earth, particularly those which are capable of forming spores, can survive during the frigid Martian nights and regenerate during sunlit hours, Man and his food crops would swiftly perish in such a rigorous environment.

Illumination and gravity on Mars would present no obstacles to visitors from Earth. The average illuminance at the surface is about 7 lumens/$cm^2$ and falls well within tolerable limits, being almost half the intensity at the Earth's surface. Similarly, the gravitational field on Mars is about 0.4 g. Physical labor would consume considerably less energy there than on the Earth.

The quantity of water on Mars is vanishingly small. While water vapor has now been detected by infrared spectrography using instruments borne by balloons above most of the Earth's atmosphere, it amounts to only a few microns of precipitable moisture. Vapor pressure in the arid Martian atmosphere is so low that the thin polar caps undoubtedly sublime rather than melt, and liquid water as such must be virtually unknown on the planet. Indeed, it has been estimated that all the water in the atmosphere and polar caps, if combined, might form a lake a few miles in breadth and 100 feet deep. Needless to say, this almost total absence of moisture would pose grave problems for visitors from the Earth.

The paucity of water on Mars is more than matched by a like dearth of atmosphere and, more importantly, of oxygen. The most recent estimates of total atmospheric pressure at the surface are of the order of 20 mm. Hg., a pressure that would be encountered approximately 18 miles above sea level on the Earth (more than three times the altitude of Mount Everest!). This Martian air, like our own, probably consists principally of nitrogen, which is spectroscopically inert in the optical window of our atmosphere and thus has not as yet been detected. Oxygen, on the other hand, has been sought by balloon-borne instruments without success. It seems likely that the partial pressure of this vital gas does not exceed 1.0 mm. Hg. or about 0.5 per cent of the amount in the Earth's atmosphere. The parallel absence of ozone means that the Sun's ultraviolet radiation would reach the surface of Mars almost unattenuated, providing still another hazard for earthlings.

Carbon dioxide is the only constituent of the Martian atmosphere which has been detected and measured from the surface of the Earth. It is probably about ten times more abundant there than it is here, but still remains below the maximum permissible level.

Table 2 summarizes human requirements and conditions on Mars as we best understand them. The consummate picture precludes the possibility of human survival. However, there seems little real doubt that Man will someday explore the surface of Mars, although protection against the hostile environment will be mandatory. While there appears to be little likelihood that he will find anything resembling the fanciful world depicted by Lowell, he may well discover peculiar forms of life adapted to Martian conditions. It is probable that Mars at one time possessed an extensive atmosphere which, due to the planet's relatively small mass and low velocity of escape, attenuated rather rapidly. Nature has endowed creatures on the Earth with an enormous facility for survival in a gradually evolving ecology through the process of mutation and natural selection. It may be that life originated in a more favorable climate on Mars and has managed to hang on tenaciously in the face of mounting adversity.

Note by Editor. We are greatly indebted to Dr. Goodman for a most entertaining and instructive account of a subject of extremely great current interest. The Mariner IV flyby past Mars in mid-July of 1965 may give us much increased insight into the problems here discussed. If the experiment is successful, it will certainly have a great effect on our concepts of the planet Mars. Readers who would like to pursue Dr. Goodman's subject further are invited to make use of the A.L.P.O. Library for this purpose.

TABLE 1. PHYSICAL DATA FOR THE EARTH AND MARS

| Property | Earth | Mars |
|---|---|---|
| Mass (⊕ = unit) | 1.0 | 0.1 |
| Age (years) | $5x10^9$? | $5x10^9$? |
| Mean Distance From Sun (A. U.) | 1.00 | 1.52 |
| Orbital Eccentricity | 0.017 | 0.093 |
| Inclination of Equator To Orbit | 23°.5 | 24°.0 |
| Period of Rotation | $23^h56^m$ | $24^h37^m$ |
| Period of Revolution (years) | 1.0 | 1.88 |
| Surface Gravity (g) | 1.0 | 0.4 |
| Velocity of Escape at Surface (miles/sec) | 7.0 | 3.1 |

TABLE 2. HUMAN ENVIRONMENTAL REQUIREMENTS AND MARTIAN CONDITIONS

| Environmental Parameters | Human Requirements | Martian Conditions |
|---|---|---|
| Temperature (°C) | | |
| Seasonal Mean High | 40 | -20* |
| Seasonal Mean Low | -10 | -70* |
| Illuminance (lumens/cm$^2$) | | 7 |
| Maximum | 30 | |
| Minimum | 0.02 | |
| Water | Plentiful | Extremely Scarce |
| Atmosphere (mm. Hg.) | | 20** |
| Minimum Total | 107 | |
| Oxygen Maximum | 400 | 1** |
| Oxygen Minimum | 107 | |
| Carbon Dioxide Maximum | 7 | 2** |
| Carbon Dioxide Minimum | 0.05 | |
| Gravity (g) | | 0.4 |
| Maximum | 1.5 | |
| Minimum | ? | |

*At equator; estimated on basis of extrapolated diurnal variation.
**These numbers represent the best current estimates.

# FIRST REPORT OF THE LUNAR TRAINING PROGRAM

By: Clark R. Chapman, L.T.P. Recorder

Visual observations of the moon and planets constitute the major portion of A.L.P.O. work. The arrival of the Space Age, however, has brought with it not only increased interest for amateurs in lunar and planetary observing but also some degree of pessimism about the scientific value of such observations. Within a few years there will be satellites orbiting about the moon, and the first Mars-orbiter is scheduled for 1971 (1973 at the latest). The first successful Ranger missions have already provided us with excellent detailed coverage of small regions on the moon that no earth-based observer can ever come close to rivaling. If successful, the Mariner flight to Mars now in progress will take photographs of a small strip on Mars with a resolution similar to Tiros photographs of the earth. Moreover, photographic work done recently at some professional observatories provides occasional pictures of the moon and planets considerably better than most amateur visual work.

There is no reason to despair, however. For several more years, earth-based observations of the moon and of Mars will be as valuable as ever. Even following the launching of the orbiters, a number of types of observation can be conducted as easily with backyard telescopes as with the orbiters (transitory lunar color phenomena, blue clearings on Mars, etc.). And it will be a long time before there will be artificial satellites around Jupiter and Saturn. There will be, however, a greater need than ever for <u>systematic</u> and <u>careful</u> visual observation. The improved photographic techniques and the organization of several photographic patrols of the planets have already put out-of-business the amateur observer who makes several careless random sketches of a planet during an apparition. But there is a great need for observers to maintain a watch for interesting features so that the photographers may be alerted. In addition, such systematic studies as daily observation of the Venus cusp caps, timing of central meridian transits on Jupiter and Saturn, and periodic color observations will be useful for many more years. The visual observer will still have for some time the advantage of brief moments of fine seeing when he can record carefully the fine detail which will elude the camera until more sophisticated balloon or satellite observations are made of the surfaces of the planets.

In training to become an experienced and reliable observer, there is no substitute for many hours spent at the telescope carefully studying the moon and the planets. In order to develop powers of observation, it is necessary to spend this time scrutinizing the detail as carefully as possible. One of the best ways to do this is to attempt to draw lunar features under telescopic observation. In the same way that a thought is not regarded as complete until it can be put into words, an observer is not trained until he can depict what he sees accurately with a pencil. Drawings of lunar craters may be compared with high resolution photographs such as those recently taken at Lick Observatory or with the recent Ranger probes. (Another method of training is to make simulated observations of high-resolution photographs of the moon or planets placed across the room, or placed at a yet greater distance and observed through a low-power telescope. This method enables one to compare his drawings with the originals.)

The Lunar Training Program of the A.L.P.O. is designed not only to train beginners to make reliable observations of the moon, but also to develop critical powers of observation valuable in other branches of observational astronomy and other sciences. As announced in the July-August, 1964 issue of this <u>Journal</u> on pg. 168 some instruction sheets have been prepared as well as several standard outline forms which will be sent to you upon request (with ten cents postage) to the author, whose address is listed on the inside back cover.

As an example of the rapid progress made by one talented beginner enrolled in the Lunar Training Program, attention is called to the four sketches by Mr. Alan Kiplinger of the crater Cassini (Figure 1). These are several of a series of Mr. Kiplinger's first lunar drawings. Although not perfect, the drawings approach the care and artistic quality of the drawings of the best lunar artists. They are a fine example of what patience and devotion to accuracy of details can produce. Although the drawings of Mr. Kiplinger are already better than all but the best sketches submitted to the Lunar Section, they do exhibit one minor flaw: there is a slight tendency for the hills and small mountain peaks to be shown somewhat smaller in proportion to the rest of the crater than they really are. For instance, the two hills between craters A and B (the largest craters within Cassini) are shown considerably smaller on most of Mr. Kiplinger's sketches than the outlines of the hills on the standard outline form (which was traced from an excellent photograph).

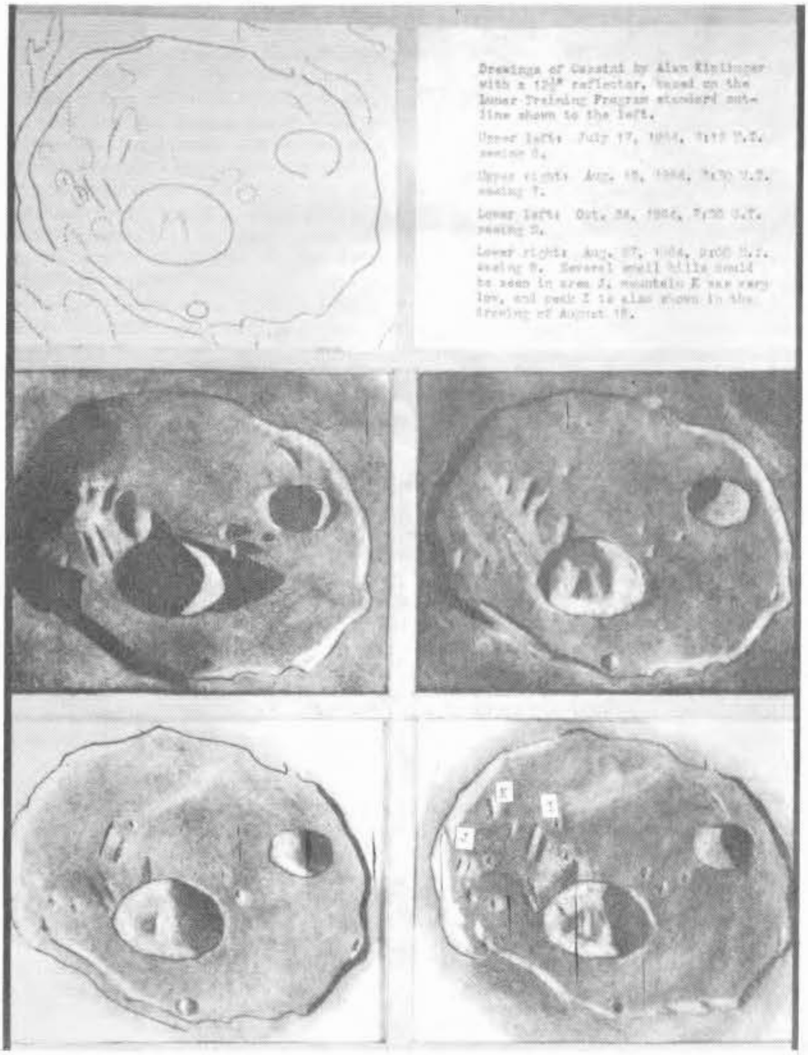



FIGURE 1. Outstanding sample lunar drawings by a contributor to the Lunar Training Program. See also text.

This is a common error which can be corrected rather easily. One of the author's major duties as Lunar Training Program Recorder is to look over sample drawings made by trainees and to comment on some of the difficulties of which the observer may be unaware. It is the author's hope that this article, along with Mr. Kiplinger's fine example, will point out the continuing value of visual observations and the need for careful training such as is carried out in the Lunar Training Program.

Note by Editor. We would like to express our full agreement with the general point of view developed in Mr. Chapman's article. Many appear to wish to question the value of continued amateur lunar and planetary observations. While casual work of mediocre quality must be worth even less than in the past, we suspect that the trained and persevering amateur observer will remain very needed in properly selected projects. It is well to remember that the German amateur Schwabe discovered the periodicity of sunspots when all professional astronomers knew them to occur with complete randomness.

## THE JOINT A.L.P.O. - B.A.A. LUNAR DOME PROJECT

By: Harry D. Jamieson, A.L.P.O. Lunar Recorder
and W. L. Rae, Editor, B.A.A. Lunar Section

Just over a year ago, it was agreed between the A.L.P.O. Lunar Dome Section and the B.A.A. Lunar Section that both bodies co-operate in an intensive study of lunar domes, their distribution, form, and nature. Both Sections had for some time been studying these difficult objects independently, and it was felt that much more might be achieved if a co-operative project was arranged. The aim of the project was to produce as a first result a joint catalogue of domes to be published both in Britian and America. Details of the inauguration of the scheme were reported in The Moon, journal of the B.A.A. Lunar Sect.[1,2]

The stage has now been reached when a First Edition of the Joint Catalogue can be produced, and the Catalogue containing 113 domes follows this introduction. A strict control was maintained on the inclusion of objects in the Catalogue, and objects found a place only if they satisfied the following requirements:

1. No doubt existed as to whether the object was a dome within the limits of instruments and photographs available.

2. Agreement was reached on the most accurate position of the object. This presented many difficulties because many dome observations showed a wide variation of position.

3. The object had to be confirmed as a dome by several observers before final acceptance, and preferably confirmation was accompanied by incontrovertible photographic evidence.

It is felt that even with such controls, some of the objects included as domes may not be in fact true domes; and also, with the ill-defined boundaries of domes, some of the positions may not be completely accurate. However, the collaborators feel reasonably happy about the majority of objects in the Catalogue. The intention of both Sections is to continue this project and to increase the number of included domes. To this end, observers throughout both Associations are requested to observe domes, dome areas, and suspected domes whenever possible and to submit their observations.

Observations of domes appear in many places, particularly in issues of J.B.A.A., The Strolling Astronomer, and the B.A.A. Lunar Section publication, The Moon. Objects have been considered for inclusion from such observations, and credit is given to the following observers and sources:

### A.L.P.O. Contributors

| | |
|---|---|
| Capen, C. F. | 24" Refr., 16" Refl. |
| Delano, K. J. | 12.5" Refl., 8" Refl. |
| Jamieson, H. D. | 10" Refl. |
| McIntosh, P. S. | A.C.I.C. Charts |
| Olivarez, J. | 17" Refl., 8" Refl., 2.4" Refr. |
| Ricker, C. L. | 8" Refl. |
| Schneller, K. | 8" Refl. |
| Westfall, J. E. | 4" Refr. |

### B.A.A. Contributors

Abineri, K. W.
Barnes, C. G.
Bestwick, J. D.

Chalmers, J.
Cooke, S. R. B.
Doherty, B. T.

Ellis, R. E.
Elger, T. G.
Ford, A.
Heath, A. W.
Herring, A. K.
Howie, F. G.
Lamech, F.

Marsh, J. C.
Moore, P. M.
Pither, C. M.

Rae, W. L.
Warner, B.
Weekes, J. H.

A few notes on the Catalogue itself may be in order. The designation given each dome is in actuality its position in Xi and Eta coordinates, Xi first. For instance:

Dome JC + 777-318 lies at Xi: + .777, Eta: -.318

Dome JC + 745+265 lies at Xi: + .745, Eta: +.265

For those observers who have no chart with Xi and Eta co-ordinates, but who do have one with lunar longitude and latitude, Xi and Eta may be converted into longitude and latitude by the following formulae:

Lunar latitude: sin lat. = Eta

Lunar longitude: sin long. = Xi sec lat.

Latitude and Eta are positive to the lunar north; longitude and Xi, to the I.A.U. east.

This First Edition of the Joint Catalogue takes the form of positions only. Subsequent editions will additionally include classified and written descriptions of the objects.

Joint Catalogue

| | | | |
|---|---|---|---|
| JC +777-318 | JC +061+068 | JC -343+582 | JC -486+219 |
| +745+265 | +004+041 | -362-556 | -492+235 |
| +615+126 | +002+088 | -362-871 | -496-062 |
| +613-344 | -001+080 | -365-561 | -497+218 |
| +609-381 | -019+730 | -366-453 | -502-071 |
| +608-376 | -057-047 | -370-563 | -502+227 |
| +603-380 | -060-056 | -375-554 | -503+245 |
| +593+131 | -061-051 | -378-560 | -506+439 |
| +568+244 | -066-057 | -385-555 | -508+200 |
| +536+183 | -067-050 | -427+053 | -510+175 |
| +534+288 | -077-060 | -431-197 | -510+220 |
| +524+187 | -078-054 | -435+042 | -510+229 |
| +519+186 | -108+317 | -438-102 | -514-206 |
| +510+200 | -121+675 | -449+132 | -566-131 |
| +430+280 | -138+447 | -450+207 | -523+183 |
| +424-462 | -155-347 | -455+136 | -523+441 |
| +363+130 | -156-353 | -458+130 | -523+484 |
| +358+149 | -212+049 | -458+137 | -528+220 |
| +353+155 | -232-467 | -462+132 | -528+247 |
| +349+161 | -247+013 | -466+124 | -530+200 |
| +339+107 | -250+021 | -47 +1 * | -532+166 |
| +325+733 | -257+030 | -472+125 | -536+136 |
| +269+300 | -301+019 | -474+242 | -611+451 |
| +255+304 | -301-233 | -476+238 | -620+452 |
| +183+348 | -343+574 | -478+242 | -622+446 |
| +153/160+510/1 | -343+580 | -483+157 | -630+155 |
| -643+651 | -717+345 | -884-326 | -885+046 |
| -888+055 | -895+059 | -897+144 | -900+005 |
| -931-071 | | | |

References

1. The Moon, Journal of the B.A.A. Lunar Section, 12, 2, page 22.

2. ibid, 12, 3, pages 41-2.

Note by Editor. It is intended that this paper should be only the first of a series upon lunar domes in a cooperative study with our friends of the British Astronomical Association. We want to know more than just the positions of domes; diameters, heights, slopes, and surface details also need to be studied. A.L.P.O. members are invited to join in this effort - indeed, it is a bit absurd that so far only about 1% of our members have participated. Occasional or haphazard work will again be of very limited worth, but equipped members wanting a stimulating lunar project are invited to write to Lunar Recorder Jamieson. Domes are chiefly observed under very low solar lighting, both morning and evening.

* Several small confirmed domes south of Hortensius with their placement uncertain.

Figure 2. A "Valentine Dome" in the eastern part of Mare Serenitatis near Xi = +.160, Eta = +.510. Drawn by John E. Westfall on October 27, 1964, $6^h50^m$-$7^h10^m$, U.T. 4-inch refr., 180X, 220X, 300X. Seeing 6, transparency 4. All drawings published on pages 181 & 182 were selected and submitted by Harry D. Jamieson. All show lunar south at the top and lunar west (I.A.U. sense) at the right. Colongitude of this drawing 168°0.

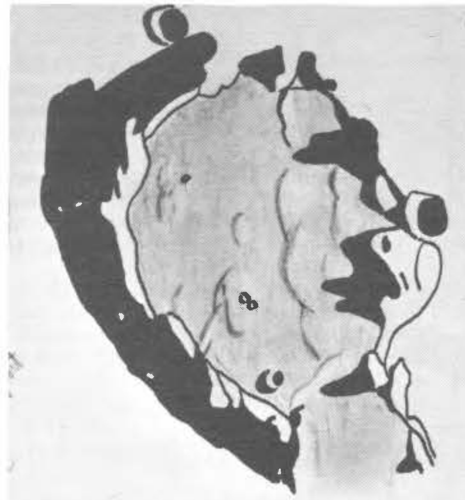


Figure 3. Lunar domes within the crater Flammarion. Drawn by John E. Westfall on October 28, 1964 at $10^h0^m$-$10^h16^m$, U.T. 4-inch refr. 180X-330X. Seeing 6, transparency 3. Colongitude 181°8. All domes low, oval, and smooth. Seven of the domes shown are in the B.A.A.-A.L.P.O. Joint Catalogue.

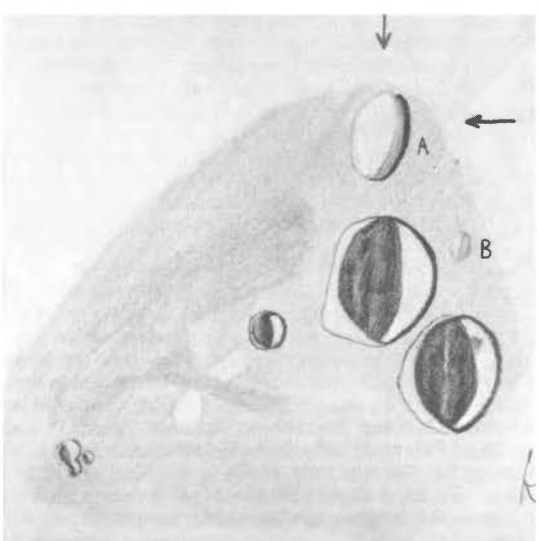



Figure 4. Two domes near the craters Beer and Feuilée. Drawing by Harry D. Jamieson on April 14, 1962 at $1^h41^m$-$2^h1^m$, U.T. 10-inch refl., 270X-330X. Seeing 4-5, transparency 3-2. Colongitude 21°2. Dome A is the Joint Catalogue dome -137 +447 and is about 70-80 meters high. Dome B is the unconfirmed dome -147+451, of small size and low height (note the gray shadow). The positional designations are explained in the text.

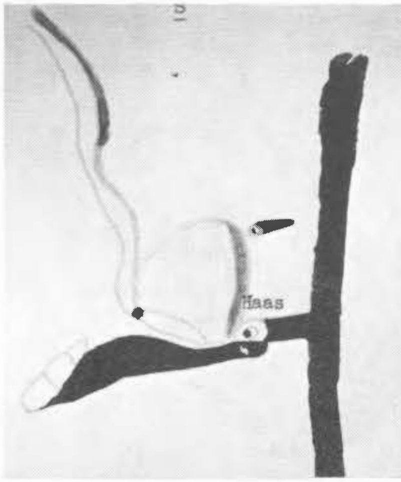



Figure 5. Swelling south of crater Haas, suggested by Wilkins. Drawn by José Olivarez with an 8-inch reflector at 180X. March 22, 1964, $3^h20^m$, U.T. Seeing 7, transparency 4. Colongitude 13°0. Note how the ridge crosses the northern and eastern (I.A.U.) edges of the dome, which cast a lighter shadow than did the wider portion of the ridge shown.

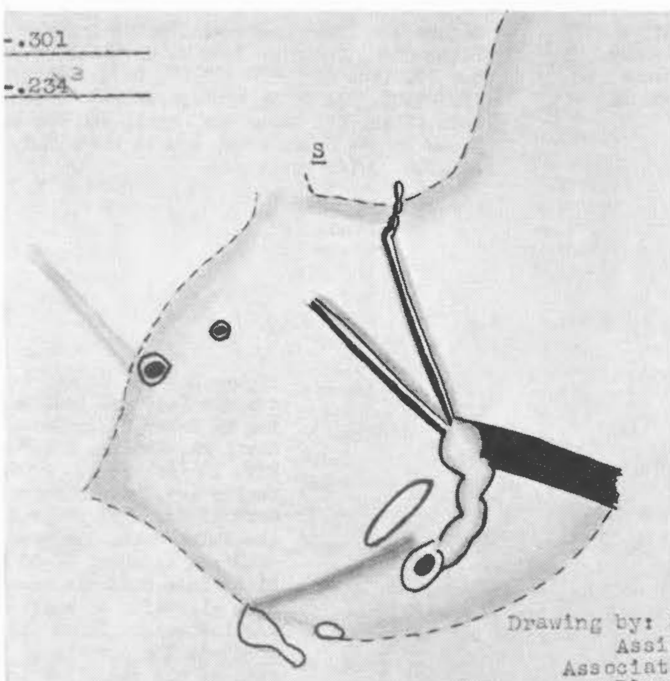



Figure 6. Joint Catalogue Dome -301-233, near Guericke. Drawing by José Olivarez on December 25, 1963 at $0^h30^m$, U.T. 8-inch refl., 180X. Seeing 5, transparency 5. Colongitude 21°0. This dome has a diameter of 57 kms. It is a fine example of a class of "special" large domes. Note the peaks, clefts, and craterlets over the dome's surface.

## OPERATION "MOON-BLINK"

By: John J. Gilheany,
TRIDENT ENGINEERING ASSOCIATES, INC. and UNITED STATES NAVAL ACADEMY

(Revision of a paper read at the Twelfth A.L.P.O. Convention at Denver, Colorado, August 28-31, 1964.)

A number of observations of lunar "volcanic" activity have been reported over the last 100 years. Until about 10 years ago, however, the evidence for such activity on the moon has not been conclusive. Yet one cannot completely dismiss the observations of such able nineteenth century astronomers as Lohrmann, Maedler, Schmidt, Secchi, and Huggins.

On October 26, 1956, Dr. Dinsmore Alter was able to photograph, in the blue-violet portion of the electromagnetic spectrum, an obscuration of a portion of the floor of the crater Alphonsus. He attributed the obscuration or veiling to the presence of a localized atmosphere, i.e., outgassing from the floor of the crater. Inspired by the work of Alter, Dr. N. A. Kozyrev began a systematic spectrographic study of Alphonsus. On the night of November 3, 1958, Kozyrev obtained spectrographic evidence of a gaseous discharge from the summit of the central mountain in the crater Alphonsus. This observation is one of the most significant lunar observations ever made since it is conclusive evidence of activity of some type on the moon.

In October and November of 1963 James Greenacre and Edward Barr, at the Lowell Observatory, observed ephemeral color changes near the crater Aristarchus. These observations sparked the interest of amateur astronomers, and several have since then reported viewing similar phenomena.

The present extent of our knowledge of these transient lunar phenomena is meager, to say the least. We do not know the exact nature of these events, the composition of the gases released, the energies involved, etc. Yet knowledge of these things is vital to our national as well as scientific interests. Our nation is committed to landing an astronaut on the surface of the moon and returning him safely to earth by the end of this decade. These gaseous emissions might constitute a serious hazard. Within the red haze, intense bright spots with a significant lateral motion have been observed. The effects of these spots and of the gases themselves on man and materials must be investigated.

From a logistics standpoint, this phenomenon could be a significant help. Dr. A. A. Kalinyak of the Pulkovo Observatory has identified Kozyrev's spectrum as containing the Swan band of $C_2$. More recent work by Kozyrev in Aristarchus has indicated the presence of hydrogen. Therefore, the possibility exists that hydrogen, acetylene ($C_2H_2$), or some other potential fuel may exist on the moon. If the exact composition of this gas and the conditions under which it exists on the moon were known, then our scientists and engineers could begin developing equipment for extracting and processing the gas. Power and propellant engines could be developed which would use this gas as a fuel. A usable fuel supply on the moon would be invaluable in man's exploration of the moon and planets. The timetable for the exploration of our Solar System can be greatly influenced by the date on which this information is obtained.

For these reasons, the Office of Advanced Research and Technology of the National Aeronautics and Space Administration has initiated "Operation Moon-Blink". The purpose of this program is to determine the location, frequency, duration, and ultimately the nature of transient lunar phenomena. Trident Engineering Associates, Inc., of Annapolis, Maryland has developed equipment and techniques which will increase the probability of detecting these ephemeral color changes on the moon. The approach utilizes a color blink technique. The telescopic image is intercepted by a rotating filter wheel which contains two filters, one in the red and one in the blue. The purpose of the alternating filters is successively to transmit and not to transmit a particular band of color in the image. The image is then allowed to fall on the surface of some electro-optical device such as an image converter or intensifier tube, or an orthicon tube, where it can be viewed. The intensity of the light passing through the alternating filters must be balanced so as to produce no substantial background flicker as the filters alternate. If, then, a portion of the lunar image being viewed begins to luminesce in the red (or blue), this portion of the image will blink in and out. The use of this technique will increase the probability of detecting subtle color changes in the lunar image.

The simplest model of the "Moon-Blink" detector, which utilizes an image converter

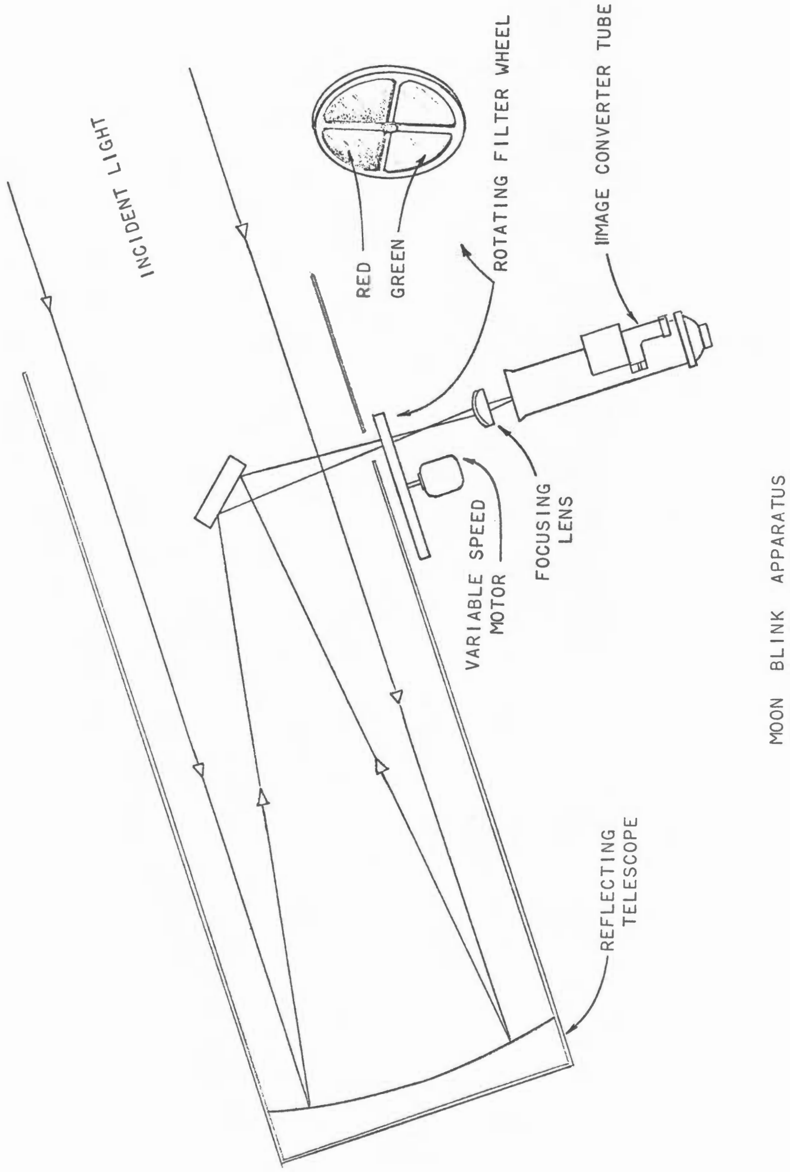



Figure 7. Diagram of "Moon-Blink" detector utilizing image converter tube. Detector designed and built by Trident Engineering Associates, Inc. See also text of article by John Gilheany in this issue.

---

tube, is shown in Figure 7. To date, the RCA 6914 and C-73428G image tubes have been used in the laboratory, as well as with the fine 16-inch telescope owned and built by Mr. Lyle

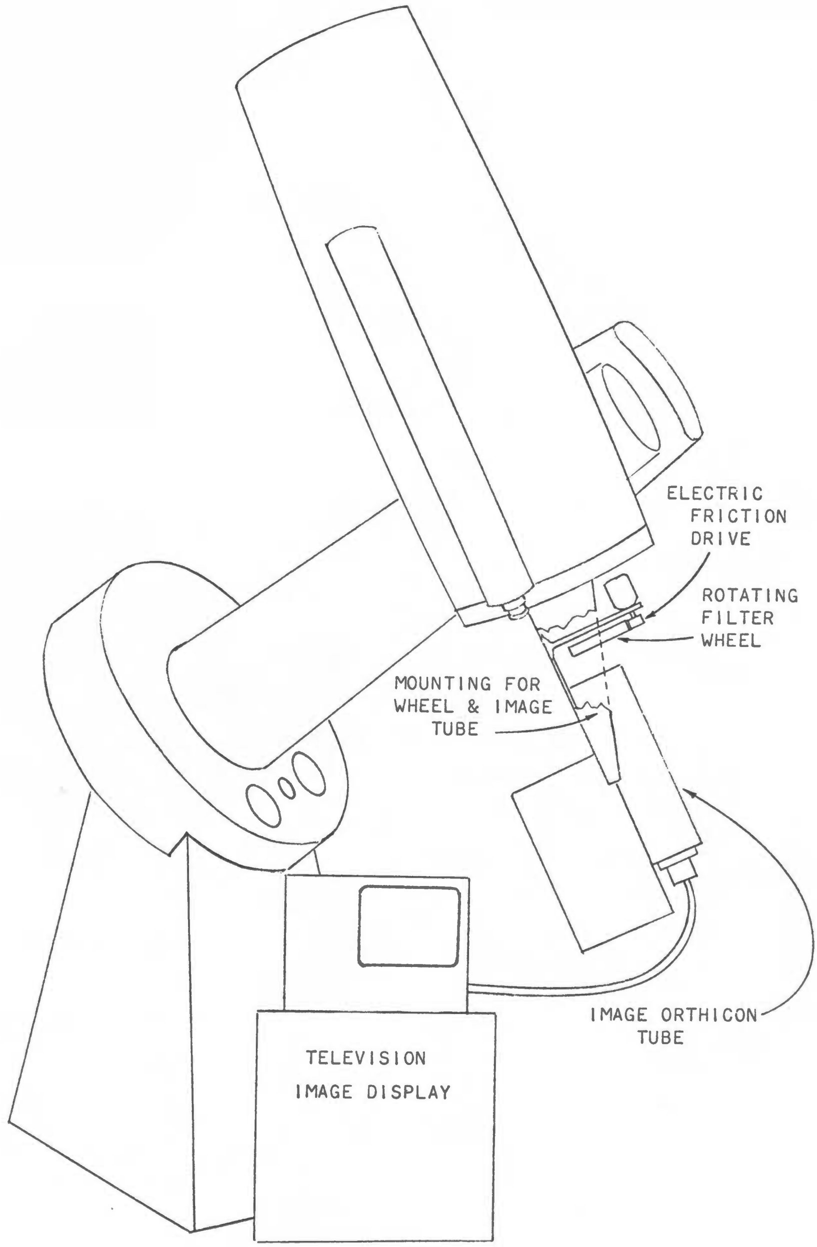



Figure 8. More advanced model of "Moon-Blink" detector employing an orthicon tube. See also text.

---

T. Johnson of Port Tobacco, Maryland. The tubes utilized were made available by the Engineering Research and Development Laboratory, Fort Belvoir, Virginia, and the Lancaster Tube Division of the Radio Corporation of America. The basic difference between these

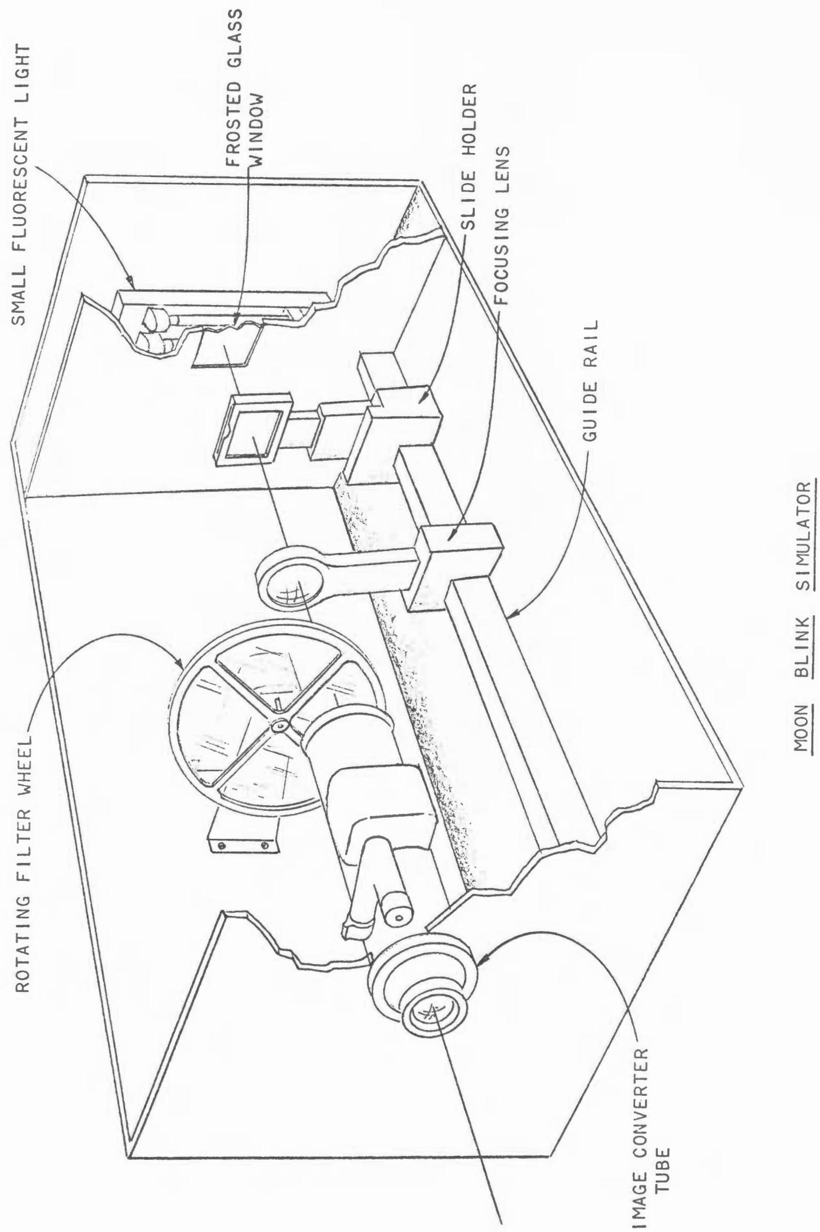



Figure 9. "Moon-Blink" simulator built to demonstrate color blink technique. Description in text of Mr. Gilheany's article.

---

tubes is in their electromagnetic spectral response, but both tubes have a resolution of better than 50 line pairs per mm. Since the imaging quality of the tubes is so excellent, amatuers using this equipment on their telescopes can, in many cases, continue their normal viewing program.

A more sophisticated model of the "Moon-Blink" detector will utilize an orthicon tube rather than an image converter tube. A sketch of this equipment is shown in Figure 8. The main advantages of the orthicon tube are that the contrast can be varied and that very brief exposures are possible.

On June 5, 1964, color blink equipment was mounted on the 16-inch reflector of the Optical Research Facility at Goddard Space Flight Center. A successful blink was observed when the 'scope was trained on a distant red light. Overcast prohibited observation of the moon on the morning of June 6, when Gilbert Schmidling and his group in New York reported an observation of a red glow near Aristarchus.

A 24-inch reflector with an image orthicon system is presently being installed west of Las Cruces, New Mexico by the Dearborn Observatory, Northwestern University. This facility, which is under the direction of Dr. J. A. Hynek, was funded by NASA to carry out a patrol for detecting unusual lunar phenemena. They are considering a continuous three-color patrol using a rotating filter wheel. A similar capability is being developed with a 16-inch telescope at the Table Mountain Observatory of the Jet Propulsion Laboratory of the California Institute of Technology.

A "Moon-Blink" simulator has been fabricated for the purpose of demonstrating the color blink technique (see Figure 9). In the simulator, a 35 mm. slide of the lunar surface is illuminated by fluorescent lights. The image of this slide is then projected onto the face of an RCA C-73428G image converting tube. Before striking the face of the image tube, the image is intercepted by a rotating filter wheel. The filters in the filter wheel are Wratten No. 29 (red) and 44A (blue). Appropriate neutral density filters have been inserted to eliminate flicker as the filter wheel rotates. A minute trace of transparent red food dye has been deposited in the 35 mm. slide. It is virtually impossible to detect the red spot with the naked eye, yet the spot is readily observable with the "Moon-Blink" simulator.

By the end of 1964, "Moon-Blink" equipment was installed at the following places: Johnson Observatory, Port Tobacco, Maryland; Mount Sano Observatory, Rocket City Astronomical Association, Huntsville, Alabama; Rand Corporation, Santa Monica, California; Kansas City Astronomical Association, Kansas City, Missouri. In early 1965 installations will be made in Arizona and Colorado.

A "hot-line" telephone network is presently being established by Mrs. Winifred Cameron of Goddard Space Flight Center, Greenbelt, Maryland. This network, which is being sponsored by the Office of Manned Space Flight, will connect the East Coast "Moon-Blink" stations with most of the major East Coast observatories. The purpose of this network will be the rapid alerting of observatories (most of which are not actually involved in lunar work) to the occurrence of transient lunar color phenomena. It is hoped that available instruments can then be utilized to record and to determine the nature of these transient color phenomena.

## LUNAR TRANSIENT PHENOMENA: N.A.S.A. - A.L.P.O. COOPERATION

By: John E. Westfall, A.L.P.O. Lunar Recorder

The N.A.S.A. Goddard Space Flight Center has recently established an office to investigate lunar transient phenomena, headed by Winifred S. Cameron, who feels, along with the writer, that it would be to the mutual advantage of the A.L.P.O. and N.A.S.A. to cooperate in this investigation.

A lunar transient phenomenon is any temporary occurrence on the lunar surface, or any lunar change not explicable solely by changing libration or varying illumination. A.L.P.O. lunarians have often reported such phenomena, but the value of such reports has been reduced because they have not promptly been made known to all interested parties, or because data have been omitted.

The "Lunar Transient Phenomenon: A.L.P.O. Report Form" ("LTP FORM") accompanying this announcement has been designed for the prompt and complete reporting of any unusual lunar occurrence observed by an A.L.P.O. member. LTP Forms are available, on request to

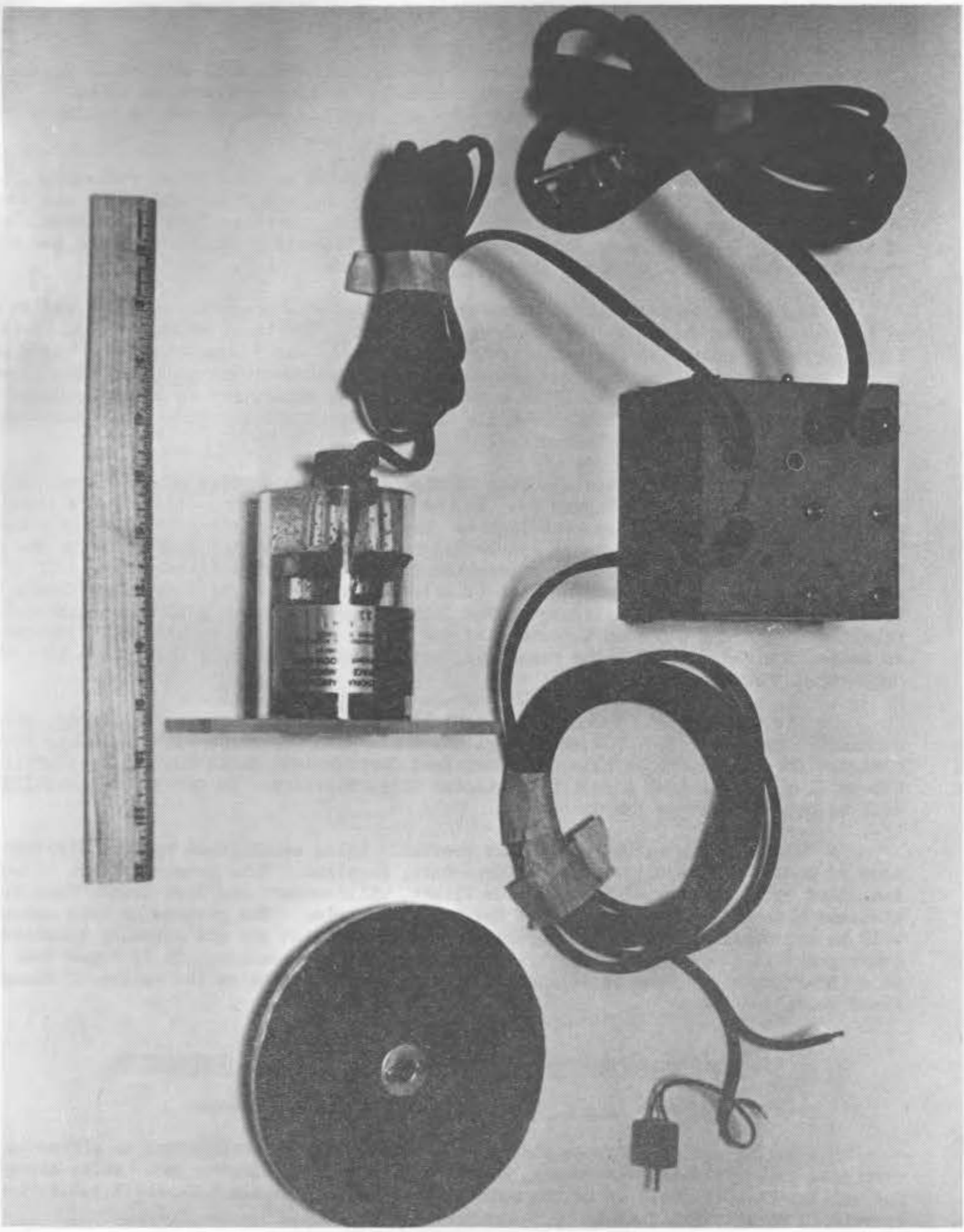


Figure 10. "Moon-Blink" detector components. Image tube mounted inside lucite cylinder, power supply, and filter wheel. Photograph contributed by Mr. John Gilheany.

---

the writer, to any interested A.L.P.O. member. It is suggested that all A.L.P.O. members who regularly observe the moon have a supply of these forms on hand at all times. If and when an unusual phenomenon is observed, the LTP Form should be immediately filled out and mailed to the writer, together with any pertinent notes, sketches, or photographs.

Anyone observing any unusual lunar phenomenon whould immediately attempt confirmation by notifying other observers. Any nearby observatories contacted should be furnished with the moon's declination and local hour angle.

Given adequate response from A.L.P.O. observers, the LTP Form should be of value to all parties concerned--the observer, the A.L.P.O., and NASA. Observations reported will be used by both the A.L.P.O. and N.A.S.A.

The report - form follows:

**LUNAR TRANSIENT PHENOMENON: A.L.P.O. REPORT FORM**

---

**Personal Data**

Name____________________ Address____________________ Site____________________

Lunar Observing Experience (Check One): under 1 yr____ 1-5 yrs______ over 5 yrs_______

---

**Observational Data**

U.T. Date___________ U.T. Time______________

Telescope: Aperture_____ Type_____ Magnif._____ Filters, etc.________________

Atmosphere: S (0-10)______ T (limiting visual magnitude)______ Wind________________

---

**Lunar Data**

Colongitude _______ Approximate Altitude of Moon ____________

---

**Confirmation of LTP Observation (Please Explain)**

At Your Site ________________________ Elsewhere ____________________________

________________________ ____________________________

---

**LTP Data**

Selenographic Position (IAU): latitude _____ longitude _____

Name of Formation, and position within or around: ____________________________

Duration of Phenomenon ______________

Brightness Variations ____________________________________________________

Shape Variations ________________________________________________________

Color Variations ________________________________________________________

Description (Continue on back or on attached sheets if necessary):

---

PLEASE ADD SKETCH OR SKETCHES ON BACK OR ON ATTACHED SHEET(S)

## THE VENUS PHASE ANOMALY

By: Alan Binder

During the eastern apparition of 1963-1964 I made an extended series of observations of Venus. One of the objectives of this series was to determine how the observed phase curve departed from the calculated curve. The observations began on October 6, 1963, 38 days after superior conjunction, and ended on June 16, 1964, 4 days before inferior conjunction. The computed value of $K^*$ on these two days was 0.985 and 0.024 respectively.

*Here K is the Ephemeris ratio of the illuminated part of the planet to the whole disc regarded as circular. Its value is near 1 at superior conjunction, near 0.5 at dichotomy, and near 0 at inferior conjunction.

On 141 days, or 62.7% of the days during the period of observations, observations were made with a 4.15-inch, F/22.5 Dall-Kirkham reflector. Brandon orthoscopic oculars were used to give 150X and 300X. The observations were usually made when the sun was above the horizon. A few observations were made during early twilight when the sky was still bright.

The observed value of K was determined from measurements of drawings of the planet and was computed to the second decimal place. The theoretical value of K was taken from The American Ephemeris and Nautical Almanac. The results are shown in Figure 11.

It has been my experience in this series of observations and in other series of Venus observations that the phase of the planet is underestimated (observed K less than geometrical K) for the first, second, and even third observation made after a long absence from the telescope. This effect is shown during the period from mid-December, 1963 to February, 1964. Poor weather limited the number of observations made during those dates, and most of the phase estimates were indeed less than the calculated phase. This type of error occurred several other times, though for less extended periods, throughout the apparition.

The causes for the deviations of the observed phase curve from the calculated phase curve appear to be as follows (Figure 11):

Region (1-2) The phase defect is so small that it escapes detection.

(2-3) A short period when the phase defect wavers between being detectable and not being detectable.

(3-4) The coincidence of the two phase curves in this interval is accidental. In any case, a discussion of this interval is deferred until the interval (4-5) has been discussed.

(4-5) When making the phase estimate here, one unconsciously compares the terminator to an imaginary circle, which is, of course, the invisible limb of the planet. This circumstance induces one to draw the terminator more nearly circular than it really is and results in an overestimate (observed K too large) of the phase.

(3-4) The effect described for the (4-5) interval also appears to occur in this interval. It is further possible that one tends to exaggerate the difference between the imaginary circle and the elliptical terminator when this difference is very small. These two effects may cancel, as is found in Figure 11; or one of these two effects will dominate, depending upon observer, telescope size, etc.

(5-6) Two independent effects operate in this region. When the theoretical value of K decreases to 0.75, one ceases to compare the terminator to the invisible limb circle and begins comparing the terminator to a straight line, the line connecting the cusps. This comparison induces one to draw the terminator straighter than it is and results in an underestimation of the phase. In addition to this psychological effect, a second and more pronounced effect occurs in this region of the curve. This second effect is the "real" Schroeter effect and is independent of the psychological effects noted in this paper.

(6-7) As above, from k= 0.75 on, one compares the terminator to a straight line; and this situation continues until k decreases to 0.25. Thus in this region, (6-7), the phase should be overestimated! However, the Schroeter effect is dominant and causes the observed phase to be less than the theoretical phase until point 7 is reached.

(7-8) In this interval one overestimates the phase because the terminator is compared to a straight line. Again, a second effect exaggerates this overestimation. Since the cusps are now very dim, they are easily lost from view; and as is shown in Figure 12, this effect also causes the observed phase to be overestimated.

(8-9) From k= 0.25 to k= 0.00 one compares the terminator to a circle, this time to the visible limb. This comparison results in the terminator's being drawn more nearly circular than it is and causes the phase to be underestimated. It is noted that the cross-over point (8) is not at k= 0.25, but at k= 0.17. This difference is due to the "dim cusp" effect that dominates in this interval.

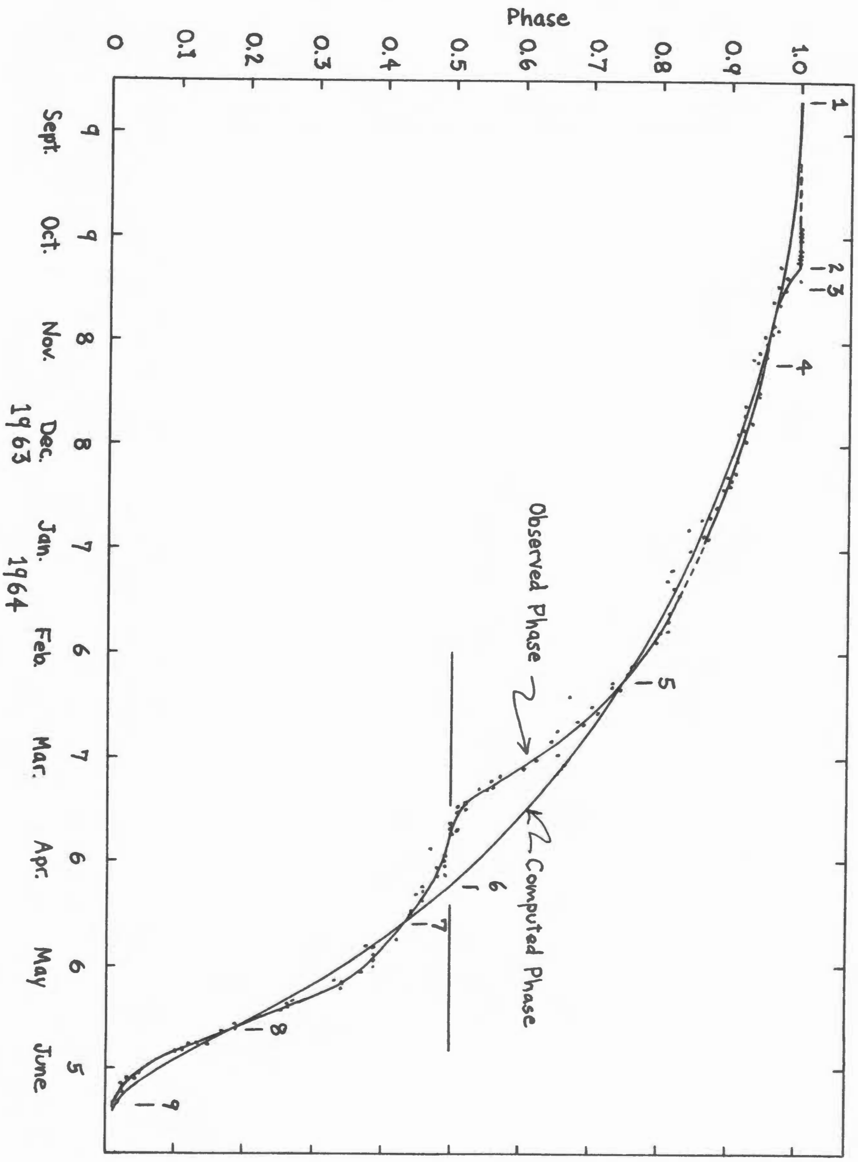



**Figure 11.** The observed phase of Venus compared to the computed (geometrical) phase in observations by Alan Binder during the evening apparition of 1963-64. Graph prepared and contributed by Mr. Alan Binder. The intervals between the numbers and an interpretation of the deviations between the curves are explained in Mr. Binder's accompanying article. Phase is measured by the quantity K, the illuminated percentage of the whole disc regarded as circular.

---

In conclusion, I believe that with the exception of the Schroeter effect, the observed deviations of the observed phase curve (observed K) from the calculated phase curve (geometrical K) of Venus are due to observational errors.

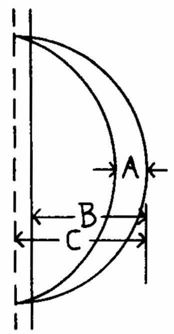



Figure 12. Diagram to explain why the phase of the narrow crescentic Venus is overestimated. The faint cusps disappear, and one fails to see their true extent. The result is a false semi-diameter B, less than the true semi-diameter C. One observes the ratio A/B instead of A/C and gets too large a value for K. Contributed by Alan Binder.

## SOME RECENT A.L.P.O. LUNAR PHOTOGRAPHS

It has been most gratifying to note considerably enhanced interest in lunar photography among A.L.P.O. members during the last few years. It has been even more gratifying to see results of definitely better quality than amateurs were usually able to achieve with comparable apertures in the past. It may accordingly be in order to present here some recent lunar photographs from our members which appear to us to possess unusual merit.

Figures 13 and 14 are samples of the work of Messrs. Thomas Osypowski and Thomas Pope in Milwaukee. Their procedure has already been briefly described on pp. 125-127 of our May-June, 1964 issue. Readers will remember in examining Figures 13 and 14 that the finest details on the original prints cannot be preserved in publication. During the Milwaukee Convention of the Astronomical League and the A.L.P.O. our colleagues Osypowski and Pope will present a paper describing their photographic procedures and showing slides of some of their best results.

Figure 15 on pg. 195 is a lunar photograph submitted by Mr. Kenneth Schneller, 17826 Hillgrove Road, Cleveland, Ohio 44119. Again we cannot hope to preserve in publication all detail on the print supplied by Mr. Schneller. Our colleague is anxious to share his interest in the techniques of lunar photography with our readers, and we accordingly quote portions of a letter from Mr. Schneller dated April 8, 1965:

"The enclosed is a one second exposure with normal development in Acufine. A 6 mm. Brandon eyepiece produced the large f-ratio while guiding was done accurately by adjusting the clock drive to the proper lunar rate with an amplifier oscillator. The camera shutter was carefully rouge polished and lubricated with a thin oil. The shutter was placed very near the eyepiece, between the film plane and the eyelens. Thus, there was no detectable shutter recoil. Shutter motion was almost instantaneous over the restricted field induced by the eyepiece. As a further prevention for vibration, the normal, short trigger cord for the camera was replaced with a long cord and an air bulb. As can be seen from the photograph, the above precautions proved helpful.

"Written beside Figure 15 are pertinent data for height measurements by the shadow-length method. The picture might possibly be useful for cartographic work. Best resolution is obtained for linear features. Note, for example, rilles at the following positions:

Xi -465, Eta + 255
Xi -438, Eta + 250
Xi -418, Eta + 225.

(Here Xi and Eta are the usual rectangular coordinates.)
A word of caution: Because the Brandon eyepiece is corrected for visual use, distortion over the field is not linear but polynomial. Thus, except for localized areas, positions cannot be measured with a linear scale."

If quantitative work requiring an exact knowledge of solar lighting is to be carried out on a lunar photograph, then it is imperative to record the time when the photograph is taken. If the time is known to the minute, the colongitude will be known to about 0.01 degrees; and the angular height of the sun can also be determined to about 0.01 degrees as far as the effect of errors in recorded times is concerned.

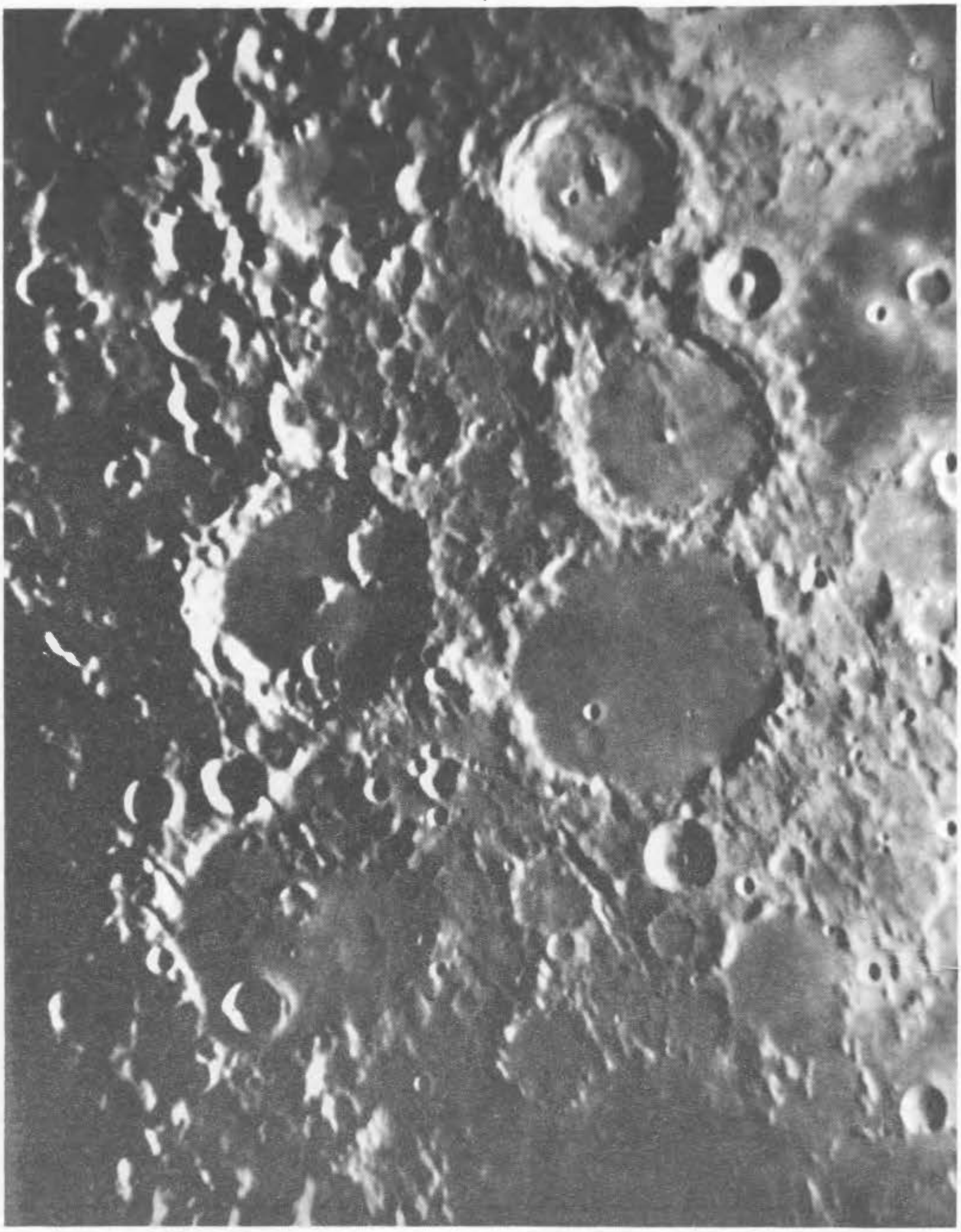


Figure 13. Photograph of Ptolemaeus, Alphonsus, and vicinity by Thomas Osypowski and Thomas Pope on August 29, 1964 at $10^h15^m$, U.T. 12.5-inch Newtonian reflector of focal length 111 inches, eyepiece projection method. Seeing excellent, transparency good. Adox Dokupan film, exposure 1 second at f:50. Colongitude 170°2. The Ranger IX impact occurred near the central peak of Alphonsus. Lunar south at top, lunar west (I A U sense) at right.

Figure 14. Photograph of Clavius, Tycho, and vicinity by Thomas Osypowski and Thomas Pope on September 28, 1964 near $10^h0^m$, U.T. Pan-X film, exposure 1 second at f:60. Colongitude 176°1. Other data same as for Figure 13.

Figure 15. Lunar photograph of Copernicus and vicinity by Ken Schneller on March 13, 1965 at $4^h16^m$, U.T. 8-inch reflector, f:160 with eyepiece projection. Seeing 7, transparency 5. Plus -X film. Exposure 1 second. Print here reproduced a 4X enlargement. Lunar south at at top, lunar west (I.A.U. sense) at right. Colongitude 33°47. Sun's selenographic latitude -1°51. See also text of article beginning on page 192.

## A LUNAR CONVERSION TABLE

By: W. M. Swinburn, Nelson, New Zealand

(Paper read at the Ninth A.L.P.O. Convention at Long Beach, California, August 24-26, 1961.)

With the introduction of the Kuiper Lunar Atlas Supplement new fields of interest in slenography are possible. The measurement of true surface distances between specific surface positions, finding the area of ring formations, and determining shadow length for a great number of features are examples of practical work projects. Before extensive programming can be considered seriously, however, the tedium of conversion from the grid orthographic system to the realistic latitude and longitude reference system must be overcome. Extensive calculations of the true positions by means of the secant equation (sin lambda equals Xi sec Beta) is impractical, tedious and restrictive. The Lunar Grid Conversion Table, then, is a simple tabulation prepared in order to give a direct transposition from this accepted orthographic grid system into latitude and longitude measures. In its presented form it extends in accuracy beyond the limits of direct measurement from the Kuiper Atlas photographs, although the evaluations are still inferior to the finest positional determinations from the past.

Because the basic calculations were completed late in May of 1961 the table is presented with some hesitation since the substance of it has not yet been thoroughly checked. However, if readers will regard the work as a preliminary draft, any errors in calculation and transcription should not preclude the table's acceptance.

# LUNAR GRID CONVERSION SCALE Sheet 1

Xi .00 to .49 for Eta .00 to .4

| IAU Xi | Vertical Co-ordinate measures along Prime Meridian for .05 intervals (Eta) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | .00 | .05 | .10 | .15 | .20 | .25 | .30 | .35 | .40 |
| .01 | 00.57306 | 00.57362 | 00.57507 | 00.57975 | 00.58467 | 00.59166 | 00.60056 | 00.61169 | 00.62528 |
| .02 | 01.14613 | 01.14751 | 01.16611 | 01.15916 | 01.16945 | 01.18433 | 01.20134 | 01.22334 | 01.25028 |
| .03 | 01.71917 | 01.72122 | 01.72778 | 01.73888 | 01.75445 | 01.77500 | 01.80222 | 01.83527 | 01.87583 |
| .04 | 02.29249 | 02.29528 | 02.30389 | 02.31861 | 02.33972 | 02.36767 | 02.40278 | 02.44778 | 02.50134 |
| .05 | 02.86611 | 02.86945 | 02.88028 | 02.89862 | 02.92500 | 02.96000 | 03.00306 | 03.05972 | 03.12725 |
| .06 | 03.43972 | 03.44416 | 03.45722 | 03.47947 | 03.51083 | 03.55278 | 03.60612 | 03.67251 | 03.75361 |
| .07 | 04.01418 | 04.01889 | 04.03416 | 04.06000 | 04.09694 | 04.14583 | 04.20806 | 04.28555 | 04.38028 |
| .08 | 04.58861 | 04.59444 | 04.61169 | 04.64111 | 04.68333 | 04.73945 | 04.81058 | 04.89915 | 05.00750 |
| .09 | 05.16361 | 05.16889 | 05.18972 | 05.22279 | 05.27028 | 05.33333 | 05.41361 | 05.51334 | 05.63555 |
| .10 | 05.73945 | 05.74641 | 05.76801 | 05.80500 | 05.85778 | 05.93001 | 06.01750 | 06.12889 | 06.26529 |
| .11 | 06.31529 | 06.32334 | 06.34723 | 06.38778 | 06.44613 | 06.52306 | 06.62167 | 06.74363 | 06.89333 |
| .12 | 06.89194 | 06.90083 | 06.92697 | 06.97140 | 07.03467 | 07.11917 | 07.22667 | 07.35840 | 07.52334 |
| .13 | 07.46945 | 07.47889 | 07.50722 | 07.55555 | 07.62445 | 07.71582 | 07.83249 | 07.97725 | 08.15445 |
| .14 | 08.04751 | 08.05806 | 08.08888 | 08.14055 | 08.21500 | 08.31361 | 08.43917 | 08.59528 | 08.78667 |
| .15 | 08.62750 | 08.63778 | 08.67056 | 08.72639 | 08.80612 | 08.91195 | 09.04694 | 09.21445 | 09.41945 |
| .16 | 09.20833 | 09.21889 | 09.25361 | 09.31334 | 09.39833 | 09.51169 | 09.65555 | 09.83467 | 10.05389 |
| .17 | 09.78888 | 09.80000 | 09.83778 | 09.90100 | 09.99166 | 10.11195 | 10.26566 | 10.45612 | 10.68945 |
| .18 | 10.36945 | 10.38278 | 10.42251 | 10.48972 | 10.58583 | 10.71361 | 10.87639 | 11.07836 | 11.32612 |
| .19 | 10.95278 | 10.96667 | 11.00833 | 11.07947 | 11.18112 | 11.31639 | 11.48861 | 11.70250 | 11.96445 |
| .20 | 11.53639 | 11.55000 | 11.59583 | 11.67083 | 11.77807 | 11.92056 | 12.10222 | 12.32778 | 12.60445 |
| .21 | 12.12222 | 12.13749 | 12.18416 | 12.26334 | 12.37612 | 12.52612 | 12.71723 | 12.96140 | 13.24583 |
| .22 | 12.70945 | 12.72500 | 12.79083 | 12.85695 | 12.97507 | 13.13306 | 13.33361 | 13.58306 | 13.88888 |
| .23 | 13.29723 | 13.31418 | 13.36566 | 13.45222 | 13.57639 | 13.74139 | 13.95194 | 14.21334 | 14.53361 |
| .24 | 13.88611 | 13.90416 | 13.95778 | 14.04862 | 14.17862 | 14.35134 | 14.57167 | 14.84502 | 15.18057 |
| .25 | 14.47778 | 14.49583 | 14.55222 | 14.64694 | 14.78249 | 14.96308 | 15.19305 | 15.47889 | 15.82917 |
| .26 | 15.06945 | 15.08917 | 15.14778 | 15.24641 | 15.38806 | 15.57639 | 15.81639 | 16.11445 | 16.47975 |
| .27 | 15.66390 | 15.68333 | 15.74502 | 15.84805 | 15.99555 | 16.19139 | 16.44139 | 16.75194 | 17.13306 |
| .28 | 16.26111 | 16.28112 | 16.34444 | 16.45167 | 16.60500 | 16.80840 | 17.06917 | 17.39194 | 17.78833 |
| .29 | 16.85833 | 16.87750 | 16.94555 | 17.05667 | 17.21639 | 17.42807 | 17.69899 | 18.03416 | 18.44641 |
| .30 | 17.45833 | 17.48001 | 17.54833 | 17.66390 | 17.82947 | 18.04915 | 18.32975 | 18.67862 | 19.10639 |
| .31 | 18.05833 | 18.08333 | 18.15306 | 18.27306 | 18.44473 | 18.67279 | 18.96361 | 19.32507 | 19.76945 |
| .32 | 18.66390 | 18.68694 | 18.76030 | 18.88416 | 19.06222 | 19.29862 | 19.60000 | 19.97500 | 20.43527 |
| .33 | 19.26945 | 19.31030 | 19.36945 | 19.49778 | 19.68196 | 19.92667 | 20.23861 | 20.62697 | 21.10361 |
| .34 | 19.87778 | 19.90278 | 19.98139 | 20.11418 | 20.30445 | 20.55750 | 20.88028 | 21.28233 | 21.77507 |
| .35 | 20.48888 | 20.51361 | 20.59502 | 20.73249 | 20.92947 | 21.19083 | 21.52445 | 21.93527 | 22.45056 |
| .36 | 21.10000 | 21.12725 | 21.21140 | 21.35306 | 21.55639 | 21.82667 | 22.17140 | 22.60056 | 22.12807 |
| .37 | 21.71667 | 21.74363 | 21.83057 | 21.97697 | 22.18667 | 22.46566 | 22.82167 | 23.26500 | 23.80972 |
| .38 | 22.33333 | 22.36280 | 22.45222 | 22.60278 | 22.81945 | 23.10722 | 23.47473 | 23.94899 | 24.49473 |
| .39 | 22.95555 | 22.98333 | 23.07639 | 23.23233 | 23.45528 | 23.75222 | 24.13167 | 24.60306 | 25.18333 |
| .40 | 23.57778 | 23.60916 | 23.70416 | 23.86445 | 24.09473 | 24.40056 | 24.79139 | 25.27807 | 25.87697 |
| .41 | 24.20555 | 24.23694 | 24.33433 | 24.49944 | 24.73639 | 25.05194 | 25.45445 | 25.95639 | 26.57334 |
| .42 | 24.83333 | 24.86667 | 24.96767 | 25.13833 | 25.38233 | 25.70695 | 26.12167 | 26.63861 | 27.27473 |
| .43 | 25.46945 | 25.50194 | 25.60528 | 25.78001 | 26.03139 | 26.36582 | 26.79249 | 27.32500 | 27.98057 |
| .44 | 26.10278 | 26.13833 | 26.24473 | 26.42528 | 26.68389 | 27.02807 | 27.46750 | 28.01529 | 28.69333 |
| .45 | 26.74444 | 26.77947 | 26.88861 | 27.07445 | 27.34028 | 27.69391 | 28.14641 | 28.71083 | 29.40528 |
| .46 | 27.38888 | 27.42417 | 27.53667 | 27.72697 | 28.00083 | 28.36472 | 28.83028 | 29.41058 | 30.12583 |
| .47 | 28.03333 | 28.07251 | 28.18833 | 28.38416 | 28.66529 | 29.03945 | 29.51801 | 30.11529 | 30.85167 |
| .48 | 28.68611 | 28.72473 | 28.84333 | 29.04473 | 29.33333 | 29.71834 | 30.21030 | 30.82473 | 31.58249 |
| .49 | 29.34166 | 29.38112 | 29.50306 | 29.70972 | 30.00695 | 30.40250 | 30.90806 | 31.54000 | 32.31917 |

## L U N A R   G R I D   C O N V E R S I O N   S C A L E   Sheet 2

Xi .50 to .99 for Eta .00 to .4

| IAU Xi | Vertical Co-ordinate measures along Prime Meridian for .05 intervals (Eta) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | .00 | .05 | .10 | .15 | .20 | .25 | .30 | .35 | .40 |
| .50 | 30.00000 | 30.04139 | 30.16667 | 30.37947 | 30.68416 | 31.09055 | 31.61083 | 32.26000 | 33.06169 |
| .51 | 30.66390 | 30.70639 | 30.83500 | 31.05306 | 31.36667 | 31.78416 | 32.31834 | 32.96917 | 33.81111 |
| .52 | 31.33333 | 31.37528 | 31.50750 | 31.73167 | 32.05334 | 32.48249 | 33.03167 | 33.71834 | 34.56667 |
| .53 | 32.00555 | 32.05000 | 32.18583 | 32.41667 | 32.74667 | 33.18778 | 33.75167 | 34.45750 | 35.32975 |
| .54 | 32.68333 | 32.72917 | 32.86834 | 33.10500 | 33.40222 | 33.89641 | 34.47697 | 35.20194 | 36.09899 |
| .55 | 33.36667 | 33.41390 | 33.55695 | 33.79915 | 34.14805 | 34.61308 | 35.20833 | 35.95389 | 36.87639 |
| .56 | 34.05555 | 34.10445 | 34.25083 | 34.50000 | 34.85833 | 35.33527 | 35.94723 | 36.71361 | 37.66280 |
| .57 | 34.75000 | 34.80000 | 34.95000 | 35.20555 | 35.57306 | 36.06361 | 36.69173 | 37.48028 | 38.45639 |
| .58 | 35.45000 | 35.50194 | 35.65695 | 35.91861 | 36.29613 | 36.80000 | 37.44583 | 38.25528 | 39.25945 |
| .59 | 36.15833 | 36.20840 | 36.36750 | 36.63722 | 37.02445 | 37.54166 | 38.20528 | 39.03861 | 40.07112 |
| .60 | 36.86945 | 36.92389 | 37.08639 | 37.36280 | 37.76030 | 38.29166 | 38.97389 | 39.83001 | 40.89333 |
| .61 | 37.58888 | 37.66140 | 37.81250 | 38.09583 | 38.50416 | 39.05000 | 39.75100 | 40.63233 | 41.72507 |
| .62 | 38.31667 | 38.37195 | 38.54444 | 38.83555 | 39.25528 | 39.81566 | 40.53667 | 41.44173 | 42.56917 |
| .63 | 39.05000 | 39.10778 | 39.28433 | 39.58333 | 40.01500 | 40.64111 | 41.33233 | 42.26308 | 43.42306 |
| .64 | 39.79166 | 39.85000 | 40.03233 | 40.34000 | 40.78233 | 41.37500 | 42.12500 | 43.09613 | 44.29111 |
| .65 | 40.54166 | 40.60250 | 40.78778 | 41.10445 | 41.55840 | 42.16767 | 42.95134 | 43.93833 | 45.17056 |
| .66 | 41.30000 | 41.36195 | 41.55361 | 41.87725 | 42.34528 | 42.97140 | 43.77807 | 44.79444 | 46.06390 |
| .67 | 42.06667 | 42.13112 | 42.32750 | 42.66058 | 43.14166 | 43.78583 | 44.61529 | 45.66250 | 46.97222 |
| .68 | 42.84444 | 42.90945 | 43.11222 | 43.45473 | 43.94862 | 44.61140 | 45.46667 | 46.54583 | 47.89694 |
| .69 | 43.63057 | 43.71566 | 43.90500 | 44.25833 | 44.76667 | 45.44862 | 46.32917 | 47.44249 | 48.83778 |
| .70 | 44.42778 | 44.49751 | 44.72725 | 45.07306 | 45.59613 | 46.29862 | 47.20612 | 48.35445 | 49.79694 |
| .71 | 45.23611 | 45.30667 | 45.52612 | 45.90000 | 46.43888 | 47.16250 | 48.09862 | 49.28333 | 50.77583 |
| .72 | 46.05555 | 46.12889 | 46.35416 | 46.73888 | 47.29305 | 48.03945 | 49.00445 | 50.23001 | 51.77500 |
| .73 | 46.88611 | 46.96280 | 47.19473 | 47.59083 | 48.16250 | 48.93196 | 49.92889 | 51.19555 | 52.79613 |
| .74 | 47.73057 | 47.80194 | 48.05000 | 48.45750 | 49.04694 | 49.84083 | 50.87167 | 52.18333 | 53.84249 |
| .75 | 48.59166 | 48.67112 | 48.91801 | 49.33945 | 49.94694 | 50.76834 | 51.83333 | 53.19166 | 54.91667 |
| .76 | 49.46390 | 49.55000 | 49.80306 | 50.23639 | 50.86500 | 51.71169 | 52.81500 | 54.22417 | 56.01861 |
| .77 | 50.35416 | 50.44000 | 50.70334 | 51.15167 | 51.80167 | 52.07836 | 53.82167 | 55.28527 | 57.15416 |
| .78 | 51.26111 | 51.35000 | 51.62001 | 52.08500 | 52.75667 | 53.66472 | 54.85000 | 56.37306 | 58.32500 |
| .79 | 52.18611 | 52.27862 | 52.55861 | 53.03888 | 53.73527 | 54.67778 | 55.90916 | 57.49583 | 59.53806 |
| .80 | 53.13057 | 53.22507 | 53.51667 | 54.01280 | 54.73527 | 55.71280 | 56.99583 | 58.65222 | 60.79391 |
| .81 | 54.09723 | 54.19613 | 54.51280 | 55.0128C | 55.76111 | 56.77917 | 58.11667 | 59.85000 | 62.10278 |
| .82 | 55.08333 | 55.18722 | 55.50000 | 56.03527 | 56.81667 | 57.87306 | 59.27083 | 61.08806 | 63.46667 |
| .83 | 56.10000 | 56.20612 | 56.52975 | 57.08749 | 57.89805 | 59.00473 | 60.46889 | 62.38112 | 64.90555 |
| .84 | 57.14166 | 57.25000 | 57.58945 | 58.16889 | 59.01667 | 60.17389 | 61.70945 | 63.73057 | 66.42222 |
| .85 | 58.21390 | 58.32725 | 58.67975 | 59.28583 | 60.17140 | 61.38583 | 63.00473 | 65.15000 | 68.03667 |
| .86 | 59.31667 | 59.43778 | 59.80695 | 60.44055 | 61.36917 | 62.64778 | 64.36111 | 66.64667 | 69.77500 |
| .87 | 60.45833 | 60.58555 | 60.97140 | 61.63611 | 62.61445 | 63.96390 | 65.78333 | 68.20667 | 71.66667 |
| .88 | 61.64166 | 61.77417 | 62.16801 | 62.88112 | 63.91390 | 65.34723 | 67.29333 | 69.95416 | 73.77083 |
| .89 | 62.87222 | 63.02975 | 63.44139 | 64.18112 | 65.27778 | 66.80667 | 68.90334 | 71.82500 | 76.18333 |
| .90 | 64.15833 | 64.30555 | 64.75861 | 65.54444 | 66.71390 | 68.35667 | 70.64000 | 73.90000 | 79.10555 |
| .91 | 65.50555 | 65.66169 | 66.14528 | 66.98611 | 68.24000 | 70.02334 | 72.54166 | 76.27778 | 83.16667 |
| .92 | 66.92778 | 67.09278 | 67.61250 | 68.51667 | 69.87917 | 71.83667 | 74.67222 | 79.15000 | |
| .93 | 68.43333 | 68.63001 | 69.17697 | 70.15833 | 71.65000 | 73.83888 | 77.13333 | 83.11667 | |
| .94 | 70.05278 | 70.24805 | 70.86529 | 71.94583 | 73.61250 | 76.12778 | 80.19444 | | |
| .95 | 71.80555 | 72.02083 | 72.70416 | 73.91667 | 75.82778 | 78.85555 | 84.78333 | | |
| .96 | 73.73888 | 73.98333 | 74.75972 | 76.16111 | 78.45833 | 82.50833 | | | |
| .97 | 75.93057 | 76.21667 | 77.13389 | 78.84166 | 81.88333 | | | | |
| .98 | 78.52500 | 78.88333 | 80.05000 | 82.40000 | | | | | |
| .99 | 81.89444 | 82.41667 | 84.26667 | | | | | | |

## LUNAR GRID CONVERSION SCALE Sheet 3

**Xi .02 to .86 for Eta .45 to .85**

| IAU Xi | Vertical Co-ordinate measures along Prime Meridian for .05 intervals (Eta) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | .45 | .50 | .55 | .60 | .65 | .70 | .75 | .80 | .85 |
| .02 | 01.28333 | 01.32334 | 01.37222 | 01.43233 | 01.50806 | 01.60473 | 01.73249 | 01.91030 | 02.17583 |
| .04 | 02.56723 | 02.64723 | 02.74528 | 02.86529 | 03.01723 | 03.21083 | 03.46695 | 03.82251 | 04.35473 |
| .06 | 03.85250 | 03.97279 | 04.11801 | 04.30100 | 04.52862 | 04.81945 | 05.20306 | 05.73917 | 06.54000 |
| .08 | 05.13945 | 05.30028 | 05.49694 | 05.73917 | 06.04305 | 06.43196 | 06.94694 | 07.66222 | 08.73527 |
| .10 | 06.42917 | 06.63001 | 06.87697 | 07.18085 | 07.56169 | 08.04944 | 08.69555 | 09.59416 | 10.94305 |
| .12 | 07.72222 | 07.96500 | 08.26111 | 08.62697 | 09.08555 | 09.67334 | 10.45278 | 11.53694 | 13.16750 |
| .14 | 09.01945 | 09.30334 | 09.65028 | 10.07862 | 10.61611 | 11.30528 | 12.21973 | 13.49333 | 15.41250 |
| .16 | 10.32112 | 10.64667 | 11.04502 | 11.53694 | 12.15445 | 12.94667 | 13.99833 | 15.46582 | 17.68196 |
| .18 | 11.62807 | 11.99613 | 12.44641 | 13.00278 | 13.70167 | 14.59862 | 15.79111 | 17.45750 | 19.98028 |
| .20 | 12.94139 | 13.35250 | 13.85555 | 14.47750 | 15.25840 | 16.26334 | 17.60000 | 19.47140 | 22.31280 |
| .22 | 14.26169 | 14.70250 | 15.27334 | 15.96195 | 16.82807 | 17.94173 | 19.42697 | 21.51000 | 24.68500 |
| .24 | 15.58972 | 16.08888 | 16.70028 | 17.45750 | 18.41058 | 19.63722 | 21.27500 | 23.57807 | 27.10334 |
| .26 | 16.92612 | 17.47083 | 18.13833 | 18.96529 | 20.00722 | 21.35000 | 23.14613 | 25.67289 | 29.57500 |
| .28 | 18.27279 | 18.86361 | 19.58888 | 20.48722 | 21.62083 | 23.08389 | 25.04444 | 27.81801 | 32.10916 |
| .30 | 19.62917 | 20.26767 | 21.05167 | 22.02417 | 23.25167 | 24.83945 | 26.97195 | 30.00000 | 34.71472 |
| .32 | 20.99751 | 21.68500 | 22.52947 | 23.57807 | 24.90361 | 26.62056 | 28.93333 | 32.23085 | 37.40639 |
| .34 | 22.37836 | 23.11161 | 24.02334 | 25.15056 | 26.57807 | 28.43028 | 30.93249 | 34.51834 | 40.19833 |
| .36 | 23.77306 | 24.56308 | 25.53433 | 26.74333 | 28.27667 | 30.27112 | 32.97445 | 36.86973 | 43.10972 |
| .38 | 25.18278 | 26.02639 | 27.06472 | 28.35840 | 30.00306 | 32.14751 | 35.06472 | 39.29667 | 46.16667 |
| .40 | 26.60972 | 27.50833 | 28.61667 | 30.00000 | 31.76030 | 34.06308 | 37.20972 | 41.81058 | 49.40445 |
| .42 | 28.05416 | 29.01083 | 30.19166 | 31.66834 | 33.55167 | 36.02306 | 39.41889 | 44.42697 | 52.87222 |
| .44 | 29.51801 | 30.53500 | 31.78416 | 33.36667 | 35.38057 | 38.03233 | 41.69899 | 47.16667 | 56.64249 |
| .46 | 31.00389 | 32.08416 | 33.42195 | 35.10000 | 37.25222 | 40.10000 | 44.06418 | 50.05612 | 60.83583 |
| .48 | 32.51308 | 32.65972 | 35.08139 | 36.86973 | 39.17112 | 42.23112 | 46.52639 | 53.13001 | 65.67001 |
| .50 | 34.04805 | 35.26472 | 36.77507 | 38.68233 | 41.14444 | 44.43722 | 49.10612 | 56.44249 | 71.65000 |
| .52 | 35.61111 | 36.89502 | 38.50833 | 40.54111 | 43.17862 | 46.73057 | 51.82836 | 60.07389 | 80.79166 |
| .54 | 37.20500 | 38.57500 | 40.28433 | 42.45361 | 45.28333 | 49.12417 | 54.72583 | 64.15833 | |
| .56 | 38.83433 | 40.28888 | 42.10833 | 44.42697 | 47.46945 | 51.64166 | 57.84805 | 68.96250 | |
| .58 | 40.50222 | 42.04641 | 43.98583 | 46.46945 | 49.75000 | 54.30750 | 61.26917 | 75.16667 | |
| .60 | 42.21058 | 43.85389 | 45.92445 | 48.59028 | 52.14333 | 57.15639 | 65.10833 | | |
| .62 | 43.96801 | 45.71801 | 47.93333 | 50.80500 | 54.67417 | 60.24528 | 69.61000 | | |
| .64 | 45.77917 | 47.64723 | 50.02417 | 53.13001 | 57.37306 | 63.65833 | 75.37222 | | |
| .66 | 47.65000 | 49.65000 | 52.21000 | 55.58749 | 60.28555 | 67.54333 | 86.21667 | | |
| .68 | 49.59249 | 51.73888 | 54.50916 | 58.21250 | 63.48611 | 72.20833 | | | |
| .70 | 51.61334 | 53.92947 | 56.94613 | 61.04528 | 67.09444 | 78.57500 | | | |
| .72 | 53.72947 | 56.24083 | 59.55416 | 64.15833 | 71.34583 | | | | |
| .74 | 55.95833 | 58.70222 | 62.38112 | 67.66667 | 76.85000 | | | | |
| .76 | 58.32306 | 61.35000 | 65.50555 | 71.80416 | | | | | |
| .78 | 60.85722 | 64.24444 | 69.05667 | 77.16111 | | | | | |
| .80 | 63.61390 | 67.48333 | 73.31667 | | | | | | |
| .82 | 66.66667 | 71.23333 | 79.06667 | | | | | | |
| .84 | 70.15416 | 75.91667 | | | | | | | |
| .86 | 74.36667 | 83.24166 | | | | | | | |

The construction of the table is quite straightforward. A quadrant, being the basis for lunar reference systems as well as for trigonometric values, is naturally fundamental to this conversion. Along the Eta axis a parallel to the equator is taken for every 0.05 of a lunar radius, and the lengths of the twenty parallels derived in this way are found from the simple formula $c = \sqrt{2h - h^2}$, where c is the length of the parallel, or half chord as it also is, and h is the radius minus the value of Eta along that parallel. These calculations which take the radius of the moon as 1.00 must all be less than unity. As decimal values, then, their product with any Xi reading will give sine equivalents, and consequently the lengitude of a Xi value for any of the 20 Eta tabulations. Although theoretically interpolation cannot be done in the usual manner without introducing measurable error, the discrepancy between a proportional method of determining intermediate values and the strictly correct procedure is seriously significant only when using the table for extensively foreshortened lunar features. However, a future extension of the table to include every 0.01 of a lunar radius in Eta in conformity with the Xi intervals will make any alternative to simple proportional interpolations superfluous for anything but the most exacting work.

In use the procedure is to determine intermediate values in Xi and Eta by proportional differences from the body of the table, which is in degrees and decimals of a degree and denotes longitude. For finding latitude the Xi column is treated as being values in Eta; and in the column for Eta = .00 the values of latitude are read, and proportional corrections are applied.

An example may clarify the steps: We propose to find the distance between a craterlet near Eratosthenes at Xi = -0.2055, Eta = 0.2895 and one near Archimedes at Xi = -0.1285, Eta = 0.5420.

Taking the column for Eta = 0.25, we find a (negative) longitude of 11°92056 for Xi = 0.20 and one of 12°52612 for Xi = 0.21. Linear interpolation supplies 11°92056 + 0.55X (12°52612 - 11°92056) = 12°25362. In the column for Eta = 0.30 and the same values of Xi the same procedure gives 12°10222 + 0.55(12°71723 - 12°10222) = 12°44048. We finally need to interpolate on Eta; here 12°25362 + 0.79(12°44048 - 12°25362) = <u>12°40124</u> as the desired longitude, where 0.79 is the ratio (.2895 - .25) ÷ (.30 - .25).

To find the latitude we take the column for Eta = 0.00 and note that the latitude is 16°26111 for Xi = 0.28 and 16°85833 for Xi = 0.29. Since we want Xi = 0.2895, we take 16°26111 + 0.95X(16°85833 - 16°26111). The desired latitude is <u>16°82847</u>.

These steps are then repeated for the craterlet near Archimedes. The Eta = 0.50 column gives an interpolated longitude of 8°53379, and the Eta = 0.55 column gives an interpolated longitude of 8°85150. Interpolation to Eta = 0.5420 gives a longitude of <u>8°80066</u>. Interpolation on Xi for latitude in the Eta = 0.00 column results in a value of <u>32°82000</u>.

The final calculation of distance is then a classical problem in spherical trignometry.

<u>Comments by Editor</u>. We must apologize to our readers and to Mr. Swinburn for the great delay in the publication of this paper. Yet we hope that it may now be even more useful to advanced amateur students of the moon than it would have been in 1961. The interpolations involved need to be done very carefully, as students using this process in trigonometric tables will verify. Often available positional data would not be accurate enough to justify as many decimal places as Mr. Swinburn carries. Our thanks to our contributor for some useful tables!

## <u>BOOK REVIEWS</u>

<u>Telescopes</u>, edited by Gerard P. Kuiper and Barbara M. Middlehurst, University of Chicago Press, 1960, 2nd printing 1962, 255 pages, $8.50.

Reviewed by William O. Roberts

This is the first volume in a newer astronomical series, <u>STARS AND STELLAR SYSTEMS</u>, following the scheme developed by the editors in <u>THE SOLAR SYSTEM</u>. Comments made in earlier reviews* of these volumes apply generally to this book as well. It may as well be said right now that the present text is hardly one for the novice. Yet the fact remains that this is the kind of reference which often proves to be the most useful and long-lived on the amateur's bookshelf. His observatory reflects in a microcosm the design and practice of a large institutional establishment. It must follow that the better he understands instruments and their uses, the more effectively he will be able to plan and to operate his observatory for his own work. Let us see what this book has to offer.

There are twelve chapters and a supplemental listing of optical telescopes of greater than 20 inches aperture. The first article, naturally, is on the 200-inch Hale Telescope on Palomar Mountain by I. S. Bowen. The subject is treated concisely, yet adequately, in 15 pages; and a generous bibliography is included. A substantial group of illustrations comes with the text; among them are eleven of Russell Porter's amazing drawings which, for once, have been reproduced with sufficient scale and clarity. This is followed by W. W. Baustian's description of the Lick Observatory's 120-inch telescope. A. B. Meinel contributes a section on the design of reflecting telescopes. This is characterized by comparisons of designs and materials. Interesting was the discussion on Corning's new family of materials, Pyroceram, which appears to hold promise as a low-expansion material for telescope mirrors. The information given suggests that mirrors of zero coefficient, great hardness, and strength are a distinct possibility in the not too distant future.

Dr. Bowen has written a second article, this time on Schmidt cameras. The fifth chapter, Telescope Driving Mechanisms, is by R. R. McMath and O. C. Mohler. Many people are already familiar with some of the work done at McMath-Hulbert Observatory on precise and sophisticated designs. Three chapters follow on instruments associated with the making of very accurate astronomical measurements, namely, the transit circle, photographic zenith tube, dual-rate moon camera, and the impersonal astrolabe. Their use lies almost exclusively within the province of the professional astronomer.

Astronomical Seeing by J. Stock and G. Keller and Astronomical Seeing and Site Selection by A. B. Meinel cover a field of great importance to the lunar and planetary observer; and the effort spent in grasping the explanations will be amply repaid in better understanding of the A.L.P.O.'s efforts to establish a simple and effective seeing scale. The book is brought to a close with two chapters on radio telescope antennae and circuitry.

Most of the articles are generously provided with illustrations and bibliographies. While the plates add considerably to the cost of manufacture, they also add greatly to the clarification of the text. This reviewer finds the clear, unburdened prose a welcome change from the anecdote-laden style typical of so many works of a more popular nature. The individual who will employ this book as a guide to method, rather than as a collection of blueprints, is far more likely to realize the potential values that lie within its covers.

******

The Dawn of Astronomy, by J. Norman Lockyer, The M.I.T. Press, 1964, (From Cassell Edition of 1894), 432 pp., $2.95 paper, $10.00 cloth.

Reviewed by William O. Roberts

In 1890 Sir Norman Lockyer on a visit to Greece was impelled to note the bearings of the Parthenon and of the various foundations at Eleusis, having in maind that English churches were said to have their eastern windows facing to the place of sunrising on the festival day of the patron saint. Subsequent investigation showed that very little work had been done on this subject; and Sir Norman, with characteristic directness, went to Egypt to investigate further. The book was published in 1894 and, as Giorgio de Santillana says in the preface of 1964, "Egyptologists dismissed it with good-natured laughter."

Yet the result was full of information on Egyptian temples and religious ideas, tied into a discussion of the astronomical implications of these matters. Again, and again, the author took problems which Egyptologists had considered insoluble and proceeded to offer convincing explanations based on his keen knowledge of astronomy. From all this was de-

*Strolling Astronomer, Vol. 16, Nos. 7-8, pp. 186-187.
" " , Vol. 18, Nos. 7-8, pp. 158-159.

veloped a strong case for the notion that the Egyptian priesthood had an excellent understanding of astronomy, and a number of important uses for it. One of the more interesting proposals was that many temples were oriented to the rising or setting of various stars, or even of the sun itself, at specified times of the year. Observation of the sun's rising at the summer solistice, for example, would serve not only to regulate the calendar but to predict the early rising of the Nile, a vital matter to the agrarian civilization of the Nile Valley.

Lockyer, being dependent upon the information supplied by Egyptologists of his day for information on history, language, and customs, was badly handicapped by the state-of-the-art in 1890. The dating of the dynastic history was strongly influenced by Manetho's list of kings, yielding a period some 2600 years longer than that favored by modern authorities. Had it been possible to consult more recent translations of the Pyramid texts, some of the errors concerning the roles played by major deities, such as Set, Horus, and Osiris, might have been avoided. By way of illustration, Lockyer not only confuses Set with Anubis, which is understandable in view of the superficial similarities in their respective hieroglyphic symbols, but he also gives Ombos as an alternative name for Set when it is actually part of a title, Set, Lord of Ombos.

Astronomers familiar with Sir Norman's engaging and practical textbook, Elements of Astronomy, or with his researches into solar astronomy, will be inclined to regard this excursion with more than usual interest. It is marked by a chatty, yet lucid, prose style that recalls the literary graces of a bygone day. One regards it as a challenging study that ought to lure more than one astronomical enthusiast into the fascinating entanglement of Egyptian history and culture, if only in order that we may find out just how well the author's conclusions stand up in the light of mid-twentieth-century archaeology, philology, and astronomy. The M.I.T. Press is to be complimented for having restored this book to print.

## ANNOUNCEMENTS

Error in May-June, 1964 Issue. We regret that on pg. 128 of the issue named the Roman numerals I and II were interchanged in the formulas for the drift of the $NTB_s$ spot. They should have read:

L = 18°.5 - 9°.36 (T-Nov. 6. 44,1964) in System II.
L = 0°.1 - 1°.73 (T-Nov. 6. 44,1964) in System I.

We regret any confusion caused for readers who may have attempted to observe this spot, though we also understand that it became visually quite invisible in apertures up to 16 inches by the end of 1964.

Sustaining Members and Sponsors. As of May 3, 1965 we have in these special classes of membership:

Sponsors - William O. Roberts, David P. Barcroft, Philip and Virginia Glaser, Charles H. Giffen, John E. Westfall, Joel W. Goodman, The National Amateur Astronomers, Inc., James Q. Gant, Jr., David and Carolyn Meisel, Clark R. Chapman, Ken Thomson, Kenneth J. Delano.

Sustaining Members - Grace E. Fox, Sky Publishing Corporation, Charles F. Capen, Craig L. Johnson, Geoffrey Gaherty, Jr., Dale P. Cruikshank, Charles L. Ricker, James W. Young, Charles M. Cyrus, Alan McClure, Elmer J. Reese, George E. Wedge, Carl A. Anderson, Richard E. Wend, Gordon D. Hall, Michael McCants, Ernst E. Both, Harry D. Jamieson, William K. Hartmann, Ralph Scott, A. W. Mount, Jeffrey B. Lynn, Charles B. Owens, Joseph P. Vitous.

We express our thanks to all these colleagues for their loyalty and very helpful financial support. Sponsors pay $25.00 per year; Sustaining Members, $10.00 per year. The balance above the regular rate is used to support the work and activities of the A.L.P.O.

Status of A.L.P.O. Observing Manual. The following brief progress report on our Observing Manual was communicated by Mr. Clark Chapman on April 15, 1965. The Editor of this Journal can only underscore this appeal for full cooperation on this important project. Messrs. Chapman and Cruikshank and others have invested heavily of time, thought, and effort and merit our full support. Perhaps some discussion of the Manual can be included in our Convention with the Astronomical League at Milwaukee in early July. Clark

Chapman writes:

"The editors of the A.L.P.O. Observing Manual (Clark R. Chapman and Dale P. Cruikshank) are planning to use the summer to full advantage and hope to have a complete or nearly-complete manuscript by September. Several chapters are in final form, and first drafts have been received from the authors of several more. Several more chapters are reported to be nearing completion in first draft form. The editors hope that all first drafts will be finished by July so that editing and distribution of preliminary copies to advanced A.L.P.O. members may begin at once. Essential to the completion of a high-quality book is continual correspondence amongst the editors, authors, and other members so that good suggestions may be incorporated into the chapters and errors eliminated. The philosophy behind the manual and its general plan have been discussed in an earlier issue (Str. A., Mar.-Apr., 1964, page 75). The editors urge every interested A.L.P.O. member to correspond with them and the various chapter authors at great length during the summer weeks. The addresses of the editors and most of the authors are on the inside back cover of this issue."

W.A.A. Convention at Reno. The Western Amateur Astronomers will meet on August 19-21, 1965 at the Fleischmann Atmospherium - Planetarium on the Reno campus of the University of Nevada. Amateurs at Denver last year will remember the fascinating time-lapse photographs of the construction of this perhaps unique planetarium. The University is at an altitude of 4500 feet, assuring clear skies. This meeting may also be regarded as a kind of homecoming for the W.A.A. since the concept of this amateur federation originated with Professor G. Bruce Blair of the University of Nevada in the late 1940's. The W.A.A. President, and Chairman of this year's meeting, is Dr. O. Richard Norton, Desert Research Institute, Reno, Nevada - 89507. The deadline for the submission of papers is July 23. Interested amateurs can obtain from Dr. Norton a copy of the necessary format for papers. Every effort will be made by the host society to have the Proceedings of the 1965 Convention available at the Convention.

Thirteenth A.L.P.O. Convention at Milwaukee. All A.L.P.O. members are heartily invited to attend this year's Convention with the Astronomical League at Milwaukee. The dates are July 2, 3, 4, and 5, 1965. The tentative program and other helpful information can be found on pp. 170-171 of our July-August, 1964 (preceding) issue. Registrations and inquiries should be sent to Mr. William B. Albrecht
200 W. Hampton Ave.
Milwaukee, Wisconsin - 53225
All meetings will be at the Hotel Schroeder, 509 West Wisconsin Ave., Milwaukee, Wisconsin 53203, where most of the out-of-town delegates will stay.

The A.L.P.O. Exhibit will be assembled and arranged by Mr. Thomas Osypowski. However, all Exhibit material should be mailed to Mr. Philip R. Glaser
200 Albert St.
Waukesha, Wisconsin
Past experience has shown drawings, photographs, and charts to be the most suitable display material; and A.L.P.O. members are invited to contribute samples of their work to Mr. Glaser. Please do so soon -- it is necessary to know how much physical space to provide for our display.

An A.L.P.O. program of papers is being assembled, as usual. Indeed, it is possible that we may still be able to accept worthy amateur papers after you receive this mailing of our journal. However, it will certainly then be necessary that you hurry; for the host societies need to print the program early in June. The Editor will require a copy of every A.L.P.O. paper as soon as possible. Two copies will be better; then one can be sent to the host societies. Mr. Glaser assures us that every effort will be made to schedule adequate time for A.L.P.O. papers on the program.

Hope to see you soon at Milwaukee!

Mars Observations and Mariner IV. In spite of the extreme lateness of our recent issues, we are glad to have one very current note from Clark R. Chapman:

"As of the present writing, the Mariner IV spacecraft is still functioning properly and is expected to pass near Mars on July 14, 1965. It is expected that the cameras will take a series of pictures in a strip about 10 degrees wide on the Martian surface extending from northern desert regions near Propontis south across

Mare Sirenum until it meets the terminator near the southern limb in Aonius Sinus. A number of observers have been carefully observing Mars within recent months (especially the regions between longitudes 100°and 180°) in the hopes of visually mapping the region to be photographed.

"It has been reported that Ernst Both has observed extensive clouds in the vicinity of the forthcoming photographs. The writer, using the fifteen-inch refractor at Harvard, has also observed several clouds in the region, although in general most of the planet appears to have a clear atmosphere, as expected during an aphelic apparition. It would be very valuable to have observations of the region during the coming periods of visibility in the United States (mid-June and late July) and especially during the days around the July 14 fly-by date (which is possible from Japan).

"By this time the diameter of Mars will be only about seven seconds of arc so that it will be impossible to make high resolution maps of surface features. However, valuable observations of clouds and possible blue clearings can be made with telescopes of ten inches or greater in aperture."

It may be worthwhile to look at certain physical data on Mars during the next few months:

| Date | Angular Diameter | Tilt of Axis | Heliocentric Longitude λ |
|---|---|---|---|
| 1965, June 1 | 8″4 | 24°1 N. | 206° |
| June 15 | 7.6 | 24.8 | 213 |
| July 1 | 7.0 | 25.0 | 221 |
| July 15 | 6.5 | 24.8 | 228 |
| Aug. 1 | 6.0 | 23.7 | 235 |

The large northern tilt of the axis will favor the visibility of Propontis and other features in the northern hemisphere of Mars but will greatly hamper observing Mare Sirenum far south of the equator of Mars. The summer solstice of the northern hemisphere of the Red Planet falls at heliocentric longitude 178°; the autumnal equinox, at 268°. Thus we shall have summer in the northern hemisphere and winter in the southern hemisphere during the coming months.

Clouds and blue clearings are far more likely to be found on photographs in different colors of light than in visual observations. Large telescopes will have an important advantage, increasing even more as Mars recedes. It is scarcely necessary to say that good seeing will also be of critical importance. The Editor would also recommend that Mars be observed visually chiefly in the twilight when the reduced irradiation will allow a better view of detail than with more glare on a darker sky.

Where is University Park? Occasionally the Editor receives letters from correspondents saying that they hoped for a quick visit with him while passing through Albuquerque, New Mexico but that no one there had heard of University Park. The University Park of our A.L.P.O. address is actually the location of New Mexico State University, just outside of Las Cruces; the University of New Mexico at Albuquerque bears a confusing similarity in name but is a different school. It may help to note on the front cover that our telephone number there given is in Las Cruces, New Mexico.

## THE PLANETS AND THE MOON IN JUNE AND JULY, 1965

By: Walter H. Haas, Editor

Many popular astronomical journals carry as a regular feature descriptions of current planetary positions and astronomical phenomena. I have long hesitated to include such a feature in this periodical, feeling that its readers would probably get such elementary information elsewhere and that the space needed can be used to better advantage. Yet perhaps there is a need for some such service for our readers. The present article thus represents an experiment. It is my wish to make its point of view that of the serious amateur observer of the moon and the planets.

Mercury. The innermost planet is at superior conjunction on June 11, at greatest elongation east on July 18, and at inferior conjunction on August 15. (As usual, we give dates by Universal Time.) The tilt of the ecliptic to the horizon will make this evening apparition of Mercury harder to observe in middle northern latitudes than those which occur in March and April. It is an advantage, however, that Mercury is at aphelion on July 25; and near greatest elongation the daily motion of the planet in its orbit will be relatively slow, permitting observations over a much longer period than is usually possible for Mercury. I would suggest that telescopic observation might well extend from June 25 to August 1, with the most satisfying views during the first half of July.

Possible work on Mercury includes sketches of any markings seen, sketches and estimates of the phase, careful attention to possible changes in the markings from night to night, and studies of certain rather neglected observational techniques such as the effect of color filters when observing Mercury.

Venus. This planet was at superior conjunction on April 12. The value of K, the illuminated proportion of the disc, decreases from 0.97 on June 4 to 0.92 on July 4, and to 0.86 on August 3. The strongly gibbous Venus will thus remain rather low in the twilight during June and July.

The notorious difficulty of observing Venus is very familiar to our readers. Those properly equipped may want to concentrate on ultraviolet photography. Others may glean some ideas from William K. Hartmann's last Venus Report (Str. A., Vol. 17, pp. 248-255 and Vol. 18, pp. 6-10). Intensive estimation of the brightness and relative prominence of the north and south cusp-caps would help considerably in the interpretation of such data from the past. The bordering dusky cusp-bands should also be observed. The observed phase might also be carefully compared to the geometric phase; the results can be checked against those described in Mr. Alan Binder's article elsewhere in this issue.

On July 4 at $0^h$, U.T. Mercury and Venus will be in a very close conjunction, only 2.5 minutes of arc apart. They will be a striking pair in one telescopic field of view.

Mars. There is not much to add to what has already been said on pages 202 and 203. Readers might enjoy observing the value of K and comparing with Mr. Binder's results on Venus at similar theoretical values of K. As examples, which may not be representative, I estimated directly that K on Mars was 0.95 on May 1 and 9, 1965. The geometric values were 0.92 on May 1 and 0.91 on May 9.

Jupiter. The Giant Planet was in conjunction with the sun on May 30. It will hence be essentially unobservable during June and during July will be rather poorly placed in the morning twilight. Nevertheless, amateur observers able to keep unconventional hours are urged to begin work on Jupiter as soon as they can. The break in our coverage of Jovian phenomena near each conjunction has always been a handicap. We should labor to keep this break as short as possible; for example, our chances of interpolating rotation drift-lines across the near-conjunction gap on our charts become much better as this gap is kept smaller. Large apertures and even daylight work are helpful when trying to resume Jovian studies quickly after conjunction. The Great Red Spot should lie near longitude (II) 20° to 25°.

On July 30 there will be an appulse of Jupiter and the eighth magnitude star BD + 22° 914.

Saturn. The Ringed Planet was in conjunction on February 26 and will reach opposition on September 6. It is hence well placed in the latter part of the night. The local time of meridian transit is near 6:35 A.M. on June 1, 4:40 A.M. on July 1, and 2:39 A.M. on July 31. The value of B, the Saturnicentric latitude of the earth referred to the plane of the rings, falls between 2°54 N. and 3°07 N. during June and July so that the rings will have closed considerably since 1964. The value of B', the Saturnicentric latitude of the sun, will decrease from 5°55 N. on June 1 to 4°69 N. on July 31. The shadow of the rings on the ball will accordingly be very conspicuous just south of the projected rings.

Amateur observers of Saturn can scarcely do better than to read and study Dr. Joel W. Goodman's article "Observing Programs of the A.L.P.O. Saturn Section," Str. A., Vol. 17, pp. 77-81, 1963 (March-April). Disc drawings, numerical intensity estimates, color observations, photographs, central meridian transits of occasionally available detail, and latitude measurements with several different techniques are all possible programs. The southern hemisphere of Saturn will be seen to better advantage in 1965 than for a number of years. Detail in the rings, of course, will be very difficult. The phase-angle i reaches a maximum value of 6°0 near June 7, 1965; and amateur observers might enjoy looking for the shading of the planet's often forgotten terminator.

The satellites will be seen to better advantage with the reduction in the light from the rings. We also have for the inner satellites eclipses, occultations, transits, and shadow transits, the precise analogues of the more familiar phenomena of the four Galilean satellites of Jupiter. Satellites Rhea, Tethys, and Dione are now subject to these phenomena; phenomena of Mimas and Enceladus also occur but are beyond the reach of ordinary telescopes. Satellite phenomena are predicted on pp. 41-45 of the 1965 Handbook of the British Astronomical Association. Some sample predictions are given below; other transits and eclipses can be readily found approximately with the help of the known periods of revolution around Saturn.

| Date | Phenomenon | Beginning | Approximate Duration |
|---|---|---|---|
| 1965, June 8 | Dione eclipse-occultation | $9^h\ 16^m$, U.T. | 229 mins. |
| June 11 | Rhea shadow transit | 9 6 | 131 |
| June 11 | Rhea transit | 9 55 | 217 |
| June 17 | Tethys eclipse-occultation | 10 36 | 203 |
| June 18 | Tethys shadow transit | 9 17 | 157 |
| June 18 | Tethys transit | 9 47 | 174 |
| June 23 | Dione shadow transit | 10 37 | 154 |
| June 23 | Dione transit | 11 16 | 191 |
| June 30 | Dione eclipse-occultation | 6 49 | 221 |
| July 8 | Rhea shadow transit | 11 36 | 156 |
| July 8 | Rhea transit | 12 24 | 208 |
| July 15 | Rhea eclipse-occultation | 6 11 | 238 |
| July 22 | Tethys shadow transit | 8 49 | 161 |
| July 22 | Tethys transit | 9 14 | 171 |
| July 26 | Dione shadow transit | 6 53 | 159 |
| July 26 | Dione transit | 7 21 | 187 |

A.L.P.O. members are cordially invited to attempt to observe such satellite phenomena, especially transits of satellites and shadows. There has been some discussion of whether the shadows and satellites can be observed with ordinary apertures, even below 20 inches; and reliable results can guide our B.A.A. friends in deciding whether to continue such predictions. The usual data on aperture, seeing, transparency, magnification, etc. will help in interpreting observations contributed.

Uranus. The following data may help in finding this distant planet:

| | June 1 | July 1 | July 31 |
|---|---|---|---|
| Right Ascension | $10^h50^m13^s$ | $10^h52^m56^s$ | $10^h58^m2^s$ |
| Declination | +8° 15' | +7° 57' | +7° 24' |
| Local time meridian transit | 6:10 P.M. | 4:15 P.M. | 2:22 P.M. |

Readers can verify from the diagram on page 384 of the 1965 A.E.N.A. that on the date of opposition, March 3, 1965, satellites Ariel and Umbriel were making transits across the face of Uranus and were being occulted behind their primary. Mr. Craig L. Johnson of Boulder, Colorado states that shadow transits for Ariel and Umbriel must also be occurring and predicts the times of a number of such shadow transits. The diameters of the satellites of Uranus are so small as to be very difficult to measure; but if we take values of 500 to 1000 miles, there would result angular diameters of 0".06 to 0".12 during June and July. The diameters of the satellite shadows would presumably be comparable. Clearly very large apertures are needed to deal adequately with such phenomena; but A.L.P.O. members with access to 16-inch telescopes and larger might like to try. I know of no past observations of Uranian satellite phenomena.

Neptune. Its position in the sky is as follows:

| | June 1 | July 1 | July 31 |
|---|---|---|---|
| Right Ascension | $15^h4^m27^s$ | $15^h2^m1^s$ | $15^h1^m8^s$ |
| Declination | -15° 28' | -15° 19' | -15° 17' |
| Local time meridian transit | 10:24 P.M. | 8:23 P.M. | 6:24 P.M. |

On June 27 near $15^h$, U.T. Neptune will be in conjunction with, 10" south of, the eighth magnitude star BD -14°4102. The angular diameter of Neptune is 2"46 on July 1.

Moon. There is a partial eclipse of small magnitude, only 18% of the moon's diameter, on June 13-14, 1965. Circumstances are as follows, in Universal Time:

| | |
|---|---|
| Moon enters penumbra | June 13, $23^h15^m.4$ |
| Moon enters umbra | June 14, 0 58.0 |
| Middle of eclipse | 1 48.8 |
| Moon leaves umbra | 2 39.6 |
| Moon leaves penumbra | 4 22.2 |

In the United States the eclipse will be seen to best advantage along the East Coast. Possible amateur observational programs include umbral contact timings of selected craters, penumbra visibility studies, and searches for possible physical effects of the eclipse on lunar features.

It is scarcely practical to give dates and times for all possible lunar projects which have been discussed in this periodical. Interested lunar observers should have available a table of colongitudes and should learn how to use it. For those who wish to look for unusual colors in the Aristarchus area, this crater will be in sunlight from June 10 to June 25 and from July 10 to July 25 (U.T. dates, as usual). Alphonsus will be illuminated from June 7 to June 21 and from July 6 to July 21. The lighting under which Lyle T. Johnson and E. D. Hall saw the activity near the central peak of Alphonsus described in our July-August, 1964 issue exists near $16^h$ on June 20 and near $3^h$ on July 20 (U.T. once more). Some readers, we hope, would like to check upon John Westfall's front cover drawing of three domes near Arago. The prevailing colongitude exists again at $16^h$ on June 19 and at $3^h$ on July 19.

We shall be very glad to receive from our members constructive criticisms of the textual material above. Is the information presented useful? Should the level of discussion be more technical? Less technical? We would also like our remarks on coming lunar and planetary events to be helpful not only to members in the United States but to those in foreign countries. To do so, however, we need to know how long this journal requires to reach them; and such readers can assist by writing us on what date they received this issue.

Another thought is that if an article of this kind is to become a regular feature, then Section Recorders can use such a feature to call to the attention of our readers special projects during the future months covered. These might include such matters as simultaneous observations of Uranus, planned coordinated studies of the Red Spot of Jupiter, phase-estimates of Venus on selected dates, etc. Information on comets can also be presented when it is known sufficiently in advance. Staff members might like to comment on the usefulness and practicality of such a plan.

## NITROGEN DIOXIDE ON MARS?

By: Rodger W. Gordon

(Abstract by Klaus R. Brasch of a paper read at the Twelfth A.L.P.O. Convention at Denver, Colorado, August 28-31, 1964.)

In 1960 a theory was put forth by C. Kiess and his co-workers, attempting to explain the polar cap behavior and seasonal surface changes of Mars in terms of certain oxides of nitrogen. The polar caps, accordingly, are postulated to be composed of solid dinitrogen pentoxide ($N_2O_5$), and the dark markings of liquid dinitrogentetroxide ($N_2O_4$). Spectroscopic evidence for the presence of nitrogen dioxide ($NO_2$) in the atmosphere of Mars was cited in support of this hypothesis.

Spectroscopic studies by Sinton and others, however, indicate that $NO_2$ can be present only in quantities less than 1-2 parts per million, insufficient, it is maintained, to account for the observed phenomena. In addition, temperature conditions on Mars are believed to be such that variations from +30°C to -70°C are possible at the same location during one Martian day. In view of this great range, if the dark markings are composed of liquid $N_2O_4$, they should freeze during the Martian night; and upon reappearing into view in the morning, they would reflect sunlight brilliantly. Observational evidence of this kind is not prevalent, however. Moreover, gradual topographic changes (e.g., in

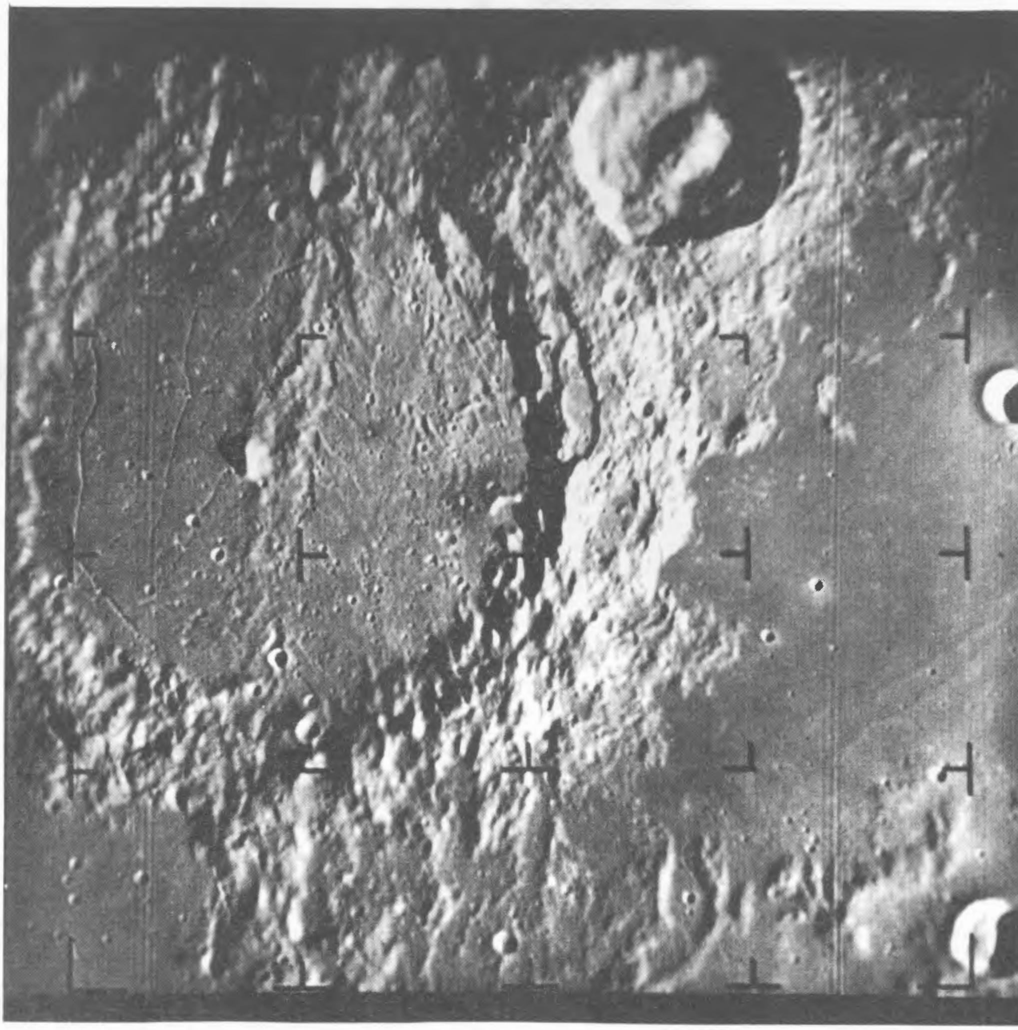


Figure 16. Ranger IX photograph of Alphonsus and Albetragius. Lunar south at the top, lunar west (I.A.U. sense) at right. Photograph given to the A.L.P.O. by Mr. Dennis Milon of the Lunar and Planetary Laboratory of the University of Arizona.

---

Thoth-Nepenthes) noted over many years of observation, as well as regular seasonal variations (e.g.,polar cap shrinkage and growth), tend to support a "water vapor - vegetative" hypothesis rather than a purely chemical theory as an explanation of the probable state of affairs on the surface of Mars.

## OBSERVATIONS AND COMMENTS

Possible Occultation of a Star by Pluto. The diameter of Pluto has been a debated question in recent years. The measured value of 0".23 by G. P. Kuiper with the Palomar 200-inch in the 1950's leads to a very great density for the planet, and D. Alter and others have proposed that what was measured was not the true disc. The problem can be resolved by observing occultations of stars by Pluto. The April, 1965 issue of Sky and Telescope carried a prediction of a possible occultation of a star of visual magnitude

15.3 by Pluto near $5^h$, U.T. on April 29, 1965. If an occultation occurred, then the integrated image of Pluto and the star would suddenly fade from magnitude 13.8 to magnitude 14.1, the reverse change occurring at occultation reappearance. Two A.L.P.O. members have reported efforts to observe this occultation.

At Boulder, Colorado Craig L. Johnson observed with a 17-inch reflector at 67X, good seeing, and transparency (limiting magnitude) 6.5. Continuous observation began at $4^h57^m$, U.T. a slight dimming was suspected near $5^h1^m$. "The problem was that while Pluto was fairly easy to see in the sense of being able to locate it in the field, it had to be viewed by averted vision, and because of this its apparent brightness was constantly changing due to small movements of the eye muscles, as is always the case when averted vision is used." Mr. Johnson attributes a seeming gradual brightening during the next few minutes to improving dark adaption and ceased observations at $5^h25^m$, U.T.

At Houston, Texas, Michael McCants and three others observed with a 16-inch reflector and an 8-inch reflector. They are reasonably certain that no occultation occurred between $4^h20^m$ and $4^h45^m$ or between $5^h20^m$ and $5^h35^m$, U.T. Clouds covered Pluto from $5^h3^m$ to $5^h20^m$. There is some evidence of a fading of the blended images near $4^h49^m.5$ and a return to full brightness near $4^h52^m$. Observers on both telescopes thought that a temporary reduction in brightness occurred. The two sets of observations do not, unfortunately, overlap helpfully.

"Moon Look." We invite interested A.L.P.O. members to participate in a systematic lunar patrol of Alphonus and the Aristarchus-Herodotus region for "lunar transient phenomena". Observations, positive and negative, should be reported to Walter H. Haas, Box AZ, University Park, New Mexico. Forms for reports will be provided. Suggestions are invited. Our goal is better information on lunar abnormalities than single unconfirmed reports can provide.

# *The Strolling Astronomer*

## SUBSCRIPTION RATES

Single Issue (in stock) $1.00

6 Months - - - - - 2.50

1 Year - - - - - - 4.00

2 Years - - - - - - 7.00

## SPECIAL MEMBERSHIPS

Sustaining Members $10 per year

Sponsors $25 per year

## ADVERTISING RATES

**Full Page Display Ad............................$40.00**

**Half Page Display Ad............................ 22.50**

**Quarter Page Display Ad .................. 15.00**

**Classified or Listing (per column inch) 4.00**

**Discount of 10% on 3-time insertion.**

**NOTICE:** **In order to facilitate the reproduction of drawings in future issues readers are requested to exaggerate contrasts on drawings submitted. Extremely faint marks cannot be reproduced. Outlines of planetary discs should be made dark and distinct. It is not feasible to reproduce drawings made in colors. Following these precepts will permit better reproductions.**

## STAFF


**EDITOR**

Walter H. Haas
Box AZ
University Park, New Mexico

**SECRETARY**

Atty. David P. Barcroft
Box AZ
University Park, New Mexico

LIBRARIAN

E.Downey Funck
Box 156
Boca Raton, Florida

BOOK REVIEW EDITOR

J. Russell Smith
1446 George St.
Eagle Pass, Texas

COUNSELLOR

Dr. Lincoln LaPaz
Director, Institute of Meteoritics
University of New Mexico
Albuquerque, New Mexico

MERCURY RECORDER

Geoffrey Gaherty, Jr.
131 Bloor St. West, Apt. 505
Toronto 5, Ontario, Canada

VENUS RECORDER

Dale P. Cruikshank
Lunar and Planetary Laboratory
University of Arizona
Tucson, Arizona

MARS RECORDER

Klaus R. Brasch
224 Montée Sanche
Rosemere, Quebec
Canada

ASSISTANT MARS RECORDER

Richard E. Wend
2050 N. Lawler Ave.
Chicago 39, Illinois

JUPITER RECORDER

Philip R. Glaser
200 Albert Street
Waukesha, Wisconsin

ASSISTANT JUPITER RECORDERS

Richard E. Wend
2050 N. Lawler Ave.
Chicago 39, Illinois

Charles H. Giffen
Institute for Advanced Study
Princeton, New Jersey

SATURN RECORDER

Joel W. Goodman
Dept. of Microbiology
University of Calif. School of Medicine
San Francisco 22, California

ASSISTANT SATURN RECORDER

Thomas A. Cragg
Mount Wilson Observatory
Mount Wilson, California

URANUS-NEPTUNE RECORDER

Leonard B. Abbey
Box 22236
Emory University
Atlanta 22, Georgia

COMETS RECORDER

Dennis Milon
Lunar and Planetary Laboratory
University of Arizona
Tucson, Arizona

LUNAR METEOR SEARCH RECORDER

Kenneth Chalk
3489 Grey Avenue
Montreal 28, Quebec, Canada

LUNAR RECORDERS

John E. Westfall
3104 Varnum St.
Mount Rainier, Maryland

Patrick S. McIntosh
Sacramento Peak Observatory
Sunspot, New Mexico

Clark R. Chapman
(Lunar Training Program)
94 Harper
Buffalo 26, New York

Harry D. Jamieson
923 W. Main St.
Muncie 5, Indiana