SOLAR DIVISION Bulletin

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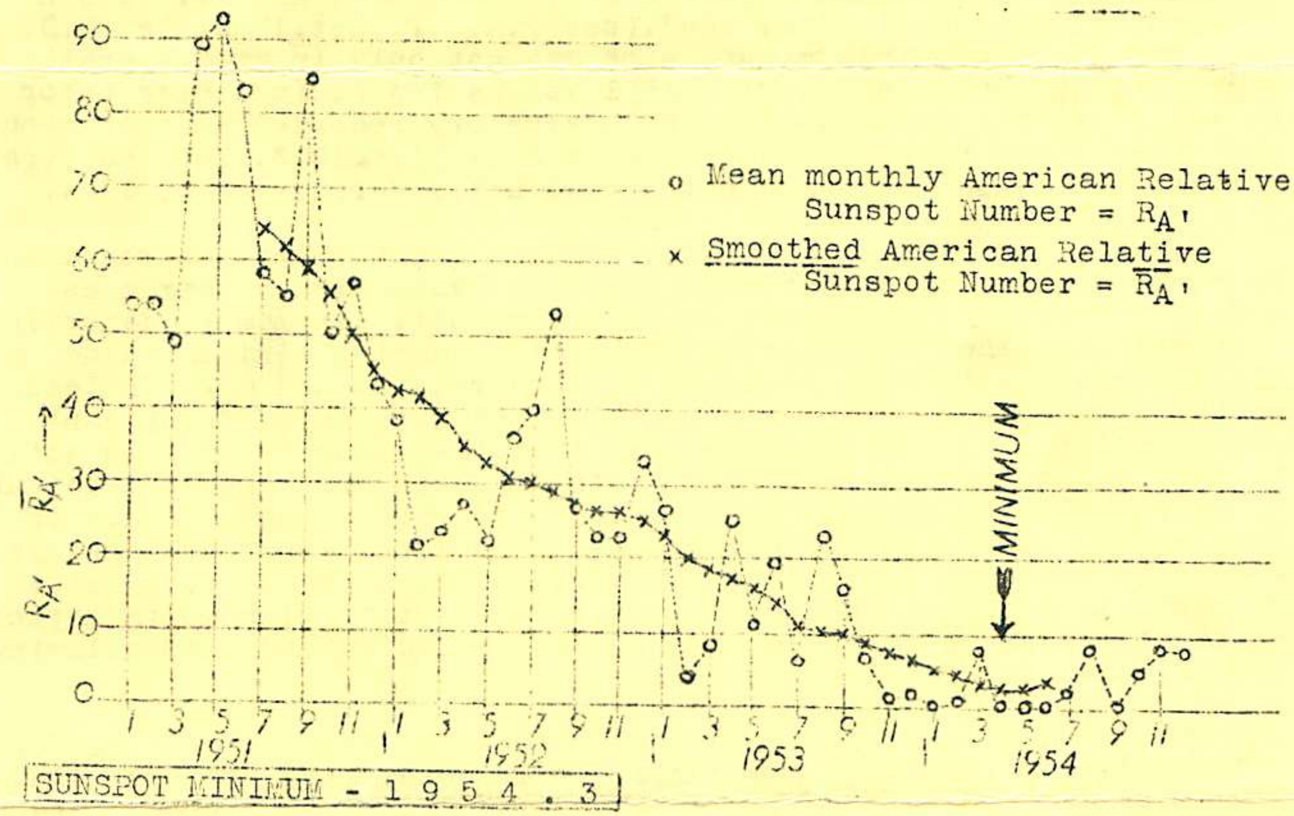

SUNSPOT MINIMUM - 1954.3

The most active sunspot cycle in the last 170 years reached the socalled EPOCH OF MINIMUM FREQUENCY during spring 1954. The activity of the well known 11-year sunspot cycle does not only apply to sunspots but equally well to faculae, prominences, flares, the corona and solar radio-noise as well, and therein lies its great importance to man, to terrestrial phenomena such as geomagnetic and ionospheric activity. The latter is of cardinal importance if radio communications are not to be interrupted wholly due to changes in the reflective properties of the ionosphere. (The ionosphere is that atmospheric layer which permits worldwide radio communications by reflecting radio signals back towards the globe.) This solar-terrestrial relationship is one of the main points of study during the forthcoming International Geophysical Year (IGY) in 1957-8.

(continued on page 2.)

After the most active period since 1778, sunspots and all other solar activity began to recede late in 1950. With a short exception during spring 1951 a more or less steady decrease followed until spotless, almost wholly inactive, days became the order of the day, particularly between November 1953 and June 1954. It was during this period that the last solar cycle came to end.

The last sunspot cycle, socalled 18th according to the old Zürich statistic going back to 1749, started in February 1944. What is meant by "started"? Since without exception each new cycle starts with sunspots appearing in high latitudes (and with reversed magnetic polarities), does the first recorded high latitude spot signify the beginning of a new cycle? The answer is no, because such an event could be subject to a high degree of arbitrariness. To wit, a high latitude spot was recorded at the Mc Math-Hulbert and Mt. Wilson Observatory on August 13th, 1953.(see P.A.S.P.,Oct.1953;also S.D. Bulletin Jan.1954) This minute spot was not only in exceptionally high latitude but also very short lived /a few hours/. Even prior to this date the Royal Greenwich Observatory recorded another minute and short lived high latitude spot on July 21st,1953. Yet the first typical new cycle spots did not appear until February 8th, 1954.

Clearly for statistical purposes such a determination would not be satisfactory. Since activity of a new cycle always commences before that of the old cycle is fully extinct, minimum is determined statistically when both cycles combined present a minimum value. All solar activity is a sequence of interrelated and more or less active eruptions superimposed on the underlying major "eruption" called solar cycle. It thus happens that the vagaries of this activity show great fluctuations from month to month and make it necessary to smooth out the minor peaks and deeps to reveal the behavoir of the fundamental cycle. To do this socalled "running means" are employed or, as in the case of sunspot numbers, socalled "smoothed sunspot numbers". A smoothed sunspot number for any particular month depends on the observed monthly averages of six preceding and six following months together with the particular month's mean.

The EPOCH OF MINIMUM FREQUENCY is both the "end" of the old cycle and the "beginning" of a new cycle. It is determined from socalled "smoothed sunspot numbers", when their value reaches minimum (Graphs)

Pertinent data of the 18th sunspot cycle.
The last cycle started in February 1944. Since an epoch of maximum and minimum is expressed in years to the nearest tenth, this would be referred to as 1944.2. Then the value of the lowest smoothed number (Zürich's) was 7.7 compared with the recent minimum of 2.4 ($\overline{RA}$'). Maximum was reached only after 3.3 years in May 1947 (1947.5) with a value of 151.8. This was higher than any other maximum since 1778. Peak activity lasted (with a smoothed value over 130) for just about 3 years, or longer than that of any other known sunspot cycle. The previous maximum in 1937.4 had a value of 119.2. The last cycle lasted 10.1 years, the previous 10.4 years. None of the last four cycles since 1913 lasted more than 10.4 years. The current minimum value of 2.4 was lowest since 1913, though close to the minimum of 1933.8 when it was 3.4.

H.L.B.

Editorial notes:

Starting with this issue the Solar Division BULLETIN will carry a regular feature called "SOLAR TERMINOLOGY". Our next installment will be on the Photosphere-Chromosphere-Corona. Another future issue will describe in detail what is known about solar rotation. All known solar phenomena will be defined and described, and also the way they are observed and recorded.

Specific data are taken from THE SUN (1954), edited by Gerard P. Kuiper, or if necessary from the proper standard textbooks or original sources.

Your comments, suggestions and questions are always welcome.

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Our February issue will carry the summary for the rest of solar activity in 1954. For lack of space it could not be included in this issue.

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ADDENDUM:

We are indebted to Mr. Alan H. Shapley, National Bureau of Standards, who pointed out in one of his letters that the following SOLAR RADIO OBSERVATORIES should have been included in our list as issued in the November 1954 S.D.BULLETIN :

Carnegie Institution of Washington
Harvard College Observatory
Sacramento Peak

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OUT OF OTHER PUBLICATIONS:

C.N. Anderson's "Notes on the sunspot cycle", JOURNAL OF GEOPHYSICAL RESEARCH, Vol.59, No.4-December 1954, suggest that there is an "indication that the long series of sunspot cycles is beginning to repeat itself". Mr. Anderson concludes that there is a long period sunspot cycle of about 169 years. Thus the 1947 maximum is compared with that of 1778 based on the long period of fifteen 11-year cycles based on sunspot minima."On this basis", writes Mr. Anderson."the next sunspot minimum should be about 168 or 169 years after the sunspot minimum of 1798,3, or during 1966 or 1967." Mr. Anderson onee again discusses "graviational effects of the planets on the sunspot cycle" and concludes "that the planets contribute little, if any, to the major components of the sunspot cycle and that the cause of sunspots must be looked for inside the sun."

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OBSERVER'S NEWS.

Mr. Ralph N. Buckstaff, one of our experienced standard observers, reported a "slight hump on the limb." His observation was made on January 6th, 1955 at 20h02 U.T. near the rising sunspot at Lat.38°N. This region was the most active region since 1953. The rare yellow coronal line was recorded here by the High Altitu· Observatory, as well as flare activity.

SOLAR TERMIN LOGY
(Definitions-Data-Descriptions)

The Sun as a Star:

A star is a gaseous globe with a minimum mass of about 10^{32} grams (aprox. 1/5 solar mass) held together with gravitational forces and generating radiant energy at a sufficient rate to remain stable over billions of years. The range of stellar masses is from about 1/5 solar mass to 50 solar masses a ratio of 1:250. In size the range is of the order of one million-the smallest star is not larger than the Earth, the largest could enclose Jupiter's orbit-the former are White Dwarfs, the latter Red Supergiants. Surface temperatures vary from about 3000°K upto 100,000°K. In luminosity the range is greatest-from a million times less luminous to a million times more luminous than the sun.

The sun is a typical Main-Sequence star just like more than 95% of all stars not further than 10 parsec (=32.6 Light Years). It is classified according to its spectrum as a <u>dG2</u> star, meaning that it is a dwarf-type star with a G2 spectrum. Spectral classifiactions running from hottest -O-type-to coolest M-type stars;from blue-white to deep red- the order being:O,B,A,F,G,K,M - tell the astrophysicist the main characteristics of a star.

Energy generation in a star is essentially an atomic procees called fusion. The best understood process, the socalled proton-proton cycle, involves four Hydrogen atoms (=protons) which become Helium (=alpha particle) and in this process a certain amount of mass is converted into energy according to the famous equasion of Einstein. ($E=mc^2$; E=energy;m=mass;c=velocity). The better known Bethe "Carbon-cycle", where Hydrogen is converted into Helium through the medium of Carbon atoms and other isotopes, requires higher temperatures than the astrophysicist considers to be present in the sun. While the most essential asset of a star is its mass (as Eddington discovered) without the generation of sufficient energy no star could last for even known geological times.

Solar data:

Mean distance: 149,530,000 km (=92.9mil.miles)
Apparent solar diameter: 1919".3 (G.F.Auwers,1891)= 31'59".4
True diameter: 139,140,000 km (=864.392 miles)
Mass: $1,9866 \times 10^{33}$gm = $1,98 \times 10^{27}$ metric tons = 331,936xEarth's mass
Mean density: 1.41 gm/cm^3 (Earth's 5,52 gm/cm^3)
Surface gravity: 27.9 times the earth's;velocity of escape 617km/sec
Effective temperature: 5784°K(Allen,1950);solar constant 1,97 cal/cm^2min.
Absolute photovisual magnitude:+4.69
Rotation-equatorial siderial period: 24.96 days (Carrington)*)

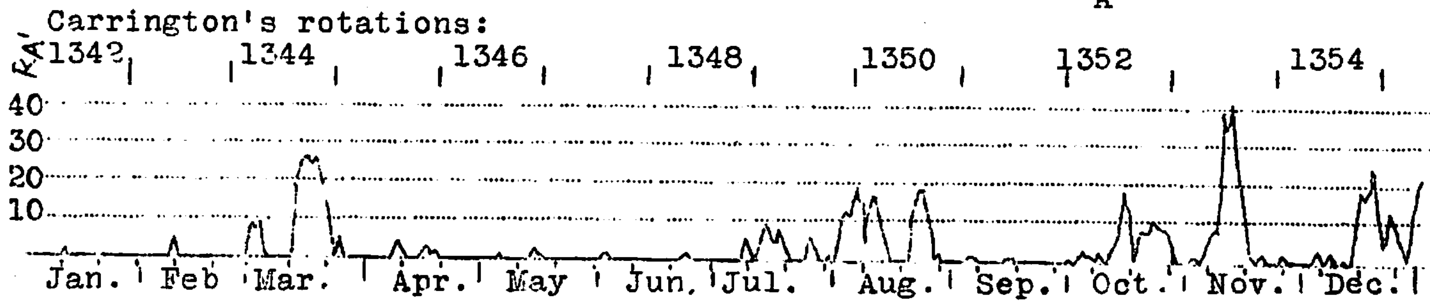
From solar models:(P.Naur**)
Abundance of Hydrogen:Helium:heavy elements-74%:25%:less than 1%
Central temperature: 13,500,000°K-13,800,000°K
Central density: 85,7 to 94,0 gm/cm^3

hlb

*)details separate **)from Benght Strömgren in THE SUN p.77

1 9 5 4

DAILY AMERICAN RELATIVE SUNSPOT NUMBERS- R_A'



""*"*"*"*"*"*"*

Mean Monthly American Relative Sunspot Numbers - R_A'

Smoothed American Relative Sunspot Numbers - $\overline{R_A}$'

1 9 5 1 - 1 9 5 4

The Smoothed numbers were computed according to the usual formula:

If R_0 is the observed relative sunspot number for a particular month, then $\bar{R}$ is the smoothed sunspot number for that month. R_n is then the observed mean monthly sunspot number n months after the month with R_0. *)

$$\bar{R} = \frac{R_{-6} + R_6 + 2\sum_{-5}^{5} R_n}{24} \quad *)$$

The actual procedure is to compute the average out of 12 months in succession (e.g. Jan.to Dec.), then the average of the next 12 months (e.g.Feb.to Jan.next); one half of these two averages is the smoothed number for the middle month of the 13 months used (e.g.July).

Month:	RA' 1951	$\overline{RA}$' 1951	RA' 1952	$\overline{RA}$' 1952	RA' 1953	$\overline{RA}$' 1953	RA' 1954	$\overline{RA}$' 1954
Jan.	53.8	-	38.6	42.4	26.6	22.9	0.1	5.2
Feb.	54.0	-	21.8	41.5	3.6	20.2	0.3	4.4
Mar.	49.0	-	23.3	39.0	7.9	18.5	8.0	3.2
Apr.	89.6	-	27.3	35.3	24.8	17.5	0.6	2.4 Min.
May	91.7	-	22.2	32.7	11.0	16.0	0.2	2.6
Jun.	83.4	-	35.9	30.9	19.6	13.8	0.2	3.1
Jul.	58.3	63.6	39.4	30.0	6.4	11.3	2.1	
Aug.	55.6	61.6	53.2	28.8	23.1	10.1	8.1	
Sep.	85.2	59.2	26.1	27.4	15.7	10.0	0.3	
Oct.	50.8	55 6	22.6	26.6	7.2	8.9	4.7	
Nov.	56.7	50.1	22.5	26.1	1.7	7.5	8.0	
Dec.	42.9	45.2	33.5	24.9	1.6	6.2	7.7	

Note: These data are illustrated graphically on page one.

*) from Astronomische Mitteilungen der Eidgenössischen Sternwarte ZÜRICH Nr. 184

DAILY AMERICAN RELATIVE SUNSPOT NUMBERS - R_A'
1 9 5 4

Day:	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	0	0	10	0	0	2	0	5	0	0	1	0
2	0	0	8	0	0	1	0	12	0	0	1	0
3	0	0	9	0	0	0	0	13	0	2	0	1
4	0	0	1	0	0	0	0	12	2	3	0	3
5	0	0	0	0	1	0	0	15	2	2	5	1
6	0	0	0	0	0	0	0	20	1	2	7	0
7	0	0	0	2	0	0	0	16	0	0	8	3
8	0	3	0	5	0	0	5	4	0	3	7	0
9	0	6	0	2	0	0	1	15	0	1	24	0
10	0	0	0	0	0	0	0	17	0	0	40	0
11	2	0	0	0	0	0	0	17	0	3	35	1
12	0	0	8	0	0	0	4	13	0	5	42	0
13	0	0	19	0	0	0	10	8	0	7	32	0
14	0	0	24	1	4	0	9	1	1	12	19	3
15	0	0	26	3	1	0	5	0	1	19	12	18
16	0	0	26	3	0	0	5	0	0	15	2	17
17	0	0	24	1	0	0	8	0	0	1	0	19
18	0	0	26	2	0	0	3	0	0	2	0	26
19	0	0	19	0	0	0	0	0	0	8	2	19
20	0	0	17	0	0	0	0	1	0	8	0	16
21	0	0	15	0	0	0	0	16	0	8	0	5
22	0	0	10	0	0	1	0	19	0	11	0	5
23	0	0	0	0	0	1	0	19	0	10	0	14
24	0	0	5	0	0	0	3	15	0	9	0	12
25	0	0	1	0	0	0	7	10	0	9	2	8
26	0	0	0	0	0	0	3	1	0	7	0	5
27	0	0	0	0	0	0	0	2	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	5
29	0		0	0	0	0	0	0	0	0	0	14
30	0		0	0	0	0	1	0	1	0	0	21
31	0		0		0		0	0		0		22
Mean:	0.1	0.3	8.0	0.6	0.2	0.2	2.1	8.1	0.3	4.7	8.0	7.7

MEAN DAILY AMERICAN RELATIVE SUNSPOT NUMBER IN 1954:

$R_A' = 3.4$

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The mean daily RA' for 1953 was 12.5. During the past year there were 229 spotless days and 25 days with RA'=1. This compares with 128 spotless and 21 RA'=1 days in 1953.(24 and 4 in 1952). Highest activity occured in November (RA'max.=42). This being the minimum year (1954.3), sunspot activity was particularly low between November 1953 and June 1954 with the exception of last large old-cycle group which occurred in March. Starting with August new-cycle spots became predominant. February brought the first typical new-cycle sunspots.