SOLAR DIVISION Bulletin

Harry L. Bondy, Editor — 43-58 Smart St., Flushing 55, N.Y.

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SOLAR ACTIVITY - October to December 1954.

Thomas A. Cragg and Harry L. Bondy.

Sunspot activity: Sunspots observed at Mt. Wilson Observatory.

Number	CMP	Lat..	First seen	Last seen	Class	cycle
11194	Oct. 4.8	-33°	Sep.30	Oct. 1	dαd	new
11195	Sep.28.7	+36°	Oct. 2	2	dαd	new
11196	Oct. 9.1	+34°	2	12	lαpd	new
11197	6.0	-17°	4	4	dαpd	new
11198	13.3	-35°	11	18	dαpd	new
11199	17.3	+ 5°	12	12	dαd	old*
11200	17.1	+11	14	19	dβd	old*
11201	18.8	+26°	14	19	dβpd	new
11202	20.1	-21°	16	17	dαpd	new
11203	25.0	+32°	18	26	lαpd	new
11204	Nov. 3.3	+26°	Nov. 5	Nov. 8	dβpd	new
11205	4.7	+26°	9	9	dαpd	new
11206	9.5	-34°	9	15	dβfl	new
11207	10.3	+27°	9	15	dβfd	new
11208	16.2	-21°	12	16	dαpd	new
11209	12.8	+31°	12	14	dβfd	new
11210	21.7	-34°	17	19	dβpd	new
11211	29.1	+23°	27	27	dαd	new
11212	Dec.15.4	+34°	Dec. 14	Dec. 21	dβpl	new
11213	23.3	+25°	17	26	dβpl	new
11214	30.0	-23°	29	Jan. 4	dβpl	new

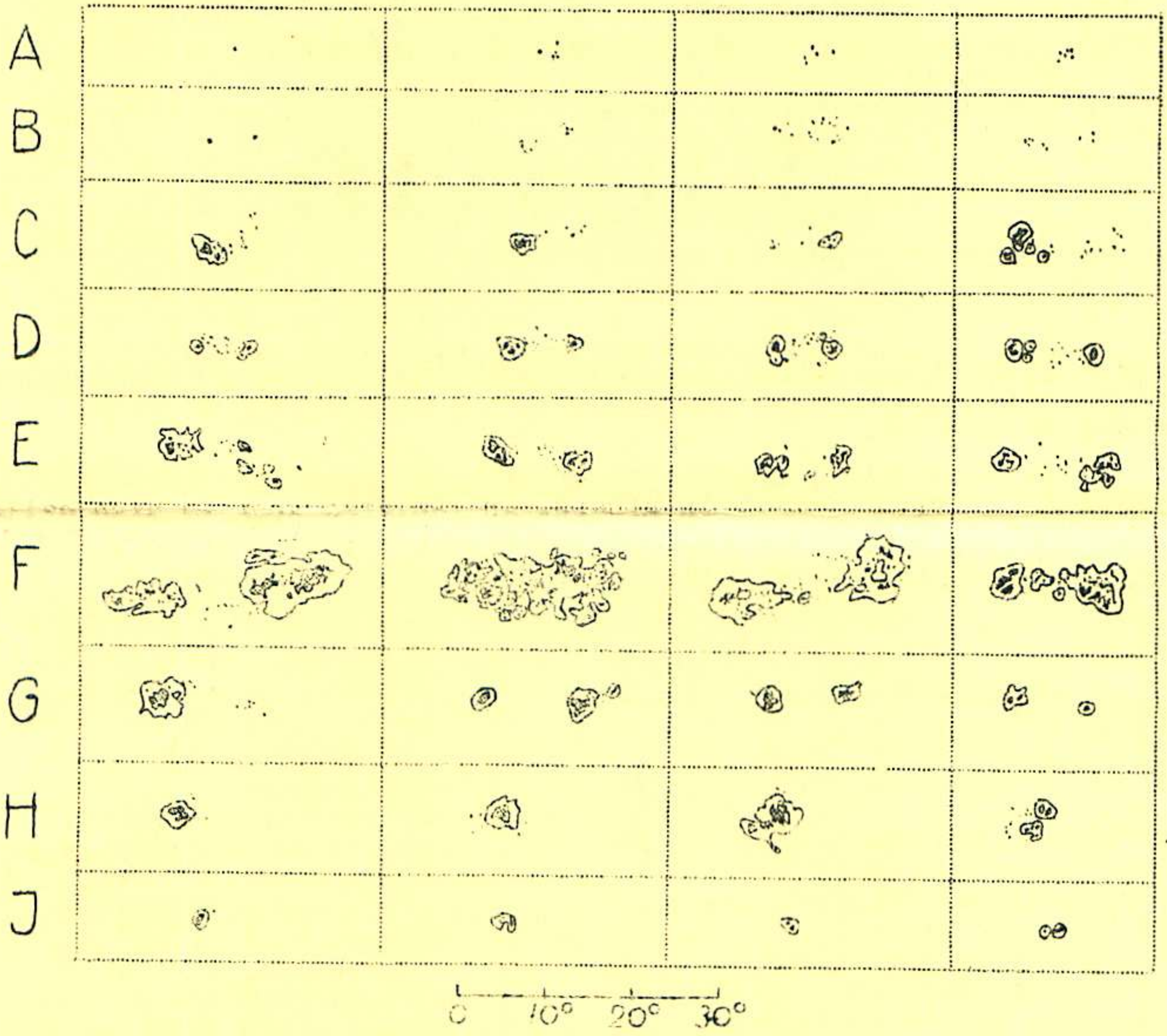
*) the last old cycle spots of 1954.

Sunspot activity in 1954 was highest during October when eight new and two old cycle groups were recorded. Compared with this total of ten, there were only eleven groups for the first six months in all. The new cycle started out more strongly in the Northern hemisphere. In the second half of 1954 there were 22 groups north and 13 groups south of the solar equator. In the first half of 1954 there were 5 groups north and 6 groups south.

(continued on page 5.)

Note: For the definition of Mt. Wilson spot classification see Solar Division BULLETIN 96-97 (August-September 1954) p. 3.

SUNSPOT CLASSIFICATION



This Sun-Spot Classification was developed by Dr. Max Waldmeier, Federal Observatory Zürich, and is now used internationally.

A: an isolated spot or group of spots without penumbra, without bipolar structure.

B. group of spots in bipolar configuration, without penumbra.

C: bipolar spot-group with one of its main spots in penumbra.

D: bipolar spot-group with both main spots in penumbra and one main spot with simple structure; group's lenght generally less than 10°

E: large bipolar group with both main spots showing generally a complex structure: between the main spots numerous small spots-at least 10°.

F: very large bipolar group or very complex group; lenght at least 15°.

G: large bipolar group without small spots between the two major spots, length at least 10°.

H: large unipolar spot with penumbrae; diameter at least 2°,5

J: unipolar spot with penumbra; diameter less than 2°,5.

SOLAR TERMINOLOGY - 2.

SUNSPOTS: Sunspots have been observed since Galileo yet their evolution is not fully understood. Ever since telescopic observations were made it was known that all large sunspots were surrounded by a less dark area. The dark spot itself is called an UMBRA. Most spots are simple umbrae. The less dark region surrounding an umbra is called PENUMBRA. Penumbrae hardly ever appear without umbrae, unless they are patches in very large spots. Both umbrae and penumbrae are clearly delineated; there is no blending of one into the other or into the bright photosphere-the bright disc. (From time to time reddish-brown to grey colors are seen in the umbrae and/or penumbrae; this is a subject for advanced solar observers and cannot be discussed here.) From photographic records a socalled BRIGHT RING around a symetrically developed penumbra has been identified; it is only 2 to 3% brighter than the photosphere.

SUNSPOT-GROUPS: The next thing that solar observers learn is that sunspots occurr in groups. An isolated spot is also called a group. Most groups have a roughly east-to-west distribution and show a bipolar configuration. A BIPOLAR GROUP shows a concentration of spots in its "ends"; the western most spot /or spots/ is called the P-spot for "preceeding"; the eastern most is the F-spot or the "following"spot. This bipolar configuration is not accidental but a consequence of the groups's bipolar-magnetic-structure. The Mt. Wilson Observatory uses a special classification for sunspots according to their magnetic polarity.(See Solar Division BULLETIN 96-97; August-September 1954.)

SUNSPOT CLASSIFICATION: For the study of sunspot evolution Dr. Max Waldmeier, Director of the Federal Observatory in Zürich, Switzerland, developed a highly descriptive classification of sunspot groups. These types are illustrated and defined on the opposite page. The definitions are more important than the illustrations. (There are never two groups exactly alike.) Classes A; B; C; H and J can hardly be confused; H-type being merely a large J-type group. Some experience is needed to differentiate between D and E. F are only the very largest groups, occurring usually only within a few years of sunspot maximum /last 1947; next 1957-8?/. A difficult spot type is class G. It can occasionally be confused for two J-groups - or one H and J or even H and A class. This is want to happen usually during high spot activity or when observations have been interrupted for several days or when this type G is coming from the invisible hemisphere. For consistency daily observations are best. Spots close to the solar limb cannot be classified accurately due to the considerable perspective foreshortening. Sometimes rapid evolution may change a group from one class to another within hours. Of course inferior seeing will strongly affect any classification- a J-group could be a C-group; A group be B.

SUNSPOT EVOLUTION: Dr. Waldmeier's classification from A to J actually reflects the evolution of the largest sunspot groups. The order A-B-C-D-E-F-G-H-J-A is an evolutionary sequence. Most spots never develope past A. The following types of spot evolution are common: A-B-A; A-B-C-A; A-B-C-D-C-B-A; A-B-C-D-G-H-J-A; A-B-C-J-A or even A-B-C-J-C-B-A. Frequently "late-type" groups such as H or J (just as any of the others) coming from the invisible hemisphere may cross the visible disc in 13-14 days without showing any change in class. The evolution-rate varies greatly. A group may evolve within 24 hours into a D-group and later remain as an H or J for two rotations. Most groups show a rapid evolution to maximum and a slow decay. But the opposite evolution-slow rise,fast decay-also occurrs.

FOR SUNSPOT O B S E R V E R S - NEW SUMMARY SHEETS.

Mr. William A. Reid, 167 South Avenue, Hawthorne, New Jersey, has for years carefully prepared our "American Sunspot-Number Reductions". These "reductions" are summaries of all individual observations or personal sunspot-numbers = Ri. Formerly they were an integral part of our Solar Division BULLETIN, now lack of funds prevent it. These summaries give an observer the best check on his or her own observations.

Recently a proposal was made to include in said summaries the total number of groups and spots. If an individual's report read Ri = 36, it was impossible to learn if this Ri consisted of 3, 2 or i groups with 6, 16 or 26 spots respectively. The new listing would show this clearly, namely: 3,6 or 2,16 or 1,26 whereby the first figure is the total number of all groups, the second figure the number of all spots. Since the well-known sunspot-number formula assigns each group a ten-fold importance over individual spots, errors in group count are most serious.

If enough of our members will show interest in these new summaries, Mr. Reid will be glad to prepare them. Otherwise only the old method will be continued. THOSE INTERESTED, PLEASE SEND YOUR NAMES TO Mr. REID.

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OUT OF OTHER PUBLICATIONS:

Prof. Gleissberg, Istanbul, Turkey, wrote in "Zeitschrift für Astrophysik"(Bd.34,S.259; 1954) on "The importance of the forthcoming Sunspot cycle": the abstract follows:

"The ensuing eleven-year sunspot cycle will be of particular interest in as much as it will increase our knowledge of the eighty-year sunspot cycle in an essential point: its course will tell if maxima of the eighty-year cycle have approximately even heights or not."

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COLOR IN SUNSPOT REPORTS:

Last month we reported an interesting observation of "color-in-sunspots" by Mr. B. C. Parmenter, Northwestern Observatory. In a personal communication Dr. James C. Bartlett, Jr. writes that he noticed color in the same group where Mr. Parmenter observed cloring three days before. Dr.Bartlett writes:..on 4 February.."I found the entire penumbra to be distinctly reddish with the western side of lighter hue. The umbra appeared normally black to me."(Ed.note: This was the H-type group at =42° (42° west of central meridian) and 20°S. No flares were reported though sun was all day under patrol at Sacramento Peak).

On 10 January 1955 at 17:30 U.T. Dr. Bartlett observed in the C-type group at +36°,21°N "a bright cherry red color" confined to a section of the penumbra. He observed with a 2" refractor at 60x through a "carbonized" glass /acting like a screen transmitting solar colors/.At 17:40 U.T. no color could be seen with a 3½" reflector. At 17:50 color reappeared. The entire penumbra now had assumed a pale-violet hue or violet-grey. The umbra had become brownish with a dark red on its western edge...by 17:53 U.T. all color had faded from the penumbra which had now become so light that its outlines were difficult to establish". (Ed.note: this spot showed flares on 6 and 7 January, but no flares were recorded on 10 January though under patrol.)

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N O T E S FOR THE S U N S P O T O B S E R V E R --FEBRUARY 1955

Sunspot activity during February was at a slightly lower level than in January, though higher than throughout 1954. Spotless days returned, the first since December.

During February the sun was photographed on 21 days /four spotless/at the U. S. Naval Observatory. Of 35 daily counted groups 20 were of C- or D-type; 13 J- and H-type; 3 B-type. Almost one half (16) of all groups occurred in latitudes ± 20° - 24°; 9 in lat. 35°-40°; 5 in lat. 15°-19°. 25 groups were north, 10 south of solar equator. Apparently an "old-cycle" group /last seen in October/ occurred for one day on 16 February in form of a small C-type group. The little larger f-spot was at -23°(=23° before central meridian) and 4°S, the p-spot was at -22°,2°S. The largest group of the month was a D-type group coming from the invisible hemisphere. Its maximum area on 21 February was 752 millionths of the solar hemisphere, the larger p-spot was at -73°,20°N.

DATA on a typical day- 7 February:

I) Easternmost was a D-type group, its p-spot was at -51°,39°N. On this day /7 Feb./ a small flare occurred in the f-spot. This was the third return of this active region which started in mid-December (11212; region 54-Yp; see summary bellow, also SD Bulletin-January p.2-group I.) Coronal line intensity continued at high level.

II) A C-type group near central meridian, its larger f-spot was at +4° and 27°N. It developed near CMP together with a plage /chromospheric faculae/ and showed strong coronal line intensity only when crossing the western limb.

III) An H-type group at +80°, 23°S (area 339 millionths of sol. hemisphere or about 7 square degrees). This was a fairly active group, fourth return of region 54-Vp producing 2 small flares on 30 January and showing strong coronal line intensity west.

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SUMMARY of SOLAR ACTIVITY-October- December 1954 (continued from p.1.)

There were NO FLARES, NO SUDDEN IONOSPHERIC DISTURBANCES (SID) in the last three months of 1954.

CORONAL ACTIVITY: A rather unusual coronal region 54-Tp associated with only a small spot/11196/started on 30 September. It extended over 60° in longitude and was narrow, between 30°-40°N. However it was associated with an equally long and bright faculae field. Intense coronal emission was recorded both east and west. "The persistence of such intense emission as this for as long as two weeks is quite unusual, particularly in view of the low sunspot activity and the absence of flares"(from Preliminary Charts on Sol.Activity-HAO TR#164) --The old cycle spots 11199 and 11200 were associated with a moderate region 54-Up. Group 11201 was not associated with any apparent coronal region. In NOVEMBER: The unusual region 54-Tp showed considerably weaker coronal activity in its second passage. Group 11206, which developed rapidly near CMP, showed no coronal emission on the east limb, but strong west- region 54-Vp. Other regions were weak to moderate. DECEMBER: The large, active group 11212, possibly connected with a Sudden Commencement (SC) in geomagnetic activity on 17 December, was associated with a weak coronal region 54-Yp when it crossed the west limb. At its next passage in January this was a most active region

American Relative Sunspot Numbers-R_A'- for February 1955

Day	RA'	Day	RA'	Day	RA'
1	25	11	29	21	12
2	33	12	28	22	19
3	40	13	15	23	27
4	35	14	13	24	27
5	28	15	11	25	29
6	31	16	11	26	31
7	36	17	1	27	33
8	27	18	0	28	36
9	26	19	0		
10	30	20	0		

Mean RA' = 22.6

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Zürich Provisional Sunspot Numbers for February 1955 (RZ)

Dependant on observations made at Zürich Observatory and its stations in Locarno and Arosa.

Day	RZ	Day	RZ	Day	RZ
1	19	11	27	21	0
2	28	12	26	22	9
3	32	13	28	23	19
4	34	14	10	24	28
5	32	15	8	25	28
6	32	16	16	26	30
7	34	17	7	27	30
8	24	18	0	28	26
9	28	19	0		
10	27	20	0		

Mean RZ = 20.8

Zürich Definitive Sunspot Numbers for 1954

Monthly means:

I..... 0.2	IV..... 1.8	VII..... 4.8	X..... 7.0
II..... 0.5	V..... 0.8	VIII..... 8.4	XI..... 9.2
III.....10.9	VI..... 0.2	IX..... 1.5	XII..... 7.6

Yearly mean: 4.4

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MONTHLY MEAN VALUES OF SOLAR FLUX AT 2800 Mc/s (10.7cm) 1954

Recorded at NATIONAL RESEARCH COUNCIL - OTTAWA, Canada

Flux in watts/m^2/cycles/second bandwidth ($x\ 10^{-22}$) - 2 Polarizations

Month	Mean flux	Highest flux	day	Lowest flux	day
January	72.0	75.6	11	68.3	6
February	71.8	73.3	4,26	69.8	19,22
March	73.5	85.5	15	66.2	26
April	69.2	72.2	8	64.0	2
May	67.7	69.0	4	65.8	23,28
June	66.6	69.0	28	62.3	27
July	67.2	69.0	27	63.8	2
August	69.9	73.1	10	67.3	19
September	71.2	75.6	30	67.7	7
October	75.4	77.8	8	68.6	3
November	75.7	87.0	11	65.8	3
December	78.8	84.7	16	74.4	10

S O L A R A S T R O N O M Y AND THE A T M .

PROMINENCE TELESCOPE - LYOT'S.

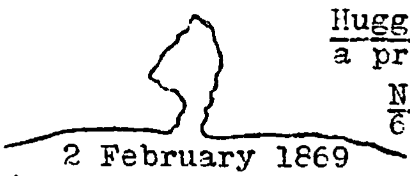
Last year during the solar eclipse many amateur observers saw for the first time solar prominences. (See our eclipse issue-October 1954) Will this "first" time be also the "last" time? It could easily be so if they were to depend on total eclipses only. But it definitely need not be thus if they care.

Thanks to the man who after all others failed, persisted and succeeded to bring the solar corona under daily observations, yes, thanks to BERNARD LYOT more amateurs have the opportunity to observe prominences regularly, with ease and without complicated and expensive instruments. From the earliest time.., since Janssen and Lockyer /1868/ discovered that the emission light of prominences may be observed outside of eclipses; since Huggins /1869/ showed that prominences in their full shape may be seen through a somewhat widened spectroscope slit; from the time when Hale and Deslandres /1889/ invented the spectroheliograph and since Hale's spectrohelioscope /1924/,.. up to the most modern "monochromators" only a scant score of amateurs was able to build and use systematically such instruments. Are there more than a dozen spectrohelioscopes in use here in the USA??

We are fortunate to have in the Solar Division Dr. Huberta von Bronsart, Stuttgart, Germany, to whom I am grateful for the information on this simple Prominence Telescope. A paper by Dr. von Bronsart describing her own observations with such a telescope will soon be published on these pages.

References:

The Prominence telescope is essentially Lyot's coronagraph, except that in this application it does not require the superfine objective, no high altitude is necessary. (Dr. von Bronsart observes in a large city from nearby a railroad station!)* The first application to use a "coronascope" for prominence observations was described in DIE STERNE in May 1940 (Heft 5,S.73) by Dr. M. Waldmeier. Dr. Waldmeier pointed out that since prominences are more than a hundred times brighter than the corona, a simple application of a dark red filter is sufficient to reveal prominences, provided the bright photosphere /bright disc/ is occulted ("eclipsed") and the most objectionable scattered light in the telescope is eliminated. In 1952 Otto Nögel writing also in DIE STERNE, December 1952 (heft 7-8;S.135) described in detail his own Prominence Telescope.consisting of a 3" objective lens of 520 cm focal length /21½"/ mounted in a wooden tubus. This is a most inspiring paper with two sketches and four photographs of prominences taken with Nögel's instrument. In a recent letter Mr. Walter Scott Houston mentioned to me that G. et R. Porret, Creteil, France, descibed a very similar telescope in L'ASTRONOMIE, March 1951, p.123. Pere et fils Porret built a somewhat different version of Lyot's coronagraph and use an ingenious "rotule" mounting (not unlike that shown by Dr. Waldmeier).



2 February 1869

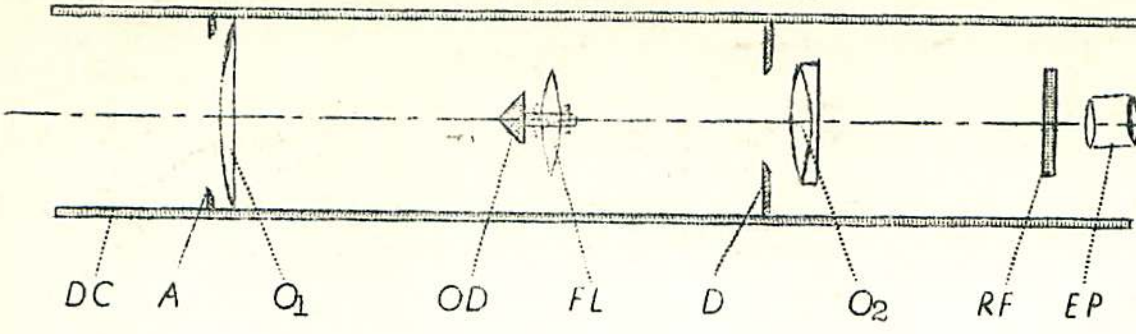
Huggin's first observation of a prominence "in full sunshine"

Nögel's prominence observations
6 March 1952 A) 15:05 UT
B) 15:25 UT

A)
B)

*)Most recently I learned that Mr. Houston built and used a "make-shift" telescope and observed prominences from St. Louis, Mo. in 1952.

PROMINENCE TELESCOPE-LYOT'S



The above diagram presents the essential parts of LYOT'S coronagraph as used for PROMINENCE OBSERVATIONS. DC is a long DEW CAP. O_1 is the main OBJECTIVE lens, which need not be an achromat. As a matter of fact a good plano-convex lens is preferable since prominence observations are made practically in monochromatic light. OD is the OCCULTING DISC, which is a highly reflecting metal cone. It is about 2% larger than the image of the bright solar disc and is placed in the focal plane of O_1. The occulting disc is mounted in a FIELD LENS-FL. This field lens FL images the ENTRANCE APERTURE-A onto a DIAPHRAGM-D. The opening in the diaphragm D is somewhat smaller than the image of the brilliant ring of diffracted light coming from the edge of the entrance apperture A. Unless this diffracted light is fully removed there is little or no chance to see prominences. Right behind D is the second objective O_2 which forms the image of the occulting disc and that of the surrounding prominences. This image is then viewed through the EYE PIECE- EP. All that is now necessary to reveal the prominences to our eyes is a dark RED FILTER-RF.

Notes: The occulting disc OD should neither be too large (if small prominences should not be hidden) nor too small (to avoid photospheric glare). For a mean solar diameter of 32 minutes of arc the occulting disc diameter is then. OD=f x 9,309mm, where f is the focal length of the main objective O_1 and its length is expressed in meters. During the year this factor varies from 9,481 /in winter/ to 9,178 /in summer/. The OD is a brass cone with a highly polished finish and is mounted securely in a hole through the field lens FL. (Mounting OD on wire or any other type of "spider" will add more detrimental scattered light)...

The diaphragm D is very essential. Its position and size can be determined experimentally by pointing the telescope at the bright sky and then detecting the position and outline of the bright diffracted light. (coming from A; the edges of the lens proper would cause even more scattered light than the edges of a sharp, clean cut, thin "apperture") on a white card of paper. Diaphragm D is made out of sheet metal and is painted black. (exact formulae bellow). The inside of the whole telescope and all lens mounts must be black for best results.

The second objective O_2 is usually placed in such a position as to give an image in a one to one ratio. However, since O_2 and EP form the view telescope, any other desired ratio may be used (e.g.for enlarging)

F I L T E R S :

Asside from seeing conditions (which need not be perfact as said) the properties of the RED FILTER RF determine the contrast of prominences against the background sky. A dark blue sky gives best results, a white, hazy sky around the sun cuts down considerably the contrast. Narrow-band filters improve the contrast.

PROMINENCE TELESCOPE continued.

(Filters)
The following KODAK WRATTEN FILTERS have a sharp cut-off, while transmitting only red light. Numbers: 24; 25; 26; 29. Filter No. 29 is best suited since it cuts off all light shorter than 610 mμ; while No. 24 extends up to about 580 mμ (the others are between these limits). All of these filters have good stability qualities and are available from the least expensive gelatin filter (a 2-inch square costs 50¢); the "B" glass (series VI costs $2.25) or even /on special order/ in glass "A". Maximum transmittence of these filters is 90%.

CORNING GLASS COLOR FILTERS (Corning, New York). Corning manufactures several solid glass filters which have the proper qualities for prominence observations. Numbers: 2412; 2408; 2404; 2403. Of these No.2403 is best suited since it cuts off all light bellow 617 mμ, while 2412 cuts off at 590 mμ (the others are inbetween). Maximum trasmittance of these filters is about 88% (less than 1/3 of this is sufficient) The Corning filters come in two finishes- molded or polished. A 2-inch square of polished glass costs $ 4.-to 5.-. These filters can be cut into smaller squares.

BAUSCH & LOMB INTERFERENCE FILTERS. Prominences are best seen in the light of Hydrogen at 6563A (=656 mμ), the socalled Balmer Hα line or Fraunhofer C-line. The spectroheliosope and to a lesser degree the monochromator permit one to observe in pure monochromatic light the sun. Bausch & Lomb, and others, manufacture a number of narrow-band filters, or transmission interference filters. "The filter proper consists of two highly reflecting but partially transmitting films of silver separated by a spacer film of non-absorbing material...The separation of the silver films governs the wavelength position of the pass band (see sketch) and hence the color of the light which the filter will transmit. This is the result of an optical interference effect which produces a high transmission of light when the optical separation of the silver film is effectively a half wavelength or a multiple of a wavelength. A filter in which the optical spacing of the silver films is one-half wavelength at the pass band for which it was designed is called a first order filter, one in which the spacing is two half wavelengths is called second order filter, and so on " (from B&L catalog D-248,5.5 Oct.'53)

The following B&L Interference filters seem best suited for prominence observations :

Series:	Order*)	Number:	Wavelength:	Peak**)	half-width:	List:
Photomicrographic	1st	42-47-59	650 mμ	45%	18 mμ	$ 15.-
Selected line	2nd	33-79-65	656 mμ	35%	9 mμ	$ 30.-

*) Order of interference **) Peak transmittence
All standard size: 2" x 2" x 3/16"

(Bausch and Lomb Optical Co., Rochester 2, N. Y., U.S.A.)

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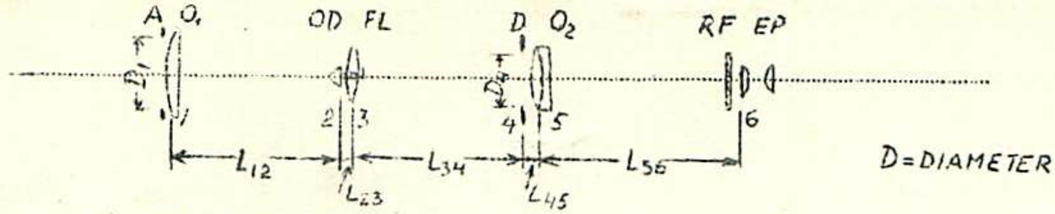
Note of caution for beginner solar observers: Direct vision solar observations must always be made with utmost caution so that no eye damage could possibly result. The use of a dark neutral filter or wedge is recommended.

(continued on page 10)

(Prominence telescope continued)



Mr. T. A. Cragg was kind to get us formulae for this telescope from Mr. Arthur Leonard. To Mr. Leonard, who fortunately considers these formulae "mere burning-glass optics", we are greatly indebted.

$$L_{12} = f_1 \quad (1)$$

$$\frac{1}{L_{34}} = \frac{1}{f_3} - \frac{1}{f_1+L_{23}} \quad (2)$$

$$D_4 < \left(\frac{L_{34}}{f_1+L_{23}}\right) D_1 \quad (3)$$

$$\frac{1}{L_{56}} = \frac{1}{f_5 \quad L_{34}+L_{45} + \frac{f_3L_{23}}{f_3+L_{23}}} \quad (4)$$

$$D_2 = \left[\frac{(f_3-L_{23})(L_{34}+L_{45})+f_3L_{23}}{f_3L_{56}}\right] D_6 \quad (5)$$

Magnifying power= $M = \frac{f_1D_6}{f_6D_2}$

Notes: D_1=diameter of aperture A or if A is not used, diameter of first objective O_1
D_2=effective diameter of field of view of eyepiece
D_4= diameter of diaphragm D
D_6= diameter of field lens of eyepiece
D_3 should be a little larger than D_2 and D_5, a little larger than D_4

- "If the focal length of the first objective is rather long compared with the other distances in the instrument, and if it is desired to have about a one-to-one magnification by the second objective, the focal length of the second objective (f_5) should be a little over one-half of that of the field lens (f_3). If it is desired to employ a rather large eyepiece and still have a high magnification, the focal length of the second objective should be made larger-up to about that of the field lens. In working up the design of the prominence telescope, L_{12} is made equal to the focal length of the first objective (f_1)-Eq.(1). Then L_{23} is made as small as practical ((consider the heat on OD-$\not{b}$)). Then the field lens (focal length f_3) is chosen to make L_{34} (calculated by Eq.(2)) a convenient length. Then L_{45} is made as small as practical. Finally, the second objective (focal length f_5) is selected to make L_{56} come out about right-Eq.(4)"(from Mr. Leonard).

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Of course all this is no substitute for a telescope; you got to build it. For further information write to me. Good luck+good seeing....hlb

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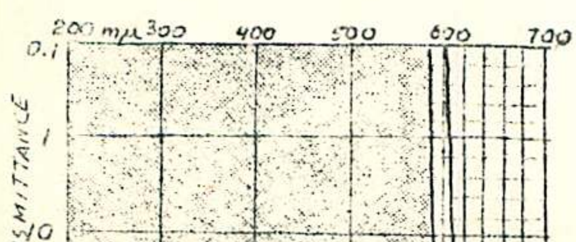
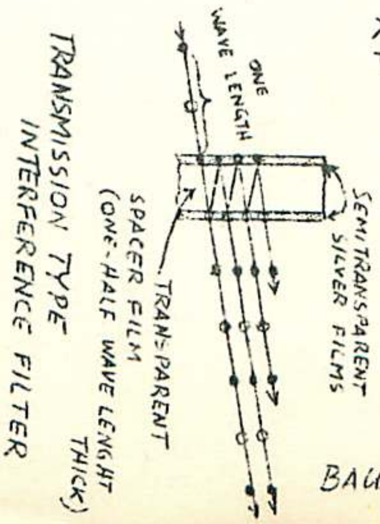
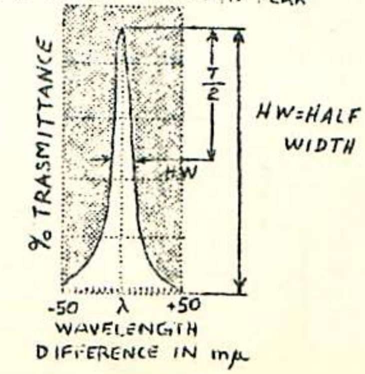


KODAK WRATTEN FILTERS



PASS BAND CHARACTERISTICS OF INTERFERENCE FILTERS
λ .... WAVELENGTH OF PEAK
T .... TRASMITTANCE AT PEAK



BAUSCH & LOMB FILTERS