A.A.V.S.O.

SOLAR DIVISION BULLETIN.

Neal J.Heines,Editor.

March 1953. P.O.Box 2353.
Number 84. - Page 239 - Paterson N.J.

During the year 1952 we requested renewed interest in the observation of Faculae in the polar areas, "which are mainly confined to the latitude belts 65°- 90°. Faculae of this type are much smaller, often circular, and rather less bright than the familar faculae.
Their appearance usually occur around,and shortly after, the sunspot minimum" according to the B.A.A. Journal.Vol.63.,No.2 p.46,;Spl.
It may well be that the Polar Faculae are the precursors of a new sunspot cycle (which still needs to be proven) and thus, they preceed the high latitude groups with with reversed polarity, which indicate the new cycle.
Considerable interest in Polar Faculae has been aroused recently due to the findings of Prof.H.W.Newton and associated R.A.S. Observatories, and, Dr,Seth B.Nicholson of Mount Wilson Observatory. There is a strong possibility that a paper to this effect will be published during 1953.
We received an interesting summary from Dr.James C,Bartlett of Baltimore Maryland on sunspot Colors, which follows.

"I find that for the whole civil year,January 1st., to December 31st., 1952, but 53% was available for observation; and that in this 53% a total of 1,288 individual spots were observed. Of this number only 14 were found to be colored,or 1 spot in every 92. This compares with 32 colored spots out of a total of 3.787, 1951, or 1 in every 118, for 33% of that year. The new year began with a well-marked manifestation of color in the leaders of a small N.H. groups
On Jnauary 1st.,1953, at 17.h , 31m, with a 3" Refractor at 45X, the two leaders of the small N.H. group were found to have an intensity of redish penumbra with brownish umbrae. With Wratten red filter the penumbra was fuzzy and somewhat lighter compared to the photosphere. With Wratten green filter the penumbra was darker and much sharper. On January 2nd., the same colors were observed; but ,thereafter rain, snow,and clouds, prevented further observation.

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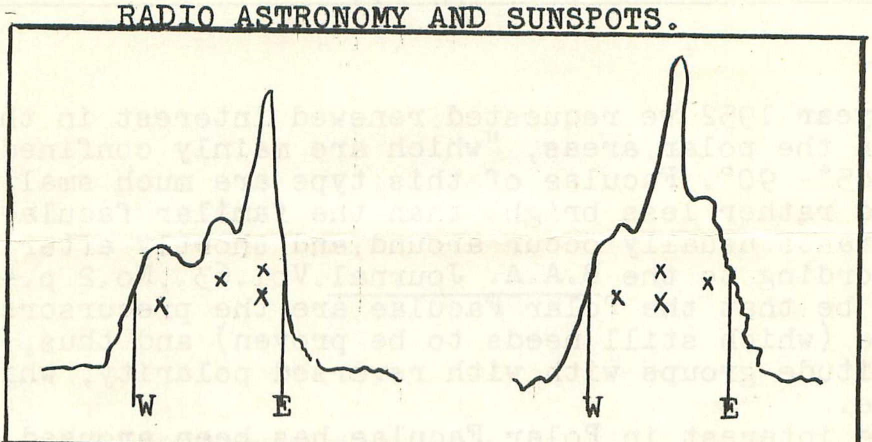
On page 62 of SKY AND TELESCOPE, January 1953,Vol.XII,No.3, we find the intensity record of W.H.Christiansen,(which we have reproduced below) with the sun passing through his 32-element Interferometer. The vertical lines represent the limits of the sun's optical disk. The x's indicate the positions and the sunspot and disturbed areas which are reflected in the peaks of the graphs. Their positions were taken from charts supplied us by Capt.W.H.Gallbraith,U.S.N.Retired.

## RADIO ASTRONOMY AND SUNSPOTS.




June 26th. 1952 June 29th.

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## SEEING CONDITIONS REPORT OF

### T.P. MAHER 1952.
### Heppner Oregon.

| DAYS | POOR | | Z | A | FAIR | | Z | A | GOOD | | Z | A | EXCELLENT | | Z | A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan 21 | 2 | 26 | 85 | 57 | 3 | 113 | 171 | 153 | 3 | 88 | 99 | 89 | 13 | 499 | 524 | 548 |
| Feb 22 | | | | | 3 | 28 | 30 | 37 | 3 | 86 | 90 | 103 | 16 | 279 | 324 | 317 |
| Mar 25 | | | | | 1 | 25 | 23 | 31 | 5 | 172 | 143 | 186 | 19 | 346 | 366 | 380 |
| Apr 27 | | | | | 1 | 28 | 26 | 26 | 5 | 115 | 120 | 129 | 21 | 496 | 629 | 589 |
| May 30 | | | | | | | | | 4 | 88 | 98 | 98 | 26 | 538 | 584 | 577 |
| June 25 | | | | | 1 | 26 | 56 | 47 | | | | | 24 | 676 | 801 | 763 |
| July 31 | | | | | | | | | 7 | 254 | 329 | 280 | 24 | 856 | 890 | 923 |
| Aug 31 | | | | | | | | | 2 | 75 | 65 | 78 | 29 | 1651 | 1631 | 1562 |
| Sept 27 | 1 | 11 | 15 | 10 | 1 | 16 | 23 | 19 | 5 | 152 | 142 | 163 | 20 | 506 | 572 | 523 |
| Oct 30 | | | | | 2 | 28 | 48 | 50 | 3 | 78 | 83 | 84 | 25 | 563 | 582 | 532 |
| Nov 21 | 1 | 0 | 7 | 12 | 2 | 50 | 56 | 59 | 8 | 142 | 153 | 174 | 10 | 250 | 295 | 255 |
| Dec 14 | 1 | 0 | 13 | 11 | 2 | 50 | 72 | 62 | 2 | 68 | 79 | 89 | 9 | 197 | 269 | 229 |
| 304 | 5 | 37 | 120 | 90 | 16 | 364 | 505 | 484 | 47 | 1318 | 1401 | 1473 | 236 | 6857 | 7467 | 7198 |

$\frac{304}{366}$ = 83.1 Observing Days

$\frac{5}{304}$ =1.6% Poor $\frac{16}{304}$ =5.3% Fair $\frac{47}{304}$ =15.5% Good $\frac{236}{304}$ =77.6% Excellent

## SPRING MEETING

Make plans now to attend our A.A.V.S.O. SPRING MEETING to be held at University of Michigan. This meeting will be one of great interest to Solar People. Opportunity for visiting the McMath-Hulbert Solar Observatories will be arranged. The dates for the FORTY-SECOND meeting are May 22nd and 23rd, 1953.

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## STATISTICS

| | | |
|---|---|---|
| The total number of sunspot groups for the month of Jan., was | -- | 6 |
| Zurich's Provisional sunspot number " " " " " " | -- | 25.5 |
| The mean monthly sunspot area (US Naval Ovservatory) for May 1952 | - | 268 |
| " " " " June " | - | 439 |
| " " " " July " | - | 649 |
| " " " " Aug " | - | 790 |

* The highest sunspot group number as assigned at Solar Division Headquarters was 7. It made its appearance on Monday, February 2nd about one day west of the east limb, it represented a small spot in the north belt and prevailed until February 11th.
* Group counting reference for observers.

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Predictions of smoothed Zurich monthly sunspot numbers for the next six months are as follows;

| | | | |
|---|---|---|---|
| Feb. | 25 | May | 21 |
| Mar. | 24 | Jun. | 20 |
| Apr. | 23 | Jul. | 19 |

Released by Prof. M. Waldmeier, Director Federal Observatory at Zurich, Switzerland, and transmitted by the Swiss Broadcasting Corporation on February 4th., 1953 via Short Wave Radio.

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No Naked-Eye Sunspots were reported for the month of Janyary 1953 by the Montreal Centre Group, of the R.A.S. of Canada.

Monthly Means Ra' - 26.6
Rz - 25.5

# American Sunspot Number Reductions

A.A.V.S.O. Solar Division

N.J.H 2/14/53

## January 1953

W.A.R. 2/17/53

DAILY Ri

| Observer | | Ki | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Mean | No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adams | | 0.70 | 28 | | 33 | | | | | /31 | | 96 | 95 | | 68 | 52 | | | /36 | 23 | | | | 23 | | 12 | 0 | | | 0 | | 0 | 0 | 33.1 | 13 |
| Bartlett | | 1.51 | 21 | 22 | | | /0 | /34 | | | | | | 62 | | 61 | 61 | 54 | | 22 | 22 | 22 | | 0 | 0 | 0 | 0 | 0 | | | | 0 | 11 | 22.4 | 16 |
| Beardsley | | 0.74 | 21 | | | /31 | 51 | | 53 | 62 | | | | | | | | | | /25 | | 23 | | 30 | 13 | | | | | | | | 0 | 31.6 | 8 |
| Beetle | X | 1.06 | | /15 | /20 | 42 | | 52 | | | 47 | 68 | | /55 | /59 | | 70 | 48 | | | | 23 | | 24 | | 12 | | | | | | 0 | 0 | 35.1 | 11 |
| Bissette | | 1.45 | | | | | 24 | 13 | | | | | | 34 | | | | | | | | | | 11 | | | | 0 | | | | | | 16.4 | 5 |
| Bollmeyer | X | 0.81 | | | | 30 | | | | | | | | | | | | | 39 | | | | | | | | | | | | | | 0 | 23.0 | 3 |
| Bondy | | 1.22 | 15 | | | 27 | | | | | | | | | | 59 | | | 35 | | | | | | | | 0 | /0 | | | | 0 | | 22.6 | 6 |
| Brennan | X | 0.93 | /36 | 24 | | 44 | | | | | | | 88 | 75 | 68 | | | | | | | | | | | 12 | 11 | | | 0 | | | 0 | 35.7 | 9 |
| von Bronsart | | * | | | | | | | | | | | | | | | 80 | | | | | 26 | | | | | | | | | | 0 | 0 | 26.5 | 4 |
| Buckstaff | X | 1.11 | | | 26 | | | | | | | | 58 | | 62 | | | 40 | | | | | | | | | | | | | 0 | | | 37.2 | 5 |
| Chase | X | 0.95 | 17 | | | 29 | | | | | | | | | | | | | 45 | | | | | | | | | | | | | | 0 | 22.7 | 4 |
| Chassapis | | 0.74 | | | | | 32 | | | 33 | 73 | | 69 | /56 | 74 | | 56 | | 35 | | 23 | 22 | /11 | /23 | 13 | 13 | 0 | 0 | /0 | /0 | 0 | 0 | 0 | 27.6 | 16 |
| Cragg | X | 0.92 | | 13 | | 28 | 32 | | | 31 | 69 | 85 | 92 | 75 | | 60 | 58 | 49 | 52 | 46 | 34 | 22 | /22 | 22 | 11 | | 0 | 0 | /0 | 0 | 0 | 0 | 0 | 33.8 | 23 |
| DeKinder | X | 0.80 | 33 | | | 31 | 28 | 51 | 33 | 34 | | | | | | | | | 38 | | 26 | | | | | | | 0 | | 0 | 0 | | | 24.9 | 11 |
| Detgen | | 1.39 | 14 | | | 26 | | | | | | 39 | | | | | | | | | | | | | | 0 | | | | | | | | 19.7 | 4 |
| Drakakis | | 1.01 | | | | 34 | 42 | 59 | 54 | | 64 | 86 | 77 | | | | 70 | | | | 13 | | | | 12 | 13 | | | | | | 0 | 0 | 40.3 | 13 |
| Elias | | 0.60 | | /13 | | 33 | 37 | 53 | 48 | | 80 | 78 | 82 | | 81 | | 62 | | /35 | | 25 | | /11 | | 12 | /12 | 0 | | | | /0 | 0 | 0 | 42.2 | 14 |
| G. Estremadoyro | | * | 31 | 27 | | 45 | | 67 | 55 | | 73 | | 88 | | | | | 64 | 50 | 31 | | 15 | 14 | | 13 | 0 | | 0 | | 0 | 0 | | | 33.7 | 17 |
| N. Estremadoyro | X | 0.80 | 19 | 21 | 36 | 33 | | | | | | | | | | | | | | | | | 29 | 30 | 17 | 35 | 33 | 14 | 0 | 0 | 14 | 0 | | 20.1 | 14 |
| Evans | R | * | | | /15 | | 42 | | | | /41 | | | | | | | | | | | | | | | | /0 | /0 | | | | | /0 | 42.0 | 1 |
| Fernald | X | 1.02 | 13 | | | /22 | | | 39 | 51 | | | | 51 | | | | | 36 | | | /11 | 11 | /11 | 11 | | | 0 | | 0 | /0 | | | 23.5 | 9 |
| Focas | X | 0.60 | | 23 | | 27 | 35 | 67 | /28 | | 71 | 76 | 86 | | 77 | | /51 | | /39 | | /26 | | /11 | | 12 | 12 | | 0 | | 0 | | 0 | | 37.4 | 13 |
| Galbraith | | * | 16 | | /26 | /25 | 42 | | | 57 | 53 | 65 | 61 | | | | 43 | 41 | 39 | 23 | 22 | 22 | 23 | 23 | 11 | 12 | | | 0 | 0 | 0 | 0 | 0 | 26.3 | 21 |
| Haines | | * | | | | 27 | | | | | | | | | 72 | | | 39 | | | | | 22 | | | | | | | /0 | | /0 | | 40.0 | 4 |
| Heines | X | 0.97 | 19 | 18 | 34 | 37 | 48 | 57 | 51 | | | | | 60 | 64 | 67 | 55 | 46 | 42 | 23 | 24 | 22 | | 24 | | | 0 | 0 | | | 15 | 0 | 0 | 32.1 | 22 |
| Loebbick | X | 1.02 | 18 | | | 23 | | | | | | | | | | | | | | /25 | | | | /11 | | | | | | | | 0 | 0 | 10.2 | 4 |
| Luft | X | 0.98 | 18 | | | 30 | | | | | | | | | | /64 | | | 42 | 24 | /24 | | | /22 | | | 0 | | | | /0 | /0 | 0 | 19.0 | 6 |
| Macris | X | 0.77 | | 21 | | 27 | 34 | 60 | /33 | 54 | 68 | 60 | 86 | | 63 | | /44 | 45 | /40 | | /26 | | /11 | /24 | 14 | 12 | | 0 | 0 | 0 | 0 | 0 | 0 | 30.2 | 18 |
| Maher | X | 0.90 | 12 | | 15 | | | 44 | 28 | 27 | 47 | 58 | /53 | | | 46 | 52 | | | 33 | 22 | 22 | 22 | | 11 | | 0 | 0 | | | 0 | | | 25.8 | 17 |
| Moore | X | 0.76 | | | | | | | | | | | | 70 | 65 | | /49 | | | | 24 | | | | 16 | | | 0 | 0 | 0 | | | | 25.0 | 7 |
| Olson | | 0.68 | 17 | | | 35 | | | | | | | | | | 64 | 65 | | /35 | 23 | | | | | 13 | | | | | | 11 | 0 | | 28.7 | 8 |
| Pierson | X | 0.83 | 19 | 17 | | 32 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 22.6 | 3 |
| Pierson Jr. | | 0.89 | 15 | | | 28 | | 27 | | | | | | /37 | 48 | | | | | | 25 | | 11 | | 0 | | | 0 | | | 0 | 11 | | 16.5 | 10 |
| Pilsworth | X | 0.86 | | | 17 | | | 53 | | | | | | | | | 62 | | | | | | | | | | | 0 | | | | 0 | 0 | 22.0 | 6 |
| Rosebrugh | X | 0.68 | | | | 29 | 30 | | | | | | | | /41 | 60 | | | 38 | 23 | 23 | | | 23 | 11 | | 0 | 0 | /0 | | 13 | 0 | 0 | 19.2 | 13 |
| Smith | ‡ | * | | | | | | | | | | | | /50 | 63 | | | | | | /11 | /12 | 23 | | | | | 0 | | 0 | 0 | 0 | 0 | 12.3 | 7 |
| Strayhorn | | 2.06 | | | | | 57 | 80 | | | | | | 80 | 82 | | | | | | 30 | 25 | | | | | | /0 | 0 | | | | | 50.5 | 7 |
| Stryker | X | 1.06 | 24 | | | | | 11 | | | | | | 35 | | | | | 24 | 24 | 22 | | | | 11 | | 0 | 0 | | | 0 | | 0 | 13.7 | 11 |
| Sullivan | | 0.60 | | | 33 | 45 | | | | | 88 | 108 | | | | 70 | 76 | | | | | 27 | 28 | 30 | 18 | | /0 | 0 | 0 | 0 | 0 | 0 | | 34.8 | 15 |
| Thomas | X | 0.84 | 16 | | 16 | | 43 | | | | 56 | 67 | | | | | | | | | | | | | 11 | | 0 | 0 | 0 | | 0 | | | 20.9 | 10 |
| Thrussell | X | 1.47 | | 17 | | 18 | | | | | | | | | | | | 40 | | 23 | 23 | 22 | | | | | 0 | | | | /0 | | 0 | 17.8 | 8 |
| Trathen | X | 1.28 | | | /11 | /22 | /24 | 37 | /23 | | | 49 | | | | 38 | 47 | 47 | | | | /11 | /11 | 12 | /11 | /0 | 0 | 0 | 0 | /0 | 0 | 0 | 0 | 19.2 | 12 |
| Venter | X | 1.28 | 18 | 14 | 13 | 25 | 27 | /36 | | 26 | /39 | 43 | 61 | /55 | 64 | /41 | 47 | 41 | 38 | 24 | 23 | 23 | | | | | | | | | | | | 32.4 | 15 |
| Warren | X | 1.10 | | | | | 32 | 45 | | | | | | | | | 41 | 39 | 24 | 29 | 26 | | | | | 0 | 0 | | | | | 0 | | 23.6 | 10 |
| Wells | | * | | | | 25 | | | 25 | | | | | | | | 35 | | | | | | | | | | | 0 | | | | | | 21.2 | 4 |
| Williams | X | 0.92 | | | | | | 47 | 33 | | | | | 69 | 64 | 40 | | | | | | | | | | | | 0 | | | | | | 42.1 | 6 |
| Ra' | | | 17 | 17 | 21 | 27 | 31 | 45 | 31 | 36 | 48 | 57 | 65 | 60 | 56 | 50 | 49 | 49 | 35 | 26 | 23 | 22 | 14 | 19 | 11 | 9 | 3 | 1 | 0 | 0 | 3 | 0 | 0 | 26.6 | |
| Rz | | | 16 | 15 | 13 | 24 | 24 | 35 | 34 | 33 | 44 | 50 | 57 | 59 | 60 | 64 | 60 | 46 | 37 | 30 | 25 | 17 | 14 | 18 | 8 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25.5 | |

* Insufficient Data Available
X Standard Observer
‡ New Observer
R Resumed Observations

/ Observations rejected because of poor visibility and sky conditions

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# "A STUDY OF SOLAR INDICES"

FACULAE. While sunspots are the coolest photospheric phenomena, faculae are the hottest. Their true nature is even less understood than those of spots. They appear somewhat elevated, though their heights are as unknown as are the depths of spots. Anyone who has tried to sketch faculae knows how complex their shape is. Most sunspots are surrounded by faculae, but many faculae are without spots, though they occur primarily in the spot zones and travel with these (Spoerer's law). Occasionally faculae are seen also in high polar regions (±70°). The visibility of faculae depends very much on their position in relation to the solar meridian. The optimal visibility occurs when they are 63° off the center of the solar disc. (9) This is due to the gaseous nature of the sun, which permits us to see deeper-ergo hotter-regions in the center of the sun's disc, while the limbs appear darkened. (10) The relatively small contrast of faculae to the brightness of the photosphere makes them almost invisible in the central zone. Faculae precede the birth of a spot and also survive it, having a much longer span of life. Just like the photosphere, faculae have a granular structure, the mean life of facular granules is 2 hours and average size 1"-2". These granules form a vein-like structure, which make up faculae. Faculae vary not only in size, but also in intensity. This brief description implies the difficulty of statistical recording of faculae. The Royal Greenwich Observatory measures individual faculae areas, just like sunspots, ie. projected areas and areas corrected for the foreshortening effect.(see previous Bulletin). Since they can be photographed in integrated light only outside the central zone, these measurements give us only about one half of all faculae. Zurich records the outlines of faculae fields on a 25 cm prejection screen. These drawings serve as a basis of their Heliographic charts (11), which form a composite view of spot and facula outlines during one solar rotation. The areas of faculae are then measured planimetrically on these charts in units of 25 square degrees. These areas per rotation in 5 latitude zones are published in the yearly summary of the Zurich publication (Astron. Mitteilungen). See Graph B.

SPECTROSCOPIC VIEW OF THE SUN. Sunspots and photospheric faculae, besides granulation, are the only phenomena visible on the solar disc in the integrated light. When G. E. Hale and Deslanders, France, discovered the spectro-heliograph in 1891, a great new field in solar observation was opened. This instrument permits one to photograph the sun in certain spectral lines usually in the red Ha line of Hydrogen or the violet H and K lines of singly ionized Calcium. The chemical composition of solar gases and the physical conditions may be thus studied. Furthermore, the nature of spectral lines - the dependance of their widths on the number of atoms per column of gas - permits one to see "higher" or "lower" layers in the solar atmosphere. This can be seen on spectroheliograms, where only a limited portion of a particular spectral line is used. (Eg. the so-called K3 spectroheliograms (see d'Azambuja's pictures of July 1927), where only the very central portion of the K line was used, show us the higher portions in the solar atmosphere, without penetrating down to the photosphere; pictures in K2 - somewhat off the center of the line, show lower portions and the K1 pictures in the wing of the line, show us practically the photosphere as we normally see it.

CHROMOSPHERE. While sunspots and faculae occur on the solar "surface", the photosphere, all the other solar phenomena happen in the Chromosphere and the Corona. The lowest layer of the chromosphere is the so-called Reversing Layer, known for giving an emmission (flash) spectrum just before and after total solar eclipse. F. Hoyle gives the height of the Reversing Layer as 1500km; (12) while Abetti in his new book "Il Sole" gives it only 500km. This points to the great difficulty in specifying solar atmospheric layers. The light of the chromosphere, according to Hoyle's book, is 12,000km, according to Abetti, 14,000km, while others give it even double these values. The chromosphere consists of spicules (see (10)) and as a whole seems to vary in height during a spot cycle, as was shown by Abetti. Fracastoro of Arcetri, Italy, published data for 1922-1948, showing how the height of the chromosphere varied. During spot maximum, the chromosphere seems to show an even height in all latitudes, while during minimum, it shows maximal height in polar regions and minimal height at the equator.

FLOCCULI. The photospheric faculae show almost the same distribution as the so-called Calcium or Ca Flocculi, which, being observed only in a particular spectral line, can be seen over the whole solar disc. Flocculi observed in the H line of Hydrogen are divided into Bright H Flocculi (emmission and Dark H Flocculi/absoption), also called Filaments. These later ones, the Filaments, are actually Prominences superimposed on the solar disc and will be described in the next paragraph more fully. The difference in appearence of flocculi is not only a matter of chemical composition plus distribution, but also of physical conditions. Hydrogen atoms require much higher temperatures in order to emit light, than do Calcium atoms. All flocculi are classified according to their extent over the sun and their intensity in so-called "Character Figures". Photographic standards by the Mt. Wilson Observatory and by Meudon are used for these Character Figures ranging from 0, (absence of flocculi), to 5, (maximum). Formerly these Character Figures were published in the Quarterly Bulletin of Solar Activity (until 1944), at present however they are not published anywhere. The only data for this index for the present solar cycle which I could get were in a study by Righini and Godoli of Arcetri. (13) This study (1932-1949) shows graphically all 3 types of flocculi. The Ca Flocculi follow the Sunspot Numbers best, particularly during the present cycle. Ca Flocculi cover about 4 times the areas of Bright H Flocculi and about 8 times those of the Dark H Flocculi (Filaments) see (10) page 110.

PROMINENCES. With the exception of the brief but violent Flares, Prominences are the most spectacular solar phenomena, particularly when observed on the solar limb. Movies, such as those made at Climax, are most fascinating. Until Janssen and Lockyer discovered that prominences can be observed with the aid of a spectroscope (1866), prominences could be seen only during total eclipses. Later the spectroheliograph and spectrohelioscope made the study of prominences much easier. Today observations are made also with coronographs plus polarzing monochromators and slow motion movies. The cause of prominences is unknown. The forces behind them are complex electromagnetic fields, radiation pressure and of course gravitation. It is not even certain whether prominences are a strictly solar phenomenon or whether they are condensing coronal matter accreted from interstellar (and interplanetary) dust, as an increasing number of British astrophysicists believe. (12) (Hoyle, Lyttleton, Bondi, McCrea..) The predominantly downward motion of matter in prominences is a strong argument for accretion theories;On the other hand there can be no doubt that some matter is also completely ejected from the sun.

Prominences show a great number of forms (see Edison Pettit's classification (14). Generally however they may be divided in a) prominences in the sunspot zones; b) outside of spot zones. The average dimensions of Quiescent Prominences (Filaments) are: Pettit: d'Azambuja: (15)

| | Pettit | d'Azambuja |
|---|---|---|
| Height - | 50,000km | 42,000km |
| Width - | 10,000km | 6,000km |
| Length - | 200,000km | 200,000km |

M. and Mme. d'Azambuja, who studied prominences at Meudon extensively for over 30 years give us a simplified life history of Quiescent equatorial Prominences (15): "A new centre of activity is indicated by a small bright flocculus within which a spot will appear on the same or the following day. The bright flocculus will grow and may last for two rotations during which time there may be eruptions and little dark filaments, which flow towards the spot-motions of matter seen on the limb or in the spectroheliloscope. The spot may develop into a complex group. The spot is followed by the appearance about 0.9 rotations later of a filament, to be seen on the edge of the flocculus remote from the equator and pointing away from an active spot. It may be about 50,000km long and its lower latitude end nearest the spot will be about 1.6° from the spot. The end of higher latitude will lie east of the spot. The latitude of the lower end follows the same distribution in time as that of the spot, Sporer's law, and this applies also to the equatorial filaments even when no spot has been visible near their end of lower latitude. By about the third or fourth rotation of the filament it will have reached its maximum length, having grown at the end remote from the spot to a length of about 200,000km. If a filament lasts for six rotations it may well grow to 300,000km. The natural result of growing at the end of higher latitude is that the centre point of the filament moves polewards. By about the 4th rotation the filament begins to break up and disappear, the end of lower latitude fading out first. Polar prominences follow much the same general line of development as equatorial prominences, but links with spots are nil and with centers of activity not clear.

The polar zone prominences develop during spot minimum (in 40°-50° lat.) and their mean distribution moves towards the poles, where they disappear during spot maximum. The main zone of prominences runs fairly parallel with the spot zone (being in about 10° higher lat.), Beginning with a new spot cycle, it follows and ends with it.

Zuerich measures prominence areas on the solar limb in so-called PE units. A PE unit is a square area along the solar limb of 1 (heliocentric) and 1" in height (geocentric). This index has been used since 1909 and is the most complete prominence index. Character figures of Dark H Flocculi (Filaments) and their actual areas are also used as is the number of Prominences. Graph B shows the Zuerich statistic. With all the inherent disadvantages (perspective distortion, incomplete data) this index follows the curve of sunspots remarkably well (1944-1951), showing approximately a two month delay.

FLARES. (Also called Chromospheric Eruptions) are the most violent solar phenomena. This phenomenon is becoming increasingly of general astrophysical interest, since a number of so-called "Flare Stars" was discovered, as active AAVSO observers know. (16) R. C. Carrington and Hodgson first, quite accidentally, observed a large flare on September 1, 1859. Since then less than a handful of lucky observers have seen flares without the aid of a spectrohelioscope. (17) Some 20 observatories the world over report their observations to d'Azambuja and these are published in the I.A.U.'s Quarterly Bulletin of Solar Activity published by the Federal Observatory in Zuerich with financial support of the UNESCO. The hours under with the sun was "watched" by any of the participating observatories, are presented diagramatically. Until 1947 the sun was under surveillance for about 6-8 hours per day; since then for about 12 hours on the average. Most observatories use spectrohelioscopes, while Mr. Wilson Observatory records automatically every 4 minutes the sun in H. D'Azambuja showed that there are large differences in the number of observed flares: e.g. while McMath Hulbert Observatory recorded during 1947 per 1 hour of observation an average of 2.8 flares; Zuerich reported 0.55 and Mr. Wilson 0.04. This points, besides the instrumental differences, also to the fact that small, bright flocculi may be counted as flares, or some bright eruptive prominences on the limb. The visibility of flares also depends on their position in relation to the central meridan, (18-19) due to the perspective foreshortening. Flares are generally divided into 3 classes in accordance to size, brightness and duration:

| Class: | No.: | Mean Duration: (Waldmeier)(18) | No.: | Mean Duration: (Ellison)(20) | Mean Areas: (Ellison) |
|---|---|---|---|---|---|
| 1 | 683 | 20.3 min. | 41 | 17 min. | 100-300x10-6 sol.hemis. |
| 2 | 209 | 33.4 " | 18 | 29 " | 300-750 " " |
| 3 | 35 | 62.4 " | 21 | 62 " | 750 and over " |
| 3+ | - | - | 29 | $\infty$ 3 hours | |

Since this classification is rather crude, the I.A.U. decided that observatories should report whenever possible the central intensity and width of the H line, which together with the time elements is most characteristic of flare activity. Flares occur close to active sunspots, most often halfway between the Preceding Leader, and following spots of a group. (20) Only one third of its lifetime is spent in reaching maximal brightness. The largest flares give off an intense flash of radiation in continuous spectrum for a brief time and it is this fact, which makes some flares visible without a spectroscope. This fact seems to support the "discharge mechanism theory" of flares. Flares are the most accurately determined areas on the sun, which unquestionably cause terrestrial effects with their intense radiation (U.V. and soft X-rays) and corpuscles, (more about this later). No changes in sunspots could be recorded, even where flares occur repeatedly (21). An excellent and detailed summary and bibliography on the study of Flares was written by M. A. Ellison in a report published by the International Council of Scientific Union in 1951(22).

NOTES for Graph B.

The Faculae curve was made from Zurich data in yearly reports, 1945-1951. These data are used primarily to study the zonal distribution of faculae. I have added together the areas in all latitudes during each rotation (Carrington's) No. 1222-1314, and plotted them. Care must be taken not to compare this curve with other curves of monthly means, (rot. period is only 27.27 days). The yearly percentages (Zurich's) of areas covered by faculae are more reliable.

The Prominence curve is given in mean PE units (see text) per month. The years 1944, 47, and 48 average about 150 obs. per year; the later years about 250 obs.

Reduced Flare Numbers curve. The average life of all flares is less than ½ hour (approx. four of class 1 to one of class 2 and 3). Any recording of flares without taking this into consideration could become highly distorted. During 1949 there were 200 more reported flares than in 1947; unless, however, one takes into consideration the fact that during 1949 almost twice as much time was spent watching the sun, a wrong conclusion could be drawn. I have taken the number of all flares from the Quarterly Bulletin of Solar Activity and extracted the total time per month under which the sun was under watch from the time chart. Multiplying the number of flares by the percentage points of the "watch time", I got the "Reduced Flare Numbers". Since no time table is available for 1944, 45, and 46, the mean percentage-time of 1947-48 was used (the increase in flares study came in 1948). Evidently these Reduced Numbers are far from foolproof, but they are useful, as experience has shown. A further smoothing was achieved, when I computed so-called 12 months running means (1/12 of 12 monthly means for the seventh month). The number of flares follows closely the Sunspot Numbers.

REFERENCES FOLLOW, GRAPH B ON SEPARATE SHEET.

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(13) G. Righini and G. Godoli "The Physical Meaning of the Character Figures of Solar Phenomena" Journal of Geophysical Research Vol. 55 No. 4 (Dec. 1950)
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(18) Astron. Mitteilungen No. 153 - Waldmeier on the Statistic of Flares.
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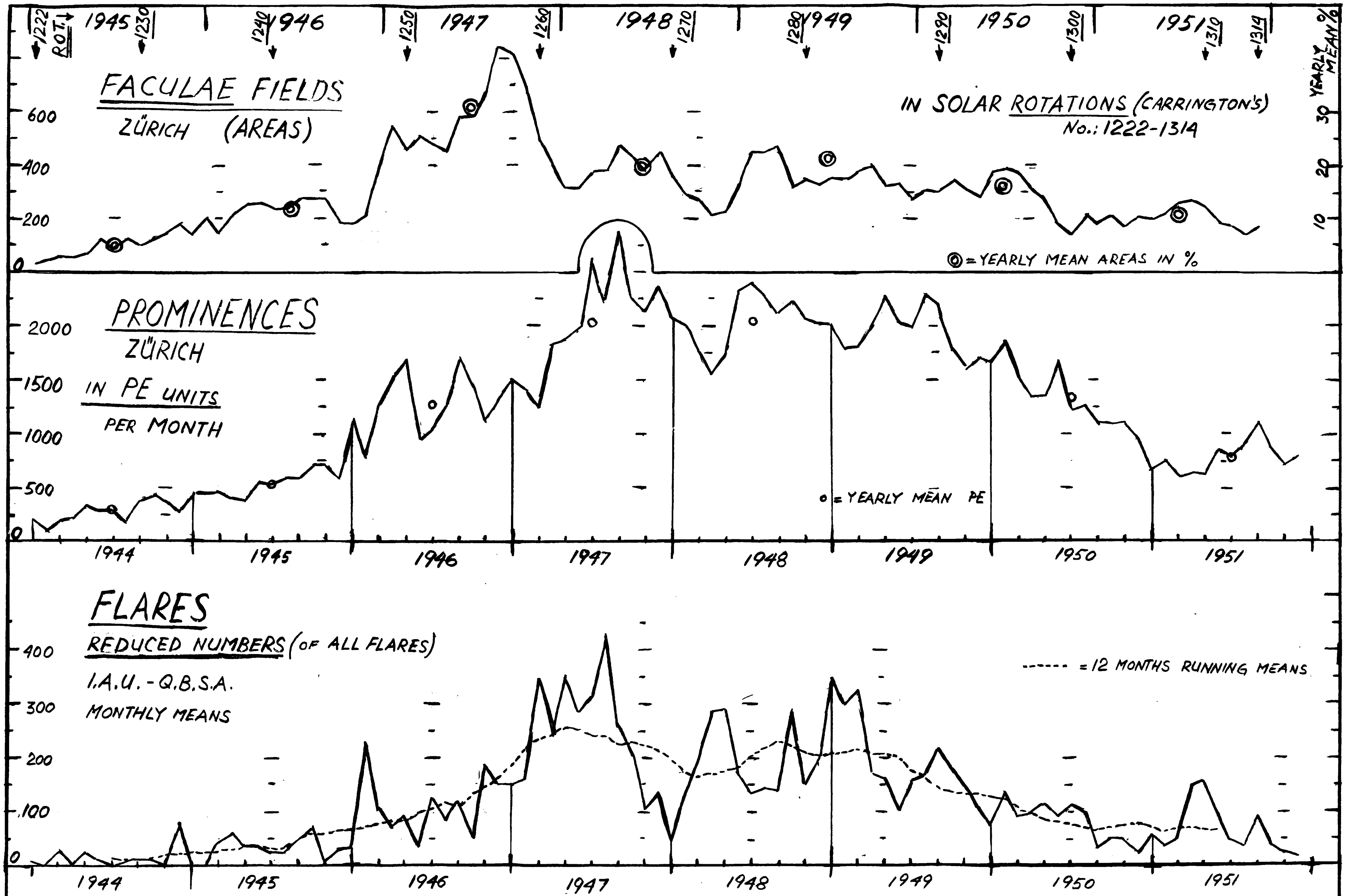
(20) M. A. Ellisson "Characteristic Properties of Chrom. Flares" - in "Monthly Notices" (RAS) Vol. 109, No. 1 (1949).
(21) Newton and Howe "Area Changes in Sunspots and Solar Flare Incidence" in "The Observatory" Vol. 72, No. 868, p. 113.
(22) Ellisson "Recent Advances in the Observation of Solar Flares" in: International Council of Scientific Unions; Seventh report of the Commission on the study on the Relations of Solar and Terrestrial Phenomena (Paris 1951)




GRAPH B

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