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ANNOUNCEMENTS

New Prices. Because it is otherwise difficult to be sure of meeting the continuing demand for the H. P. Wilkins map of the moon as a booklet (Second Edition), we are increasing the price of this booklet when ordered as part of a subscription to two dollars. Therefore, the booklet and a one-year subscription, either new or a renewal, now cost five dollars; the map booklet and a two-year subscription, new or renewal, cost seven dollars. The price of double issues of **The Strolling Astronomer** has also been set at 70 cents, **not** 35 cents. There are so far three such double issues: January-February, March-April, and May-June, 1954. These new prices go into effect on August 15, 1954.

It will be noted that the price of subscriptions is unaffected.

List of Astronomical Materials. Mr. J. Russell Smith, Skyview Observatory, Eagle Pass, Texas has compiled a list several pages long of assorted astronomical materials. Mr. Smith had especially in mind the needs of the teacher of astronomy in high schools and colleges, but actually he has included material of interest to almost any amateur astronomer. There are tabulated books, magazines, photographs, and the like with a brief description of each and a statement of where it can be ordered and for what price. We recommend Mr. Smith's very useful list highly to our readers and urge persons wishing to see it to write to him at the address given above.

Visiting Hours at McDonald Observatory. Readers travelling in West Texas or residing there might like to know when this famous observatory is open to the public. We are indebted to Mr. J. Russell Smith for the information that there are tours for visitors **promptly** at 2:30 and 3:00 P. M. each Sunday and at 1:30 P. M. on all other days. The 82-inch is open to the public for observations on the last Wednesday night of each month from 8:30 to 10:00 P. M. Admission is free. Persons wishing to attend the open nights should write to the McDonald Observatory at Fort Davis, Texas and should enclose a self-addressed stamped envelope for an admission card.

El Universo. Such is the title of the organ of the Sociedad Astronómica de México (Astronomical Society of Mexico), founded in 1902. It is written in Spanish, and we are sure that our members able to read that language will find much of interest therein. Recent issues contain articles about such topics as cosmology, current celestial phenomena, physical data on Mars in 1954, instructions for observing the moon, and a symposium on stellar evolution. The address of **El Universo** is Parque "Coronel Felipe S. Xicoténcatl," Apartado Postal No. 9647, Mexico 13, D. F., Mexico. **El Universo** is a printed magazine with an attractive format.

Nachrichtenblatt der Vereinigung der Sternfreunde. (Report of the Association of Amateurs.) This name is that of a mimeographed German monthly published by the Wilhelm Foerster Sternwarte, Berlin-Schoeneberg, Papestrasse 2, Germany. Recent issues contain discussions of current astronomical work, comets, books recently published, and solar eclipse expeditions planned for June 30, 1954. We are sure that A.L.P.O. members conversant with the German language will find the **Nachrichtenblatt** informative and pleasant reading.

LUNAR COLORS

BY D. P. AVIGLIANO

PART I—BASIC CONSIDERATIONS

Throughout both the earlier and more up to date books and articles on selenography one may find rather infrequent mention of lunar colors. These colors seen on the moon by some of the most famous of the past and present day selenographers would seem worthy of more notice than they have so far received. In the early part of 1953 the writer began a study of lunar color and as the first phase of this study is now completed it would seem fitting to present the results.

The Problems. The questions that this first phase of the lunar color study would attempt to answer are:

1. What visual colors can actually be seen in both the Maria and in some of the more localized areas on the Moon?
2. Are these color areas capable of being mapped?
3. What means of verifying these visual color areas may be employed?

Instruments and Conditions. The instruments employed in these studies were, first, an eight-inch reflector of f/12 focal ratio which was later replaced with an eight-inch reflector of f/7 focal ratio. During the latter part of these studies another reflector of 12½-inches aperture and f/6 focal ratio was added. The powers employed with these instruments for the study of the general areas were 80 with the eight-inch and 110 with the 12½-inch. For more detailed views of the smaller color areas powers of 130 on the eight-inch and 182 on the 12½-inch were used. All eyepieces employed were of the orthoscopic type. Although certain of the color areas could be seen with quite high powers, especially after they were previously found with the lower ones, the writer feels that powers greater than around 15 per inch of aperture are of no advantage in detecting the vague lunar tints. The brightness of the image and its color contrast are the important factors rather than high power details.

By far the best instrument for this type of work, of the three that were employed, was the 12½-inch f/6. This instrument enabled one to detect much more subtle nuances of color and with it, it was possible to differentiate between two areas of nearly similar tint. The eight-inch f/7 outperformed the eight-inch f/12 in these studies and it showed the major color areas quite well. It might be added here that in studies such as these the transparency of the sky is more important than the seeing conditions. Given fairly good seeing the colors appear truer and more vivid on a night of utmost transparency. Before the colors can be well seen the observer's eye must be capable of adjusting to the rather intense glare that is apparent at certain of the lunar phases. The mirrors of the telescope used must be free of any bluish or yellowish film; a yellow film is the worst offender as many of the colored areas on the Moon are of a yellowish tone.

PART II—THE COLORS

It must be remembered that the color tints seen on the Moon are all more or less vague. In observing the Moon for color one must think in terms of color, that is, the Moon must be looked at as one would normally look at, say, a landscape or a painting, not as one would view a black and white motion picture. Due to the lunar colors being very faint in hue many selenographers tend to view the surface of the Moon in terms of black, white and grey. This is a practice not helped by the usual study of black and white drawings and photographs. The writer's earliest views of the Moon gave him the impression of black, white and grey areas but since this study of lunar color has been undertaken he cannot now glance at the Moon through a telescope and refrain from noticing the main areas of lunar color.

The Colors in General. Basically there are two general subdivisions of color on the Moon:

1. The light areas. These areas are tones of white and yellow-white. They are the large areas crowded with craters that form their greatest expanse in the southwest quadrant of the Moon. They extend

somewhat around the north and southeast edges of the lunar disc and are present on other parts of the Moon in splotches and small areas.

2. The dark areas. These are the comparatively smooth Maria or seas. It is these areas that present the greatest differences in color tone of the larger areas on the lunar surface. The changes of color from Mare to Mare are extremely interesting. At some places the changes in color tone on a Mare are gradual and diffuse appearing while other tone changes are marked with a hard line of demarcation. Some of the Maria present a more or less even color tone while other Maria, even though they present a general overall color tone, are splashed with well marked areas of differing hue.

Before going on with the actual colors seen in the Maria, mention must be made of two prominent and nearly always present lunar color effects.

The first is the chromatic fringe that is seen at the edge of the Moon's limb. This, I feel, is primarily an effect of atmosphere and contrast. In a good reflector, armed with a good eyepiece, this color fringe is not too apparent. The color of this fringe is normally brownish, tending toward reddish, and it is an easy matter to distinguish this tint from the areas of true color on the Moon.

The other color effect is the fringe of brownish tone that is apparent on the lunar surface immediately adjacent to the line of the terminator. This tone accompanies the terminator line through all of the partial phases of each lunation. Where this terminator fringe crosses the lunar Maria it is generally wider appearing than is the limb fringe. Where it crosses the light portions of the Moon it appears to narrow somewhat. That the terminator fringe is due also to atmosphere and contrast is probably true, but the fact that the tint of this fringe varies somewhat in color as it progresses over the different Maria might show that there are some actual differences in color to be noted on the Maria when they are seen under very oblique lighting. This terminator tone where it crosses certain of the Maria is seen to sometimes be reddish-brown, yellowish-brown, greyish-brown or pure brown. It is more prominent than the limb fringe and is generally more noticeable at the narrower phases of the lunation.

Colors in the Maria. The following results are based on 309 color estimates of the lunar Maria. See diagram 1 on pg. 62.

1. Mare Tranquillitatis and Palus Somnii. As the sunrise terminator fringe passes over the Mare Tranquillitatis the Mare appears to be a brownish tone. When the terminator fringe passes over the central portion of this Mare the western area of the Mare that is now out of the terminator fringe area appears as a yellowish-grey. After the Mare is completely free of the terminator fringe the normal aspect that is seen throughout most of the lunation becomes very striking. This is basically one of the pure grey areas on the lunar surface. However there are well marked areas of yellowish hue splashed over the surface of this Mare. The northernmost area of this Mare to the east of the Palus Somnii is also of a yellowish hue. The sunset color behavior of the Mare Tranquillitatis is that of the sunrise behavior in reverse.

The Palus Somnii is normally a whitish-yellow; when well seen its very light yellow tone is extremely clear. See diagram 2 on pg. 63.

2. Mare Serenitatis and Lacus Somniorum. The boundary that divides the color of the Mare Serenitatis from that of the Mare Tranquillitatis is one of the most definite color boundaries on the Moon. This boundary, running in a general line from southeast to northwest, curves sharply to the northeast thus exposing the northwest portion of the Mare

Serenitatis to the pure grey of the Mare Tranquillitatis. The predominant color of the Mare Serenitatis is one of the most notable on the Moon. When clear of the terminator fringe it appears a yellow tone; when well seen, especially near full moon, it is the purest yellow on the Moon. At times a trace of brownish hue may be detected in this yellow.

If one were going to attempt to see the Maria colors for the first time it would be wise to attempt to see it by comparing the tones on each side of the sharp dividing line between the Mare Tranquillitatis and the Mare Serenitatis. On one side is the splotched pure grey tone and on the other the yellow.

The Lacus Somniorum is normally a light yellow-grey, lighter in tone than the Mare Serenitatis. See diagram 5 on pg. 64.

3. Mare Imbrium and Sinus Iridum. The general color tone of the Mare Imbrium when clear of the terminator fringe is yellow-grey. A large area in the northwest of this Mare and the area inside of the Sinus Iridum are tones of yellow, somewhat brownish. These brownish-yellow tones are divided from the rest of the Mare color by rather sharp edges. See diagram 8.

4. Mare Frigoris and Sinus Roris. The best description of the hue that is displayed by the Mare Frigoris when it is not affected by the terminator fringe is a whitish-brownish-yellow.

The area near and including the Sinus Roris is a tone that is slightly more yellowish than the yellow-grey tone of the nearby Mare Imbrium. The Sinus Roris tone is divided from that of the Mare Imbrium by a rather sharp division line.

5. Mare Crisium. When clear of the terminator fringe this Mare is a yellow-grey. Possibly the tone tends more towards grey at the beginning of the lunation and more towards yellow near full moon.

6. Mare Foecunditatis. This Mare presents much the same color tone as that of Mare Crisium, a yellow-grey. Some small areas in the northeast of this Mare partake of the more grey tones of the nearby Mare Tranquillitatis. The southern end of the Mare Foecunditatis appears lighter in tone during the earlier phases of the lunation.

7. Mare Nectaris. This Mare, when unaffected by the terminator fringe, is a yellow-grey, similar in tint to the Mare Crisium and the Mare Foecunditatis. Its tone fades into the grey of the Mare Tranquillitatis to its north.

8. Mare Vaporum, Sinus Medii and Mare Nubium. When clear of the terminator fringe these Maria are yellow-grey in their eastern portions and grey in their western portions. A very irregular dividing line running in a general south to north direction through these Maria separates the tones.

9. Mare Humorum and Oceanus Procellarum. These Maria, after the terminator fringe has passed them, are yellow-grey in hue. The Oceanus Procellarum contains some areas that are more tinged with yellow.

10. Mare Australe, areas around Copernicus and Kepler and other areas. The Mare Australe and some of the other near limb areas west of Mare Crisium are brownish-white-yellow but as these areas are near the lunar limb how much the brownish limb fringe may affect them is uncertain. However they are more yellowish in tint than the adjacent yellow-white areas. The fairly large lighter ray area surrounding Copernicus is of a slightly greyed yellow-white color as is also the somewhat smaller similar area around Kepler.

In summary it will be noted that the Maria colors are of two general tints, pure grey and yellow-grey. The yellow-greys tend, in some areas, to become brownish, and in others, to become very near to pure yellow.

More Localized Colors. As yet a thorough study of the colors in and around the craters and smaller areas of the Moon has not been undertaken. During the studies of the Maria, however, certain localized colors were seen and these more evident areas were followed through a number of lunations.

1. The Aristarchus area. By far the largest and most prominent of the more local areas of color is the roughly diamond-shaped area to the northeast of the crater Aristarchus. The craters Aristarchus and Herodotus lie on the southwest edge of this area. This area is very prominent and is about the largest area of easily seen yellow-brown that can be found on the visible portion of the Moon's surface. Under the best conditions this area is seen to approach a pure brown tint, somewhat reddish. It is unusual that more mention has not been made of this area in the past as it presents one of the most colored areas on the Moon. Soon after the Moon has passed its full phase a smaller somewhat circular area of the same general color as the main area is seen to the west of the main area; it is connected to the larger area by a band of the same color. The edges of these Aristarchus colored areas are quite definite and somewhat irregular. See diagrams 9 and 10.

2. The Copernicus spots. A darker spot on the northeast portion of the floor of Copernicus was generally seen to be of greyish tone at the beginning of its lunar day. At near colongitude 50° or 55° this spot became a yellowish-brown. At times this spot was more yellowish, at times it was more brownish. Its edges were sometimes diffuse, at other times they were very sharp. Its size also varies considerably. All these changes were irregular and apparently had no relation to the prevailing lunar lighting. A narrow band the same color as this spot was sometimes seen to extend from the spot, going up the inside northeast wall of Copernicus.

At times another smaller spot on the northwest portion of the floor of Copernicus was seen as a yellow-brown. The area outside of and to the east of this crater was seen on one occasion (colongitude 55°) to be a definite light brownish-yellow. These areas would probably repay a close and systematic study. See diagram 7.

3. Plato. The floor of this crater was generally recorded as yellowish-grey. Its southeast and northwest portions were usually lighter and of more yellowish tones. On many occasions a definite brownish cast was seen in the color of the floor and on a very few occasions the floor was seen as a neutral grey.

4. Schickard. There are two brownish areas on the floor of this crater; one, the large area in the northeast portion and the other at the west edge of the southwest portion. The rest of the floor is usually a somewhat greyish yellow-white. See diagram 6.

5. Tycho. The lunar surface surrounding this crater near full moon has a yellow tone. Before the full phase of the Moon the color is more predominant to the east of the crater. This surrounding hue sometimes has a brownish cast. See diagrams 3 and 4.

6. Stevinus. In previous studies of the intensities of lunar shadow areas the writer often noted an unusual color tone in the sunrise shadow in Stevinus.[1] A color study of this area was made and it was found that before colongitude 310° the shadow in Stevinus was not only lighter than other shadows in the vicinity but its color was an unusual shade of orange-brown. Strangely enough, detail could be faintly seen on the floor of Stevinus, including the central peak throwing a faint shadow; this, even though Stevinus lay closer to the terminator than its neighbor, Snellius, which was filled with blackest shadow. The Stevinus color seen before 310° was definite and had no connection with the terminator fringe. It was found that Professor W. H. Pickering had seen this area many years ago and he described it as reddish-brown.[2] The writer agrees

with the statement made by Pickering that this area is best seen by northern observers during the May and June lunations when the Moon is highest at these early colongitudes. When this area is well seen it is very striking.

PART III—METHODS OF VERIFICATION

Filter Visual Method. A set of colored filters was employed at the eyepiece of the telescope. The terminator fringe was confirmed as a yellow-brown. The more yellowish tones of certain of the Maria were also confirmed.

Filter Photographic Method. Photographs of the lunar Maria were made through various colored filters but due to the necessity of exaxct controls on exposure and development all that these photographs can be said to show are some of the Maria as more yellowish and others more greyish. However an easier and more efficient photographic method was later employed.

Direct Color Photographs. It was found possible to make direct color photographs of the Moon by a very simple process. These photographs were taken at all phases of the lunation. By experimentation it was found that the visual appearance of the lunar color tints could be quite accurately recorded in photographic color. These photographs have the advantage in that the colors of the areas are seen without the usual glare that accompanies a visual observation. Novices who could not make out the subtle color tones and changes when looking directly through the telescope could easily see them when looking at one of the photographs that had been taken at the time of their observation. All of the visual Maria color tendencies that have been listed are confirmed on these color photographs. The Aristarchus color area is also evident.

In closing it may be noted that the writer could find none of the greens or purples that are often reported seen on the Moon. This is not to say that these colors do not exist. The differences in eyes are sometimes very great and what may appear as a neutral grey to the writer might indeed have a greenish tone. The ability of some observers to see browns and not greens and vice versa has been noted by other investigators in the past.[3],[4] The definite tints, other than black and white, that the writer did easily see were greys, yellows, browns (sometimes reddish or orangish) and many blends of these tints. All the methods of verification that were employed, including the direct color photographs, were confirmatory of these results.

REFERENCES

1. Avigliano, D. P., "Unusual Lunar Shadows", **The Strolling Astronomer,** Vol. 7, No. 11, p. 153, November 1953.
2. Pickering, William H., "Eratosthenes, No. 5", **Popular Astronomy,** Vol. 32, p. 302, 1924.
3. Haas, Walter H., "Does Anything Ever Happen on the Moon?", **The Journal of the Royal Astronomical Society of Canada,** Vol. 36, No. 7, p. 320, September 1942.
4. Haas, Walter H., "Color Changes on the Moon", **Popular Astronomy,** p. 337, 1937.

THE USE OF FILTERS FOR OBSERVING FINE MARTIAN SURFACE DETAIL AND ATMOSPHERIC PHENOMENA

BY CHARLES CAPEN, JR.

The Problem

The reflected light of Mars is strong during and near times of opposition. Because of this fact, observers of Mars may employ filters which will increase contrast of detail.

The reflected sunlight from Mars is diffused or scattered during transmission through the earth's atmosphere. The degree of scattering is inversely proportional to the fourth power of the wavelength (Rayleigh's Law of Scattering). From the violet to the deep red is a span of nearly one octave; and therefore from Rayleigh's Law of Scattering, violet light is scattered 16 times more than the deep red. This is determined by the size of electrical fields of the molecules (oscillation of the magnetic dipoles) contained in the atmosphere. From the above, it is seen that the blue components—ultraviolet, violet, and blue light—of the spectrum are the wavelengths which are scattered most by planetary atmospheres because of their short wavelengths relative to atmospheric particle size. Scattering of the blue components of the reflected light from Mars in the terrestrial atmosphere as well as by the Martian atmosphere does contribute to reduced definition of the fine surface details.

Therefore, the longer red wavelengths of light appear advantageous since the visual spectrum is nearly one octave in span. A yellow or orange filter would be most useful in filtering out the blue components of the reflected light from Mars, leaving the less disturbed wavelengths to be resolved into an image with increased definition by the telescope. It is apparent, however, that definition can only be as good as the optics in the telescopic instrument.

Diffused or scattered blue light is particularly bad since the eye is more sensitive to the blue light than to the red light under night vision conditions. It is known from the **Purkinje effect phenomenon** that the sensitivity of the eye at low levels of brightness is reduced to red light and increased to blue light. This phenomenon occurs because the eye responds primarily by rod vision for low-level brightness, which is encountered under night conditions; while the eye responds primarily by cone vision for color daylight conditions.

Another factor to be considered is the effect of atmospheric turbulence upon the reflected light from Mars. In this relation, red light is preferable to blue light because the susceptibility of red light to atmospheric turbulence is probably 1.45% less than the susceptibility of violet light. This datum was derived in the following manner by Dr. F. Hanson: Using the index of refraction of air at 0°C. and 760 mm. (sea level) atmospheric pressure, we have violet light (4359A°) refracted in the amount of 1.0002957, while red light (6563A°) is refracted only in the amount of 1.0002914. The difference is 0.0000043. Therefore, 43 over 2957 X 100% = 1.45%.

Since the index of refraction of longer wavelengths is slightly less than for the blue wavelengths, a yellow or orange filter will decrease the prismatic dispersion of the image, which is caused by the earth's atmosphere when Mars is near the horizon (as is the case during the 1954 apparition in middle northern latitudes.)

Surface Details

The use of a yellow or orange filter will increase penetration of the Martian atmosphere because the atmosphere of Mars also diffuses or scatters the blue components of the reflected light from its planetary surface. Also, yellow to orange filters will help penetrate to surface features near the Martian limb.

Light rays from the bright Martian disk which are brought to focus by the telescope objective or primary mirror cause much irradiation or glare in the observer's eye. This effect is not so prevalent in refractors as in reflectors. Irradiation can blot out a fine, dark detail line on the surface of Mars. Bright areas on both sides of a fine dark line may expand or spread over it and completely obliterate the fine detail. A yellow or orange-red filter will cut down the irradiation of the spurious disk, while also penetrating the Martian atmosphere, and thus allow fine surface detail to present itself. An example of irradiation in the human eye can be noted when the Old Moon is seen within the New Moon's arms. The New Moon appears to be larger than the Old Dark Moon.

A yellow, orange, or orange-red filter will heighten contrast between the dark **maria** and the desert areas. Light from dark blue-green **maria** is filtered out, thus giving them a black contrast to the surrounding lighter ochre desert regions.

The Atmosphere

In order to bring out Martian atmospheric details, such as clouds of moisture or of dust, a blue filter should be employed. If there is excessive Martian atmospheric scattering, surface details will not be discernible. Martian atmospheric conditions should be of definite value, if recorded, in understanding and estimating the meteorological conditions which prevail during a given Martian season. Knowing meteorological conditions of the Martian atmosphere should be of value in determining apparent surface changes over a given Martian season. It is suggested that a blue filter be employed at the beginning of each Martian observing period, since knowing the existing Martian atmospheric conditions would be useful in the selection of the most efficient filter for the penetration of the atmosphere during the time of observation.

Planetary astronomers have noted a possible decrease in Martian atmospheric blue scattering—known as "blue clearing"—for a few days preceding and following certain oppositions of Mars. The Lowell Observatory in October 1941 noted a period of "blue clearing", which lasted for ten days. During periods of "blue clearing", surface details have been observed in blue light through the Martian atmosphere. It is thought that this phenomenon occurs when ions from the Sun, which may be the essential cause of blue scattering in the Martian atmosphere, are deflected by the earth's magnetic field during oppositions apparently favorable for "blue clearing". It is extremely important to watch for periods of "blue clearing" in the Martian atmosphere during future apparitions of Mars, as not enough data are known to predict their occurrence.

A light green filter will increase the contrast between a white frost area and a bordering ochre desert; and likewise, a blue-green filter could be used to increase contrast between a cloud and an ochre desert. It is surprising how much a green filter will darken the ochre desert in contrast to a white area.

Following is a list of Wratten filters which the author has found useful in recording Martian observations with the Lowell 24-inch Clark refractor and with his own 7-inch Beede Cassegrainian reflector:

Yellow-Amber: Nos. 8, 12, 15 and 16.
Orange-Red: Nos. 21, 23 and 25.
Green-Blue green: Nos. 57 and 64.
Blue: Nos. 38A and 47.

[We thank Mr. Capen for this article and hope that A.L.P.O. members will study and utilize the ideas presented in their studies of Mars and other planets. Mr. Capen's address is Box 857, State College, New Mexico.]

VENUS IN THE MORNING APPARITION, 1953 THROUGH SUPERIOR CONJUNCTION, 1954

BY JAMES C. BARTLETT, JR.

The Recorder takes this opportunity to thank the following observers for their many contributions: D. P. Avigliano (6 in. refl.); P. M. Hackett (10 in. refl.); T. A. Cragg (6 in. refl. and 6 in. refr.); Craig L. Johnson; A. P. Lenham (3.25 in. refr.); E. A. Lizotte (3.5 in. refl.); Patrick Moore (3 in. refr.); C. C. Post (6 in. refl.); O. C. Ranck (4 in. refr.); E. J. Reese (6 in. refl.); H. P. Squyres (12 in. refr. and 6 in. refl.); H. T. Sherman (4 in. refl.); J. E. Thrusell (4 in. refr.). In addition we are indebted to T. Saheki for a chart showing the relative positions and changes in apparent diameter of Venus for the 1954 apparition. The Recorder has also contributed a few observations. Special notice should be taken of the laudable industry of O. C. Ranck, who contributed no less than 32 of the 88 observations considered herein. A particularly valuable aspect of Mr. Ranck's work is his endeavor to maintain a **consecutive** series of observations, than which nothing is more important. Commendation is equally owing to A. P. Lenham, for his extensive use of color filters in exploring the vague markings on the planet, a technique of great value in relation to Venus.

THE ILLUMINATED ATMOSPHERE. This beautiful phenomenon was observed by C. C. Post only 11 days before Inferior Conjunction. Using a 6 in. refl. at 180X, 1^h 40^m to 1^h 55^m, U. T., April 2, 1953, with T=5, S=3 to 4, Mr. Post observed a "twilight" extension completely around the dark limb. The following verbatim quotation, taken from Mr. Post's report, illustrates the circumstances of the observation:

> "The cusp extension was increased slightly (about 15 degrees). Without the aid of a filter, I suspected a brightening of the dark hemisphere. Using a red filter (war surplus, transmission unknown) I was able to see the entire dark hemisphere **brighter** than the sky background. This brightening was definite and at least ½ tone brighter than the sky (the disk was mottled). In addition, the limb was brightened **all** the way around the disc and was at least ½ to 1 tone brighter than the general glow over the entire dark hemisphere."

Without hinting at what might be expected, Mr. Post then asked Mr. Clyde Tombaugh, the discoverer of Pluto, to take a look at the planet. Without the aid of the red filter, Mr. Tombaugh saw nothing noteworthy. However, on being handed the filter, "He immediately exclaimed that he could see the planet ringed with a bright atmospheric ring . . . " Mr. Post rightly considered this to be an entirely independent confirmation of his results (unless we are to invoke Dr. Rhine's ESP!), and took the further step of soliciting information on solar activity for the day and week from the High Altitude Observatory at Climax, Colorado. Climax responded with a series of reports, which they cautioned were to be regarded strictly as "preliminary", but which none the less show that on April 1, 1953, at 16^h 35^m U. T., Cornell reported "high amplitude outbursts of solar radio noise". Though no flares were observed on the sun, April 2nd, two were found April 3rd. On the same date there was observed a highly active spot group in which no less than 8 flares were reported during the following week. On checking his solar record for April, 1953, the writer finds that he had observed this group first on March 30th, when just off the following limb. On March 31st, at 14^h 34^m, he further observed a well-marked reddish area in the penumbra, north preceding, sunspot color being an infallible index of unusual solar activity. On April 1st, profound changes were found to have taken place in this group and on April 2nd it was observed that these changes (of size, shape, intensity, etc.) were continuing. Thus there is evidence that immediately preceding April 2nd, and continuing through that date, there had been a highly disturbed area on the sun. In this connection it should be understood that while Climax was unable to report any flare activity on April 2nd, flares are only particular manifestations of solar activity which may manifest itself in other ways and in their absence. Thus, according to the Climax report, the high amplitude radio noise bursts, recorded by Cornell on April 1st, could not be associated with flare activity. While his efforts to establish a direct correlation between solar activity and the Venusian aurora of April 2nd failed in particulars, Mr. Post nevertheless is of the opinion that the illumination of the dark side of Venus, and the illumination of the atmospheric ring on the dark limb, must be referred to solar causes, an opinion in which the Recorder entirely concurs.

The Dark Side. The visibility of the dark hemisphere was observed on various dates by Patrick Moore, O. C. Ranck, H. P. Squyres, and the Recorder, in addition to the observation of C. C. Post noted above. On March 16th, 1953, at 18^h U. T., Patrick Moore recorded his observation in these words: "For the first time in my life, I saw the Ashen Light; and it was certainly clear enough—I do not think it is due to illusion or contrast. S cusp grey; N. cusp bright. The light falls off towards the terminator." On March 22, 1953, at 18^h 40^m, U. T., Moore again observed the luminescence of the dark side; and on March 24, 1953, at 19^h 20^m, U. T., Moore recorded: "Ashen Light very clear". On the 27th he found "the Ashen Light perfectly clear"; and he last saw it on March 31st, when it was "faintly seen".

On March 24th, 1953, O. C. Ranck, 23^h 30^m, U. T., saw the dark side as "very dim"; but did not see it on March 31st. Previously, H. P. Squyres had seen it, March 15th, 0^h 20^m, U. T., with the 12 in. Zeiss refractor of the Griffith Observatory.

March 17th, 1953, at 23^h 08^m, U. T., Bartlett saw it as darker than the sky "and almost blackish". On this occasion he recorded a much darker lens-shaped area (Haas' phenomenon) with a much lighter dark limb. On March 19th, 23^h 24^m, U. T., it again seemed darker than the twilight sky; and March 20th, 1953, at 23^h 13^m, U. T., the dark side seemed to possess a bluish cast, with a faint extension of twilight completely around the dark limb (possibly an early view of the illuminated atmospheric ring). However, Bartlett did not see it March 22 or 24, nor on March 31st. On March 30th, however, the Recorder saw the dark side plainly as much darker than the sky with 7x50 prism binoculars, a rather novel view. The diameter of the planet in the binoculars was than 6.34 minutes of arc, or roughly 1/5 the apparent naked eye diameter of the moon.

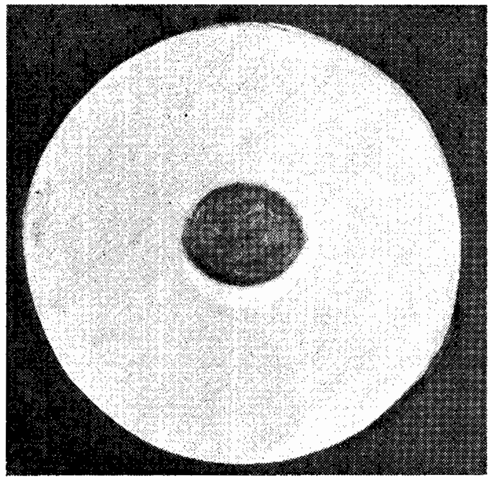

Figure 1. Venus.
March 30, 1953
23^h 30^m, U. T.
T-4, S-8 7x50 prism binoc.
James C. Bartlett, Jr.

If the reader will examine the moon with a double concave reducing glass, two or three days after new, he will gain some idea of the effect. Fig. 1 is a very inadequate representation.

The Bright Spots. These were observed, even on the narrow crescent just before Inferior Conjunction, by Thrussell, Moore, Ranck, and Bartlett; and took the usual form of brighter-than-average areas extending from the bright limb inward onto the crescent. They were frequently recorded by O. C. Ranck after Inferior Conjunction through the morning apparition of 1953, and were recorded as early after Superior Conjunction as March 16th, 1954, by the same observer. A. P. Lenham saw quite a number of them on the narrow crescent in March of '53 and found them to vary in intensity according to the color of the

Figure 2. Venus.
March 15, 1953
17^h 25^m, U. T.
3.25 in. refr. at 128x
A. P. Lenham

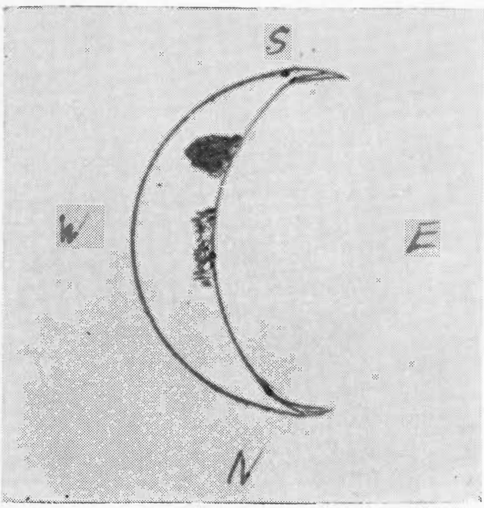

Figure 3. Venus.
March 7, 1953
0^h 30^m, U. T.
6-in. refl. at 125x
Henry P. Squyres

filter used.

This filter work of Lenham deserves more than passing notice, since it suggests either a difference in composition of the bright areas or, as is more probable, a difference in elevation. One here thinks of the different altitudes of the blue and yellow clouds on Mars. Thus on March 4th, 1953, Lenham described two adjacent bright areas on the crescent, the western one of which he found to be bright in blue light but only fairly bright in yellow and red. On the other hand, the eastern member of the pair was very bright in yellow light, bright in red, but only fairly bright in blue light. This observation was made at 17^h 35^m, U. T., with good definition.

March 6th, 1953, at 17^h 45^m, U. T., Lenham observed several bright areas, the majority of which were brightest in yellow light. On March 10th, 1953, at 17^h 30^m, U. T., Lenham observed several such spots, some of which were brighter in yellow light while others, notably the south cusp and an area on the bright limb near the north cusp, were much brighter in blue light. On March 20th, 1953, at 23^h 13^m, U. T., the Recorder found the S. cusp "quite dusky" in red light. Fig. 2, from Lenham,, will give a good general idea of the nature of these bright areas on the crescent before Inferior Conjunction.

The Dusky Spots. A peculiarity of the 1953 apparition, before Inferior Conjunction, was the persistence of dark markings almost to the date of Conjunction itself. These sometimes took the form of oval dark spots (Fig. 3), sometimes combinations of these with streak markings (Fig. 4), and sometimes only streaks (Fig. 5).

After Inferior Conjunction, as more of the crescent became illuminated, maria-like dusky spots were frequently recorded, generally diffuse and dim. Fig. 6, from E. J. Reese, gives a good idea of their general appearance as does Fig. 7 from T. A. Cragg.

However, O. C. Ranck recorded many streak markings, often in association with the large, dusky areas. On March 16, 1954, at 23^h 25^m, U. T., Ranck drew Venus very much as Lowell depicted it

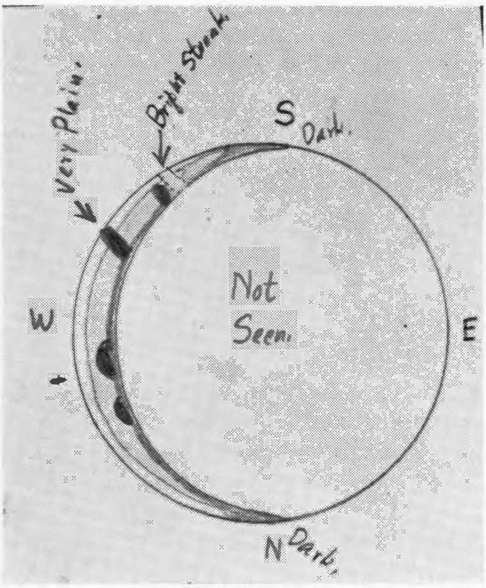

Figure 4. Venus.
March 31, 1953
23^h 15^m, U. T.
4-in. refr. at 180x
T-3 S-2 to 4
O. C. Ranck

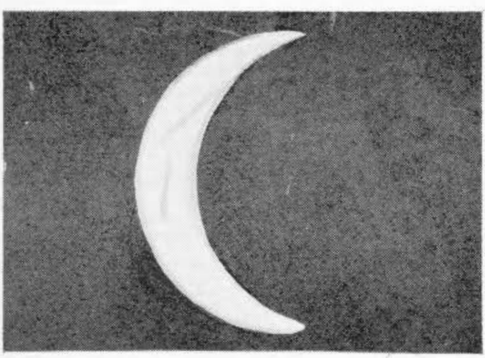

Figure 5. Venus.
March 16, 1953
23^h 30^m, U. T.
3.5 in. refl. at 100x
James C. Bartlett, Jr.

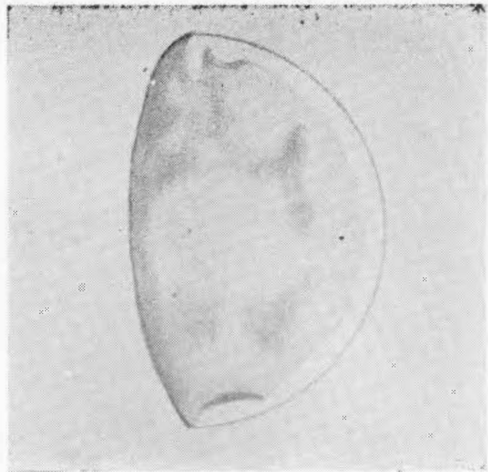

Figure 6. Venus.
July 26, 1953
10^h 55^m, U. T.
6-in. refl. at 220x
T-3 S-4
E. J. Reese

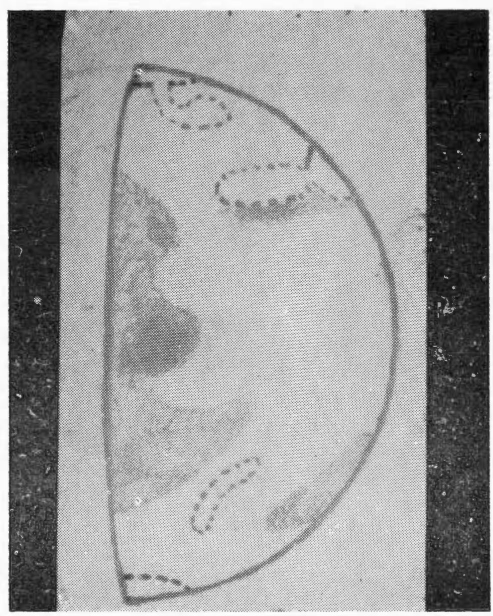

Figure 7. Venus.
June 25, 1953
17^h 50^m, U. T.
6-in. refr. at 135x
T-4 to 5 S-2 to 3
Thomas A. Cragg

Diagram I. General distribution of lunar colors at full moon, based on observations by D. P. Avigliano. For details, see article "Lunar Colors" in this issue.

Numbered areas on diagram 1

1. Mare Tranquillitatis
2. Mare Serenitatis
3. Lacus Somniorum
4. Mare Imbrium
5. Mare Frigoris
6. Sinus Roris
7. Mare Crisium
8. Mare Foecunditatis
9. Mare Nectaris
10. Mare Vaporum
11. Sinus Medii
12. Mare Nubium
13. Mare Humorum
14. Oceanus Procellarum
15. Area around Copernicus
16. Area around Kepler

Key to color abbreviations used on diagrams in this section

BG—brownish grey
BY—brownish yellow
G—grey
GB—greyish brown
GY—grey - yellow
GYW—greyish yellow - white
W—white
WBY—whitish brown - yellow
WY—whitish yellow
WYG—whitish yellow - grey
Y—yellowish
YB—yellowish brown
YG—yellow - grey
YGW—yellowish grey - white
YW—yellowish white
GBY—greyish brown - yellow

Note: In these color diagrams no attempt has been made to show the smaller details. The diagrams are not all drawn to the same scale.

All diagrams in this section are by D. P. Avigliano

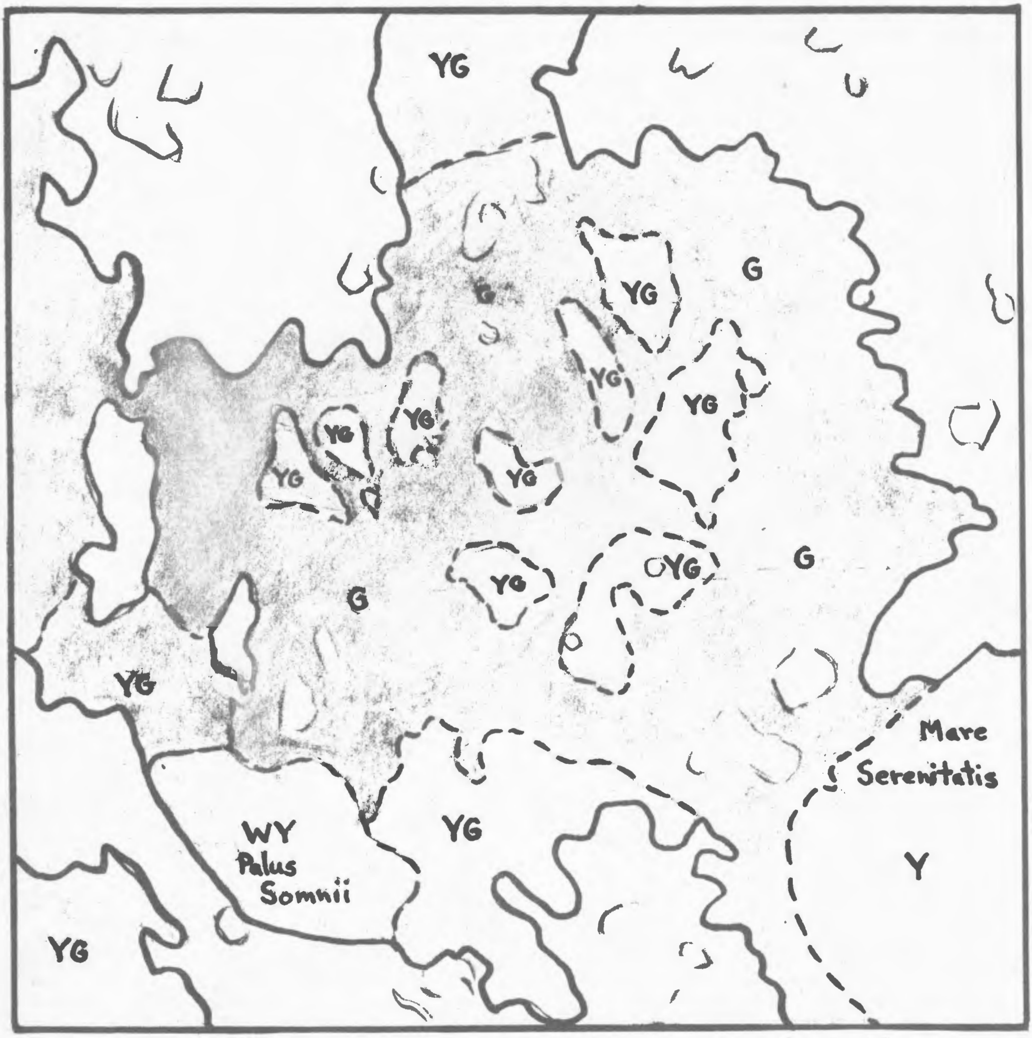

Diagram 2. The locations of the main color tints and splotches in the Mare Tranquillitatis area. Full Moon.

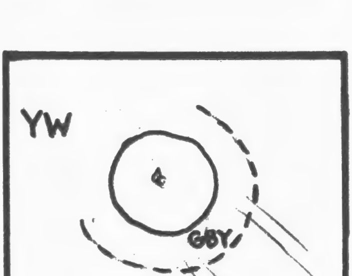

Diagram 3. Tycho.
March 18, 1954 U.T.
Colong. 74°

Diagram 4. Tycho.
April 18, 1954 U.T.
Colong. 91°

Diagram 5. Color distribution in the Mare Serenitatis area. Full moon.

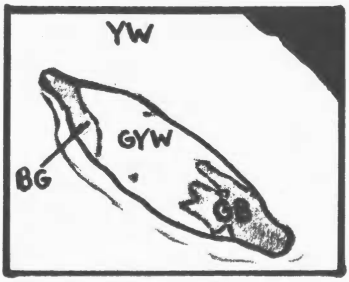

Diagram 6. Schickard.
April 18, 1954 U.T.
Colong. 91°

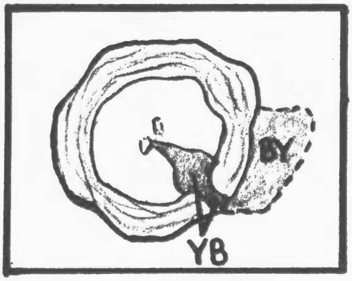

Diagram 7. Copernicus.
February 15, 1954 U.T.
Colong. 55°

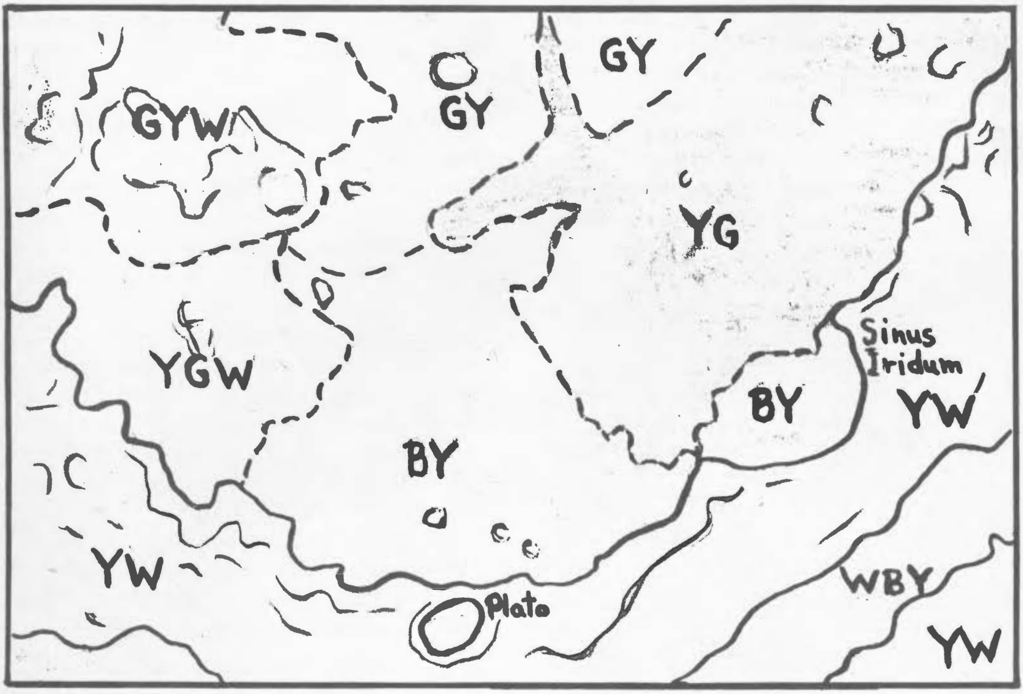

Diagram 8. Areas of color on the northern portion of the Mare Imbrium. Full Moon.

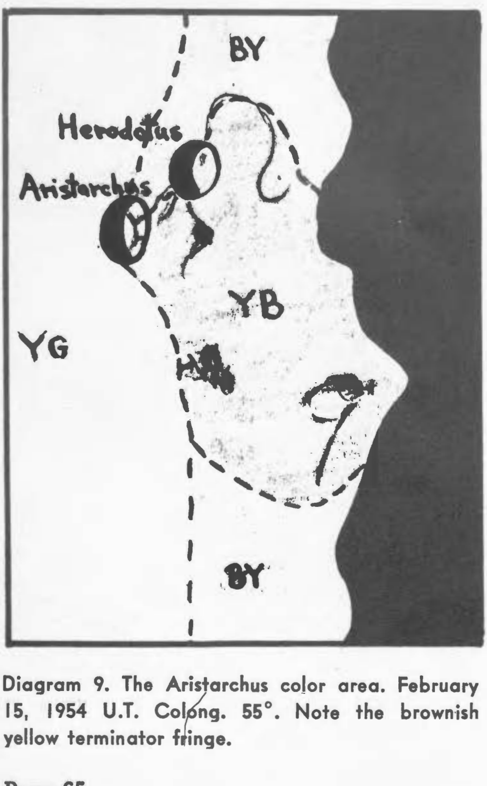

Diagram 9. The Aristarchus color area. February 15, 1954 U.T. Colong. 55°. Note the brownish yellow terminator fringe.

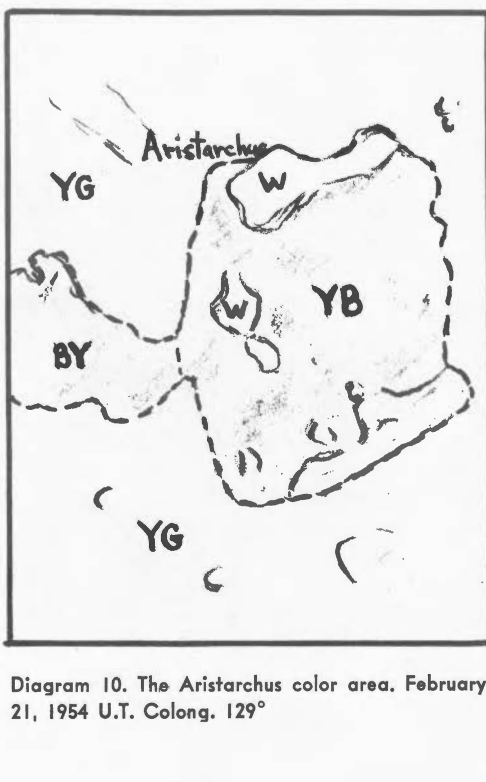

Diagram 10. The Aristarchus color area. February 21, 1954 U.T. Colong. 129°

(Fig. 8) with the streaks as the predominant type of marking. R. M. Baum has been perhaps the chief exponent in recent years of the linear markings, and a paper now in preparation will discuss his observations fully. A curious point is that those who see the large, ovoid, dusky areas generally have difficulty with the streaks; while those who record an

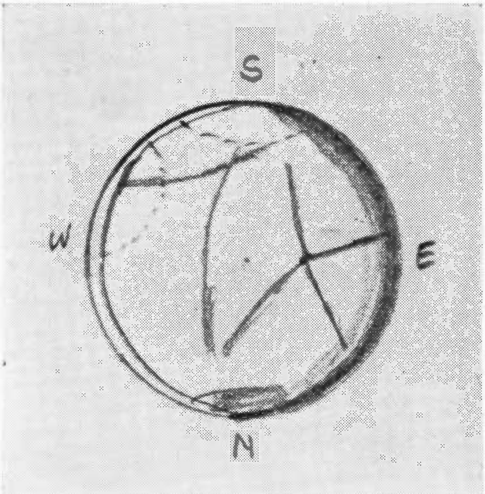

Figure 8. Venus.
March 16, 1954
23^h 25^m, U. T.
4-in. refr., 180x and 90x
T-4 S-4
O. C. Ranck

abundance of streaks appear to be relatively insensitive to the maria-like features. One here thinks of Barnard and Lowell in relation to Mars. However, there can be little question of the existence of both types of markings.

The Cusp Caps. Just before Inferior Conjunction in the spring of '53, the cusps occasionally appeared **dusky.** On March 19th, 1953, at 23^h 24^m, the Recorder observed the N. cap to be a brilliant white and the S. cap, east of Schiaparelli Vallis, was shaded. Again on March 20th, 23^h 13^m, U. T., this writer again saw the S. cusp dusky. On March 21st, 22nd, and 24th, he found both cusps dusky. This was confirmed by O. C. Ranck for March 21st and 24th. who also saw both cusps dusky on those dates.

O. C. Ranck alone supplied data for the weeks immediately following Inferior Conjunction. On May 3rd, 1953, May 10th, 1953, and June 3rd, 1953, Ranck found both cusps dusky; but on July 5th, 1953, at 15^h 15^m, U. T., Ranck found the S. cusp "very bright", the N. cusp still shaded. However, on June 14, 19, 20, 22, 25, and 26, T. A. Cragg recorded bright cusps N. and S. Cragg's drawings show the S. cusp generally the more prominent of the two, which is the usual relation. It is to be observed that there is a gap in O. C. Ranck's observations between June 3rd and July 5th, partly supplied by the June observations of T. A. Cragg. The cusps, therefore, apparently brightened during this interval.

Thereafter, Ranck generally shows the S. cusp the larger of the two; but on Sept. 18th, at 10^h 25^m, U. T., Ranck again recorded both cusps dusky; while on

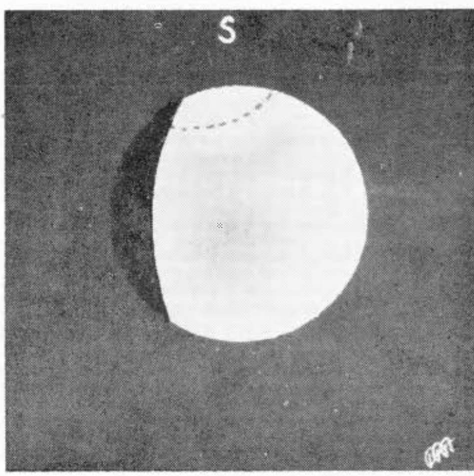

Figure 9. Venus.
September 29, 1953
13^h 30^m, U. T.
6-in. refl. at 168x and 224x
T-4 S-2.5 to 2
D. P. Avigliano

September 29th, 1953, at 12^h 15^m, he recorded a large, bright N. cap and a shaded S. cap; and again on Oct. 1, at 10^h 20^m, U. T., Recent views, following Superior Conjunction on January 30th, 1954, at 0^h, U. T., have shown a very prominent S. cap, bordered by the dark cusp band; sometimes with an equally large and bright N. cap. The large S. cap was also seen well shortly before Superior Conjunction (Fig. 9). The Recorder first observed Venus during the current apparition on February 25th, 1954, at 23^h, U. T., and found the very nearly full disc featureless; but with wretched definition.

Terminator. Slight irregularities were noted by several observers, and on May 3rd, 1953 15^h 45^m, O. C. Ranck observed a pronounced "hump" in the bright morning crescent a little S. of the N. cusp. T. A. Cragg shows a generally irregular outline, though on June 25th, 1953, at 17^h 50^m, the terminator is drawn as a smooth curve by that observer. T. A. Cragg is the only observer to contribute data at and near Greatest Elongation West, which occurred June 22, 1953, at 10^h, U. T. On June 19th, 1953, 19^h 35m, Cragg found the terminator still concave. On June 20th, 1953, 19^h 25^m, U. T., a pronounced convexity on both sides of the apparent equator, associated with concavities at either cusp made it impossible to say whether the terminator was more convex than concave and vice versa. On June 22, at about 19^h, U. T., Cragg recorded a nearly straight terminator, though of irregular outline; while on June 25th, 17^h 50^m, U. T. he found the terminator definitely convex. However, on June 26th, 18^h 40^m, the terminator appeared slightly concave. The Recorder would observe that the data are too insufficient to permit the fixing of apparent dichotomy.

Some Anomalous Observations. Mr. P. M. Hackett has submitted a series of highly interesting observations of a bright "star point" near the N. cusp of Venus, which he first observed May 26th, 1954, at 0^h, U. T., with a 10 in. refl. stopped generally to 7 ins. and with a power of 180x. Forty minutes later, he observed the bright point to have moved westward on the disc relative to the terminator. On May 26th, 1954, at 23^h 45^m, U. T., he observed what appeared to be the first indication of this point at the tip of the N. cusp; and by 0^h 10^m, May 27th, he found it a little farther onto the disc. By 0^h 55^m, U. T., May 27th, it had moved considerably farther west. Mr. Hackett speculates on the nature of this object, suggesting that it might be a mountain peak protruding above the cloud layer, possibly snow-capped. This is in harmony with R. M. Baum's observations of similar bright points near or within the S. cap, and elsewhere on the disc. Mr. Hackett believes that the apparent movement of this bright point indicates a rotation close to 24 hours. Unfortunately it is not possible to make trustworthy measurements from the drawings for a reason which will appear shortly.

The question of the rotation is, of course, a very open one; and in this connection the Recorder reiterates his opinion that the best chance for direct, visual determination is by means of irregularities at the cusps. Studies of the notable indentation in the terminator, just N. of the S. cusp cap, have also led this observer to believe that the rotation lies somewhere between 23 and 24 hours, which is neither here nor there.

However, there is one puzzling feature of Mr. Hackett's sketches which must make one question whether this star point has been correctly placed with respect to the terminator. Mr. Hackett draws the planet, for the dates given above, as it will appear at or near Greatest Elongation East which will not be reached until Sept. 6th, 1954. In other words, he shows Venus at the quarter phase, with an irregular but generally straight terminator; whereas for the dates of observation, as given, the planet was some 86% of being full. Unfortunately, this circumstance vitiates what might have been a most important observation.

We now consider something hardly less interesting. On April 5, 1954, Mr. Craig L. Johnson was observing Venus with a small, terrestrial telescope rated at 40x but which Mr. Johnson thinks may be nearer 80x. It is important to notice that the semi-diameter of Venus on that date was 5″.16 corresponding to a diameter of 10″.32 of arc. A power of only 40x would therefore yield an apparent diameter of nearly 7′, while 80x would raise a disc of almost 14′, or about half the apparent naked eye diameter of the moon. The phenomena reported, therefore, could have been visible to the instrument, at least at 80x. Around 6:40 P. M., M. S. T., April 5th, (1^h 40^m on April 6 by U. T.) Mr. Johnson suddenly saw a flash on the bright disc and near the bright limb, to be followed immediately by another. Around 6:50 P. M., M. S. T., he observed two more such flashes near the same spot. He reports that the first flash was red; the second, "almost white"; the third, a medium yellow; and the fourth, "dull yellow". In view of credible reports of recent similar flashes observed on Mars, and in the very nature of things, there is nothing impossible in these observations. The more the pity then that there is lacking practically all the data necessary to a proper evaluation. For instance, was the telescope reasonably achromatic? What was the diameter of the objective? What was the true power? How was the instrument mounted? Was it mounted? What were the exact times involved? And so on.

These questions are asked, not to cavil, but to emphasize the importance of accessory data without which an observation is rendered valueless. Again, in the very nature of things, there is no reason why even the casual observer may not make an original discovery; but in order that his contribution may have evidential value it is essential that he understand the requirements of scientific observation. These have all been explained in previous issues of **The Strolling Astronomer,** to which interested readers are respectfully referred.[1]

1. **The Determination of Central Meridian and Colongitude;** The Strolling Astronomer; January, 1952; p. 10.
   For the Beginner: The Computing and Use of Colongitude; ibid., April, 1953; p. 46.

   For the Beginner: What to Record with Every Lunar and Planetary Observation, ibid., May, 1953; p. 63.
   For the Beginner: Some Precepts Concerning Lunar and Planetary Drawings; ibid., June, 1953; p. 87.

THE LIMITS OF TELESCOPIC RESOLUTION: A SYMPOSIUM

[The present article is a continuation of a round robin discussion on this fundamental problem in our March, April, July, and August, 1953 issues. Our contributor in this issue is Mr. Arthur S. Leonard of the College of Agriculture of the University of California at Davis, Calif. We quote much of a very informative letter from Mr. Leonard dated May 18, 1953.]

. . . Assuming the conditions of perfect seeing and a perfect telescope (and this includes the eyepiece and the lens of the observer's eye), an image composed entirely of Airy diffraction patterns will be formed on the retina of the observer's eye. Each point of light in the object will be represented by a complete diffraction pattern in the image. The relative brightness of each Airy pattern will be directly proportional to the relative brightness of the point of light in the object, and its relative size (diameter) will be directly proportional to the wavelength of the light. Since the human eye is sensitive to only a rather narrow range of wavelengths, all the diffraction patterns which stimulate the retina will be of about the same size.

It might be thought that this state of affairs would place a rather definite limit on the closeness of separate details in the object that could be distinguished as such, and that the limiting closeness would be roughly equal to the diameter of the central discs of the diffraction patterns. Theoretically, at least, this is not the case. If any point of light in the object, no matter how small, were to be added or removed, a corresponding diffraction pattern in the image would be added or removed; and no other change or combination of changes in the object could be made to produce exactly the same change in the image. From this we must conclude that if the image could be analyzed with absolute accuracy and in infinite detail, the object could be reconstructed in all its details.

In actual practice, of course, there is a limit to the accuracy with which the image can be analyzed, and, therefore, a limit to the amount of "reconstruction" of the object that can be realized. This is where theory ends and experiment begins.

One rather simple experiment which may serve to show what the eye can do in the way of reconstruction of the object is to observe a television picture first from close up and then from farther back. If the image is not very clear, due to the set being either not well tuned to the broadcasting station or located in a "fringe" area, the experiment is more striking. From close up the eye can make out only a series of rather large and fuzzy dots of light of varying brightness of which the image is composed. As we move back, however, we see these same spots of light take on the form of our favorite movie actress; and, at the best distance from the screen, we can make out a surprisingly large number of separate features and details of the object. This indicates that if the individual spots of light or diffraction patterns are not too large and fuzzy, the eye may be able to do a very appreciable amount of "reconstruction" from the image that it sees. It also indicates that if the image is spread out too much, such as would result from the use of too high a magnification, the loss of detail in the image may be very appreciable.

Another simple but very instructive experiment is to view a scene through a pinhole. The writer has found a hole made with a No. 80 drill (1/74th of an inch in diameter) well suited for this purpose. The scene should include one or more small bright points of light such as are to be found on any late model automobile when it is in the bright sunlight. The very bright points of light will show rather complete Airy diffraction patterns (central disc plus several rings) and will give a good idea as to the magnitude of the Dawes limit (41 per cent of the diameter of the first dark ring) for the aperture. The size and sharpness of the smallest and sharpest details in the field of view will appear to be so much smaller and sharper than the central discs of the bright diffraction patterns that the observer may find it difficult to accept the idea that the smallest spot of light falling on the retina of his eye is actually as large as these bright central discs.

This experiment, also, indicates that where the illumination and contrast are favorable the eye can do a lot of "reconstructing" with the image. For the very bright points in the object, the eye merely reports what it sees—brilliant Airy discs—but for the other parts of the object it tries to tell what is there. This experiment shows that under the most favorable conditions of illumination and contrast the finest and sharpest details that can be seen appear to be much smaller and sharper than the separation of the closest pair of double stars that can be really resolved with the same aperture.

When it comes to separating and identifying individual details in the object, on the other hand, the Dawes limit appears to be reasonably close to the average actual limit of resolution for the aperture. This can be verified by viewing through the pinhole aperture various combinations of light and dark lines and spots on various backgrounds. It will be found that many of the individual details will appear to be considerably smaller and sharper than the closest spacing that can be resolved.

To cite an example of this—two pairs of parallel wires were observed through a small aperture. The individual wires were 0.0035 inches in diameter and were spaced about 0.078 and 0.047 inches apart. The aperture and distance were such that the Dawes limit was about midway between these two spacings. The wider pair could be resolved quite easily and the individual wires appeared so sharp that it was estimated that the limit of resolution should be about one-third of their separation. The other pair, on the hand, which had a separation of a little less than two-thirds as great, could not be resolved by any stretch of the imagination. Its actual structure might have been deduced, however, because it did not appear to be anywhere near as sharp as the individual wires of the resolved pair or as sharp as other lines in the field of view that were as wide as it appeared to be.

These controlled experiments indicate that a planetary observer might be justified in drawing some individual details considerably smaller and sharper than the Dawes limit for the aperture being used. On the other hand, the writer is of the opinion that where the angular separation of individual details is much less than the Dawes limit, an accurate picture of them cannot be drawn, although their presence might be deduced.

The following is in answer to Mr. Hare's question about the diffraction effects in the images of dark markings:

The image of a continuous light background is composed of an infinite number of over-lapping infinitesimally faint Airy discs. For all practical purposes, however, it can be treated as though it were composed of a finite number of overlapping diffraction patterns of finite brightness. The result will still be an image of practically uniform brightness. The presence of a black dot in this background will eliminate one Airy disc from the image. The result will be a uniformly bright image, minus one Airy disc—complete with all its rings. If the angular diameter of the black dot is only a small fraction of the diameter of the central disc of the diffraction pattern for the aperture being used, the Airy disc may be so faint that its loss cannot be detected by the eye. It is still there, however, and its presence (or loss from the otherwise continuous background) might be established with the aid of a very sensitive and accurate microphotometer.

As the dot is made larger, the loss of light in the image at the center of the diffraction pattern becomes greater and the central disc becomes easier to see. At the same time, however, this reduces the contrast between the light and dark rings of the diffraction pattern. By the time that the black spot has been made large and prominent enough for the rings to be seen (provided that their contrast could be maintained) the rings probably will be completely blurred out. For this reason it appears unlikely that any combination of background brightness and spot diameter can be found which will reveal to the eye even the first ring of the diffraction pattern.

The same general remarks will hold true for a dark line when seen against a light background. The width of the narrowest dark line, however, will be much less than the diameter of the smallest dark spot that can be seen against the same background. This may be one of the reasons why the finest and sharpest of recorded planetary details have line-like structures.

In observing planetary details, the most usual situation encountered is one in which neither the markings nor the background are completely dark. In this case the size of the smallest detail that can be seen will be about the same for a marking lighter than the background as for one which is darker.

[Mr. Elmer J. Reese writes that a pre-publication examination of Mr.

Leonard's article caused him to view a prepared scene through a tiny pinhole. Mr. Reese says: "The apparent width of the finest dark line that could be seen was indeed very small compared to the diameter of a bright diffraction disc. However, when two such lines were brought closer together than Dawes limit, each line lost the sharpness it exhibited when seen by itself, and the two images blurred together." —Editor . . . .]

(To be continued.)

ABOUT REFLECTORS AND REFRACTORS

BY DAVID W. ROSEBRUGH

In Mr. Clyde W. Tombaugh's discussion of "The Limits of Telescopic Resolution" on Page 110 of the August 1953 **Strolling Astronomer** he states that he disagrees with my comments (on page 44 of the March 1953 issue) to the effect that a reflector must have double the aperture to compare with a refractor.

Probably my remarks were obscure or Mr. Tombaugh would not have taken quite this meaning from them. What I intended to convey was my belief that one has to go to double the aperture for a reflector to be **definitely superior** to a refractor. This belief is occasioned by a number of odd circumstances (a) when one goes from naked eye observations to the use of a 3″ refractor at, say 60X, one takes such an enormous stride forward that one cannot again take a step forward to equal it, for to do so would require an aperture of 45″ and a power of 3600X, if we consider the aperture of the eye as 0.2″ and its power as 1X. Thus a 4″ refractor is only just noticeably superior to a 3″ and a 6″ to a 4″. (b) it is my opinion that reflectors are **equal** to refractors if they have 140% of the aperture (c) this requirement "b" taken in conjunction with "a" and with the actual commercial sizes of lenses and mirrors works out so that in some cases a reflector has to be of double the aperture of a refractor to **definitely exceed** the refractor in performance.

The adjacent table illustrates this oddity.

My experience that a reflector must be of 140% of the aperture of a refractor to equal it in power is based upon the following Newtonian reflectors which I have used during the past 25 years for varying periods of time: (1) 4.25″ RFT. This had a light grasp of 11.8 stellar mag., exactly equal to my 3″ refractor; but it would not stand a power in excess of 37X. This of course was to be expected. The 3″ refractor was generally superior. (2) 6″ F/8, with elliptical diag-

Refractor aperture inches (a)	140% of (a) "Equality" inches (b)	Next appreciably larger commercial size than (b) inches (c)	Ratio (c) to (a) % (d)
3	4.2	6 (1)	200
4	5.6	8 (2)	200
5	7.0	8 (3)	160
6	8.4	10 (4)	167
7	9.8	12	171
8	11.2	16	200
9	12.6	16	178

NOTES:
(1) definitely superior to 3″ refractor.
(2) The 6″ size would be so little better that the superiority would not be readily apparent.
(3) To be definitely better one would have to go to the 10″ size.
(4) To be definitely better one might have to go to the 12″ size.

onal good to 0.1 wave. My tests indicated the mirror as being 130% overcorrected, but within acceptable limits. Others, more experienced, considered it undercorrected. Its light grasp of 13.5 stellar mag. slightly exceeded the 13.1 mag. light grasp of my 4″ refractor. The definition was no better. However, I have just had this mirror refigured and preliminary tests indicate improved performance. (3) 8.75″ F/8.3, with elliptical diagonal good to 0.1 wave. This mirror was made by a well-known professional maker, and my tests indicated that the figure was perfect. Its light grasp of 14.0 mag. exactly equalled that of my 6″ refractor; but the reflector had, in general, poorer definition than my 6″ refractor. I used this 8.75″ reflector a great deal and thoroughly compared it against my 6″ refractor. (4) 12″ F/8.3, with a professionally made prism diagonal. Home-made mirror but with acceptable figure. Light grasp and definition superior to 6″ refractor.

These experiences give me the impression that 140% is about the point of equality; but others, especially in warmer climates so that the temperature of the air is nearer that of the human body, may have had better proportionate results with reflectors than I have had.

[Mr. Rosebrugh is one of our charter members and is well known for his active work in the A.A.V.S.O. His address is 66 Maple Ave., Meriden, Conn.—Editor.]

BOOK REVIEW

BY JACKSON T. CARLE

OUR NEIGHBOR WORLDS, by V. A. Firsoff, M. A., Philosophical Library, New York, 1953. 336 pages — $6.00.

This is an extraordinarily lucid description of the solar system, the mechanics of its organization, and the basic theories of space flight. This reviewer thoroughly enjoyed **Our Neighbour Worlds.** Mr. Firsoff's unusual gift for clarifying relatively difficult mathematical concepts gives the untrained reader a grasp of celestial mechanics and an understanding of the interworking of mass, gravity, velocity and acceleration. The formulae are provided too, for the benefit of the mathematically inclined, but they are grouped in an appendix, where they do not trouble the general reader.

The author has some ideas of his own about the origin of the solar system and about possible conditions of its planets. Some of his theories are at variance with those generally held by astronomers. He invariably presents the known facts as established by observation, a thorough review of generally accepted theory derived from the known facts, and an offering of his own views. There is never any possible confusion between knowledge and personal opinion. This reader is not qualified to pass upon the merits of Mr. Firsoff's theories. He did find them thoughtful and stimulating and the author's presentation is convincing.

Mr. Firsoff's views centralize in his theory of the mode of formation of the solar system, which he calls the "Nova Cosmogony." He postulates that our Sun was at one time a pulsating nova, which threw off shells or envelopes. These shells underwent considerable segregation of the included matter by atomic weight, and continued the rotation imparted by the primary. The interplay of forces reduced the shells to rings, principally ranged in the plane of the ecliptic.

From these rotating rings the planets condensed. Mr. Firsoff contends that in the planetary system out as far as Saturn, there exists a clear connection between the mean density of the planets and their mean distance from the Sun. This, he believes, indicates atomic segregation, explained by his cosmogony and at variance with other theories. He finds other cosmogonies intrinsically improbable or exceptional, and thus abhorrent to an inquiring mind, while he believes his theory is in conformity with the observed activity elsewhere in the universe, including observation of novae and of such objects as the Crab Nebula, which may have resulted from a nova or supernova observed by the Chinese in A. D. 1054.

Our Neighbour Worlds is not top-heavy with the author's views. It contains a wealth of solid fact and summarizes practically all observed knowledge of the solar system. It clearly establishes the gaps and voids in our knowledge, needing to be filled. The book falls into three parts. Chapters II to IV provide general background information. Chapters V to VIII deal with the theory of space flight. Chapters IX to XIV comprise a detailed astronomical description of the Solar System.

The reviewer found interest in the book's clear exposition of rocket theory and particularly, in how rockets may work with orbital velocity and take advantage of gravity to achieve interplanetary flight with minimum expenditure of fuel. Incidentally, the author thinks our future rocketeers may not find surface conditions on many of the planets as inhospitable as they frequently are pictured.

This reviewer predicts that planetary and lunar observers who read **Our Neighbour Worlds** will go to their telescopes with new understanding and appreciation of the objects their instruments reveal, and will be better equipped for a rewarding study of our neighbors in space.

OBSERVATIONS AND COMMENTS

Neptune. A drawing of this seldom-sketched planet is reproduced as Figure 10. Mr. Owen C. Ranck made this drawing with the 30-inch Thaw refractor at the Allegheny Observatory of the University of Pittsburgh. He was at Pittsburgh for the Middle East Regional Convention of the Astronomical League. The 30-inch refractor was designed for photography, and a 12-inch correcting

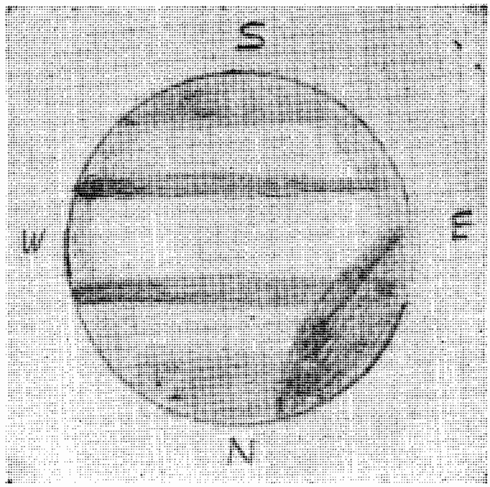

Figure 10. Neptune.
O. C. Ranck.
30-inch Thaw refractor. 550X.
May 30, 1954. 1^h 50^m, U. T.

lens is employed with it for visual work. Mr. Ranck writes that Dr. N. E. Wagman, the Director of the Observatory, and Mr. Clark McClellan assisted him and confirmed his observation. He calls attention to the shaded limb (like those of Jupiter and Saturn), the brighter Equatorial Zone (?), and the two dark belts bordering this zone (again reminding us of Jupiter and Saturn). Yet there are difficulties in this interpretation, for an Equatorial Zone in the plane of the orbit of satellite Triton would be inclined in a south by east-north by west direction, **not** east-west as drawn in Figure 10 (see diagram on pg. 518 of the 1954 **A.E.N.A.**). Readers might like to refer to 1953 observations of Neptune by Cragg, Epstein, and Ranck on pp. 103-104 of **The Strolling Astronomer** for July, 1953. (The published reproduction of Mr. Cragg's drawing is rather poor, however.). The angular diameter of Neptune was 2″.5 when Ranck made his 1954 drawing. This planet might repay more study by A.L.P.O. members having telescopes 12 inches and more in aperture.

Aristarchus. Drawings of this famous

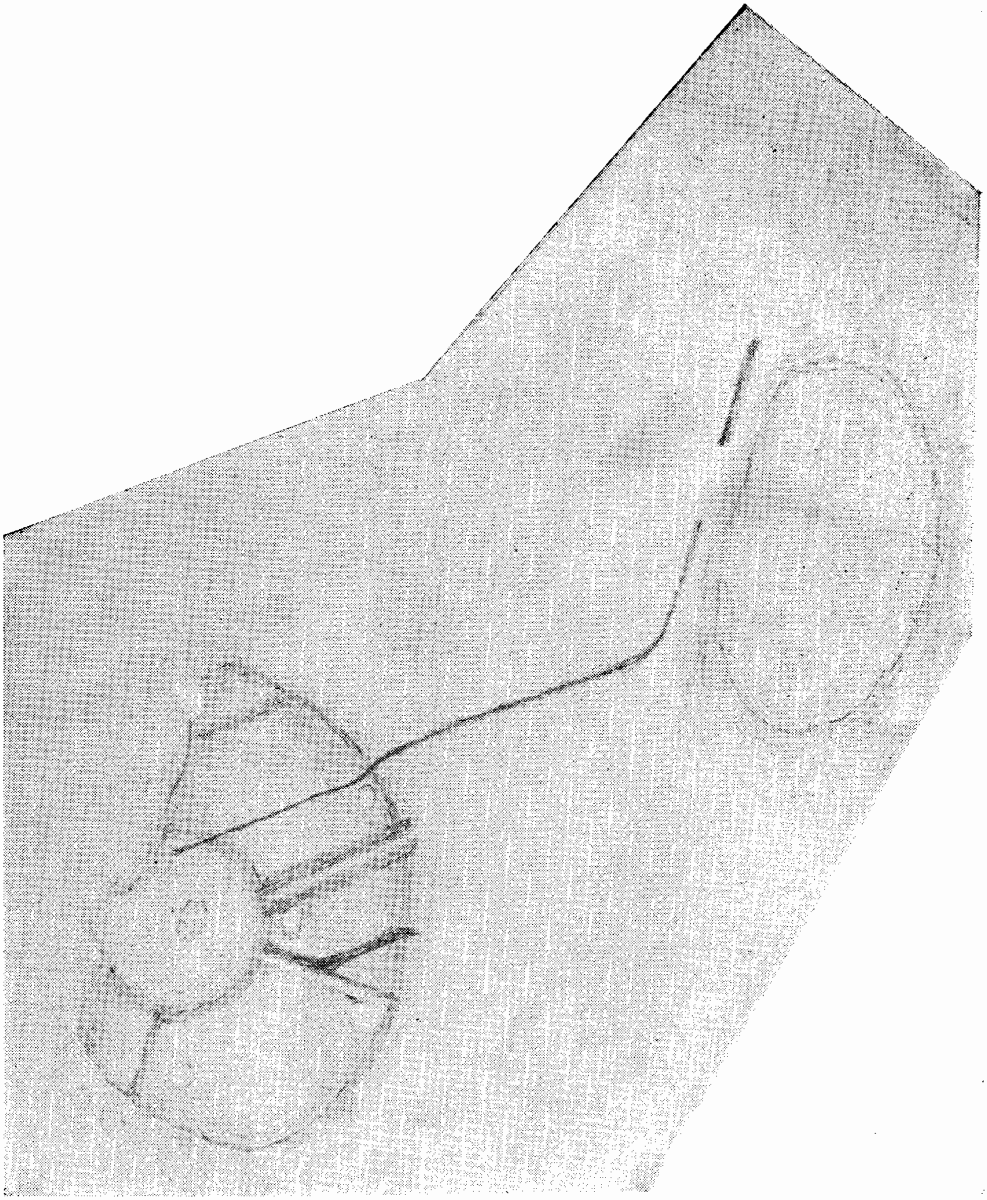

Figure 11. Aristarchus and Vicinity.

Jackson T. Carle.
8-inch reflector. 260X.
October 23, 1953. 6^h, U. T.
Colongitude = 96°.5.

lunar crater have been contributed by R. M. Adams (3.2-inch and 4.3-inch refractors), J. T. Carle (8-inch refl.), A. P. Lenham (6-inch refl.), A. K. Herring (8-inch refl.), and A. C. Montague (4.2-inch refl.). Mr. Carle's detailed drawing is reproduced as Figure 11, and part of his accompanying letter is here given **verbatim:** "I have drawn in Herodotus on the Aristarchus drawing merely to indicate the position and relationship with the extended Aristarchus band and the whitish area surrounding it, and did not attempt any detail on the floor of Herodotus. I was particularly interested in this band because of your comment on a prior drawing that the band originates (or terminates) near the central mountain in Aristarchus. You may recall that in the prior drawing I showed it ending to the south of the central mountain. I saw it clearly on repeated occasions when seeing was relatively stable and there is no doubt in my mind that this band, at least, is in the position shown within the crater. I was also struck by the fact that the faint band at the southern tip, the long band, the broad double band and the south arm of the Y are apparently parallel within the crater and that, if their parallel quality has any significance, they bear no relationship to the central mountain. The band shown as double was pretty definitely so, with a lighter area between the two lines. It was the most apparent feature because of the width of the two bands together, but the long band, though quite narrow, was distinctly blacker. The south arm of the Y is about the same width and intensity as the bottom (westerly) portion, but the north arm is apparently more narrow and fainter. The object is rimmed on the north by a brilliant white edge which merges into a white spot at the rim. I saw the other brilliant white spots as shown, but seeing was not good enough to pick up any craterlets. The dark band encircling the central mountain [floor?] was relatively dim, as was the northernmost band. There is a break in the long band opposite Herodotus, but it resumes to the south as shown, being there somewhat wider and blacker." Mr. Carle's drawing was made with Aristarchus about four days inside the sunrise terminator.

The question of whether the dark bands on the inner wall of Aristarchus are, at least in part, parallel or whether they instead apparently radiate from near the central mountain is interesting, the results of different observers being inconsistent. A drawing by A. C. Montague on February 19, 1954 near colongitude 103° confirms Jackson Carle in showing parallelism. Yet H. P. Wilkins in an excellent view with the Meudon 33-inch refractor traced one of these dark bands across the floor to the brilliant central mountain. (**The Strolling Astronomer,** Vol. 6, pp. 95-97, 1952). A.L.P.O. members might bear this matter in mind when observing Aristarchus. There is an excellent discussion of lunar dark wall bands on pp. 180-184 of Patrick Moore's **Guide to the Moon.**

Under low morning lighting two dark bands are readily seen on the east inner wall of Aristarchus; these are the double band of Figure 11 as a single object and the Y. Different observers impute very different widths to the dark bands, the variation being fully as great as for the canals of Mars. Perhaps they are really about as wide as the intervening bright portions of the wall. The conspicuousness of the dark band bordering the edge of the floor of Aristarchus on Figure 11 may well vary independently of the solar lighting. The Y is sometimes drawn as a simple and single band not reaching the rim of Aristarchus, for example by Montague on February 19, 1954 near colongitude 103° and by Herring on January 17, 1954 at 62°.4. Mr. A. P. Lenham's drawing on December 1, 1953 at colongitude 210.°5, and thus under evening lighting, shows two very bright ovals, perhaps low hills or mounds, to the west of the central mountain. Mr. Herring at 62°.4 drew a peak near the southern edge of the floor and a shaded area (less black than shadow), to its southeast. This peak is apparently shown as a low, large mound on a drawing by E. E. Hare at 61°.4, Figure 4 on pg. 1 of our August, 1951 issue.

In connection with Mr. Frank Suler's strange failure to see the two main dark bands on the east inner wall of Aristarchus on November 18, 1953 at 51°.8 (pg. 159 of the November, 1953 **Strolling Astronomer**), Mr. Howard G. Allen writes that he saw both bands an hour earlier on the same date.

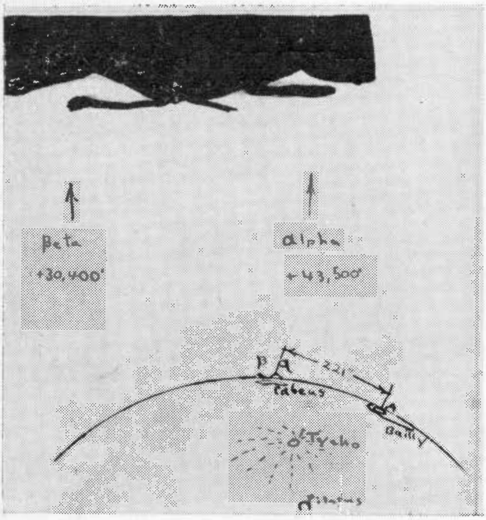

Figure 12. Two High Peaks in Leibnitz Mountains.

John E. Westfall.
4-inch refractor. 180X, 120X.
January 18, 1954. 2^h 30^m, U. T.
Colongitude = 73°.0.

Possible Very High Peak in Leibnitz Mountains. Mr. John E. Westfall on February 1, 1954 wrote in part as follows: "[On January 18, 1954] I noticed two peaks near the southern limb, one of which reared itself to an immense height. I saw that this must be much higher than the heights usually accepted even for the Leibnitz Mountains. Using my micrometer, I found the height of the large peak (Alpha) with seven measures, and that of the small peak (Beta) with three measures. I also roughly found the position . . . The height of the lower peak was reasonable (30,400 feet), but the results gave the height of the larger as 43,500 feet! In order to be sure, I did the entire formulae over again, but got the same result . . . I have reason to believe that this is the peak given as Alpha (just south of Cabeus) on the Wilkins map." The reference is to Section XXIII of the Wilkins map, and the positional agreement is certainly good. Figure 12 indicates the position and appearance of Mr. Westfall's objects. Both the solar lighting and the libration will be very critical to future presentations of these high mountains. Therefore, we want to state that at 2^h 30^m, U. T., on January 18, 1954, the time of these measures, the colongitude was 73°.0, the sun's selenographic latitude was 0°.1 N., the earth's selenographic longitude was 4°.9 W., and the earth's selenographic latitude was 1°.0 S. Mr. Westfall intends to remeasure Cabeus Alpha, if such it be; and we strongly urge other A.L.P.O. members having micrometers also to measure this peak, for confirmation of so extraordinary a height is very important. This observation should further indicate the value of a micrometer in lunar and planetary studies, and we remind readers of the Carroll and Bohannon micrometer described in our January-February, 1954 issue.

Moretus. This large lunar walled plain may be found on Section XXIII of the Wilkins map and is not far from the moon's south pole. We have drawings by Elmer J. Reese with a 6-inch reflector on February 23 and 24, 1953 at colongitudes 21°.6 and 33°.0 respectively and by Keith W. Abineri with an 8-inch reflector on February 4, 1952 at 18°.6. Mr. Reese's first drawing is reproduced as Figure 13. It should be an encouraging example of how an active observer equipped with even a 6-inch telescope can contribute to the mapping of the lunar surface. On February 24 Mr. Reese observed a "quite easy" cleft on the west part of the floor of Moretus; this cleft is absent from the Wilkins map. More observations are desired. Mr. Abineri's drawing confirms a number of the objects recorded by Mr. Reese.

Conon. This crater in the lunar Apennines has been the object of a prolonged and careful study by a number of A.L.P.O. members under the leadership of Mr. Elmer J. Reese. There are on hand visual observations from R. M. Adams (3.2-inch refr., 4.3-inch refr., and 10-inch refl.), T. A. Cragg (6-inch refr.), and E. J. Reese (6-inch refl.) and some praiseworthy photographs by Lyle T. Johnson (10-inch refl.). On February 21, 1953 at 23^h 45^m, U. T., colongitude 7°.9, Mr. Adams with his 10-inch reflector drew a round, bright spot near the center of Conon when most of the floor was in shadow and suspected changes in brightness during 10 minutes of observing. This observation is hard to understand, for many good observers have been unable to find any central peak in this crater. A few hours after Mr. Adams observed, Mr. Reese on February 22 at 9°.3 saw no central peak at all, although Hill P in the northeastern part of the floor was illuminated. Adams saw his "central hill" the next night and in the March, 1953 lunation but looked in vain for any bright spot inside the large floor shadow on April 22, 1953 at 8°.2, on June 20, 1953 from 8°.8 to 9°.5, on October 16, 1953 at 9°.4, and on April 11, 1954 at 3°.6. Other drawings by Adams show Hill P in the northeast part of the floor, Hill Q in its southwest part, Dark Band A on the southeast inner wall, and Dark Band C on the northeast inner wall. Mr. Reese has continued to give

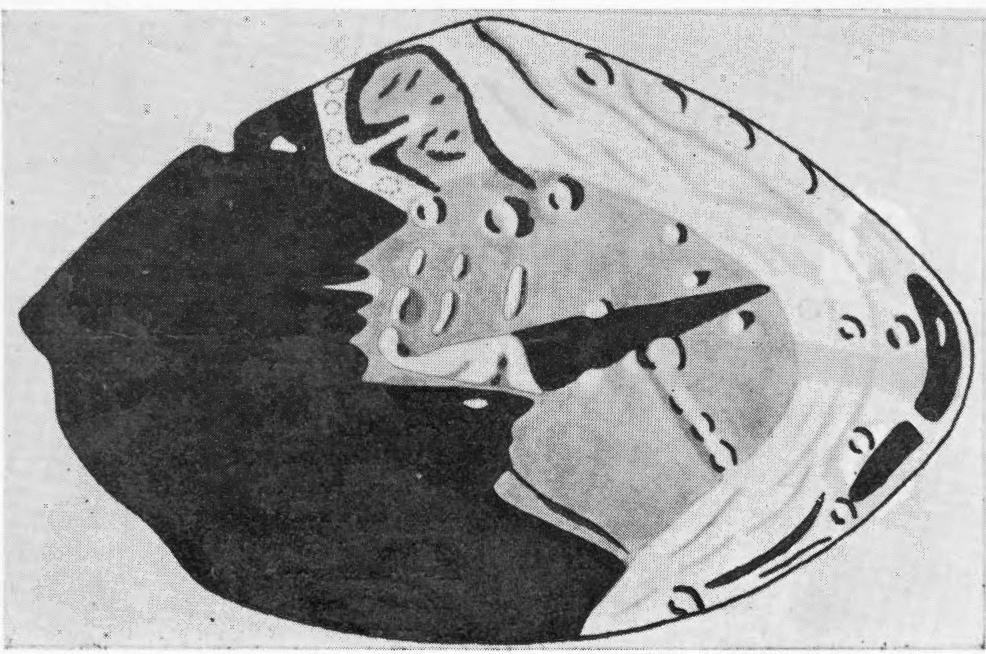

Figure 13. Moretus.

Elmer J. Reese.
6-inch reflector. 240X.
February 23, 1953.
Colongitude = 21°.6.

close attention to the dark streaks on the floor of Conon and has continued to find evidence of changes in their visibility independent of the solar lighting. Thus Streak S was glimpsed as rather wide and diffuse on February 23, 1953 at colongitude 20°.4 but was clearly seen as thin, dark, and linear the next night at 33°.2 with the same seeing and transparency. A drawing by Cragg with the Mount Wilson 6-inch refractor on June 22, 1953 at 34°.5 confirms many of Reese's objects in Conon and also shows a curious lighter band just above Hill Q in the shadow on the southwest inner wall. Cragg found Fault B much darker than Streak S, Cleft V, Band U, or Band Z on this occasion. The nomenclature used here is Mr. Reese's and is given on Figure 1 on pg. 83 of our June, 1952 issue.

Mr. Lyle Johnson's photographs may give some confirmation to these changes in Conon long reported by visual observers. At least Mr. Reese finds evidence of a somewhat different appearance of W. H. Pickering's "floor cloud" (Reese's Bright Area O) in photographs by Mr. Johnson on January 30, 1953 at 89°.4 and on March 1, 1953 at 95°.6. Mr. Johnson made duplicate photographs on each night, and the duplicates appear to confirm each other about the difference. This procedure is certainly an excellent one, and we hope that more of our members with large enough telescopes will turn to lunar photography.

Timocharis. Figure 14 is a drawing by Elmer J. Reese of this ring-plain on the Mare Imbrium. There will be noted the central mountain with a crater on its summit, the darkness of the central

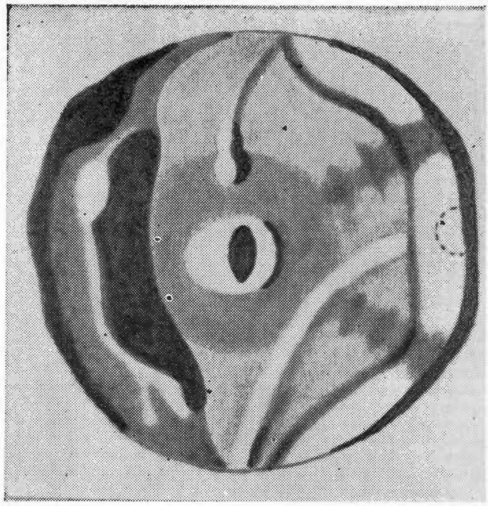

Figure 14. Timocharis.

Elmer J. Reese.
6-inch reflector. 240X.
July 22, 1953. 1^h 45^m, U. T.
Colongitude = 39°.5.

portion of the floor, and the two mottled dark bands joining the darker central part of the floor to the east rim. If these are typical wall bands, their extension on the floor is of much interest. On June 22, 1953 at 32°.5 O. C. Ranck drew Timocharis with a 4-inch refractor at 180X in good seeing and looked in vain for the central peak. D. P. Avigliano observed Timocharis and the surrounding area in the June, 1953 lunation with 6-inch and 8-inch reflectors between colongitudes 35°.0 and 95°.8. He was looking especially for the "haziness" around Timocharis reported by a few past observers. No unusual appearances were noted, and the area was always as well defined as many other lunar areas at similar distances from the terminator.