SOLAR DIVISION Bulletin

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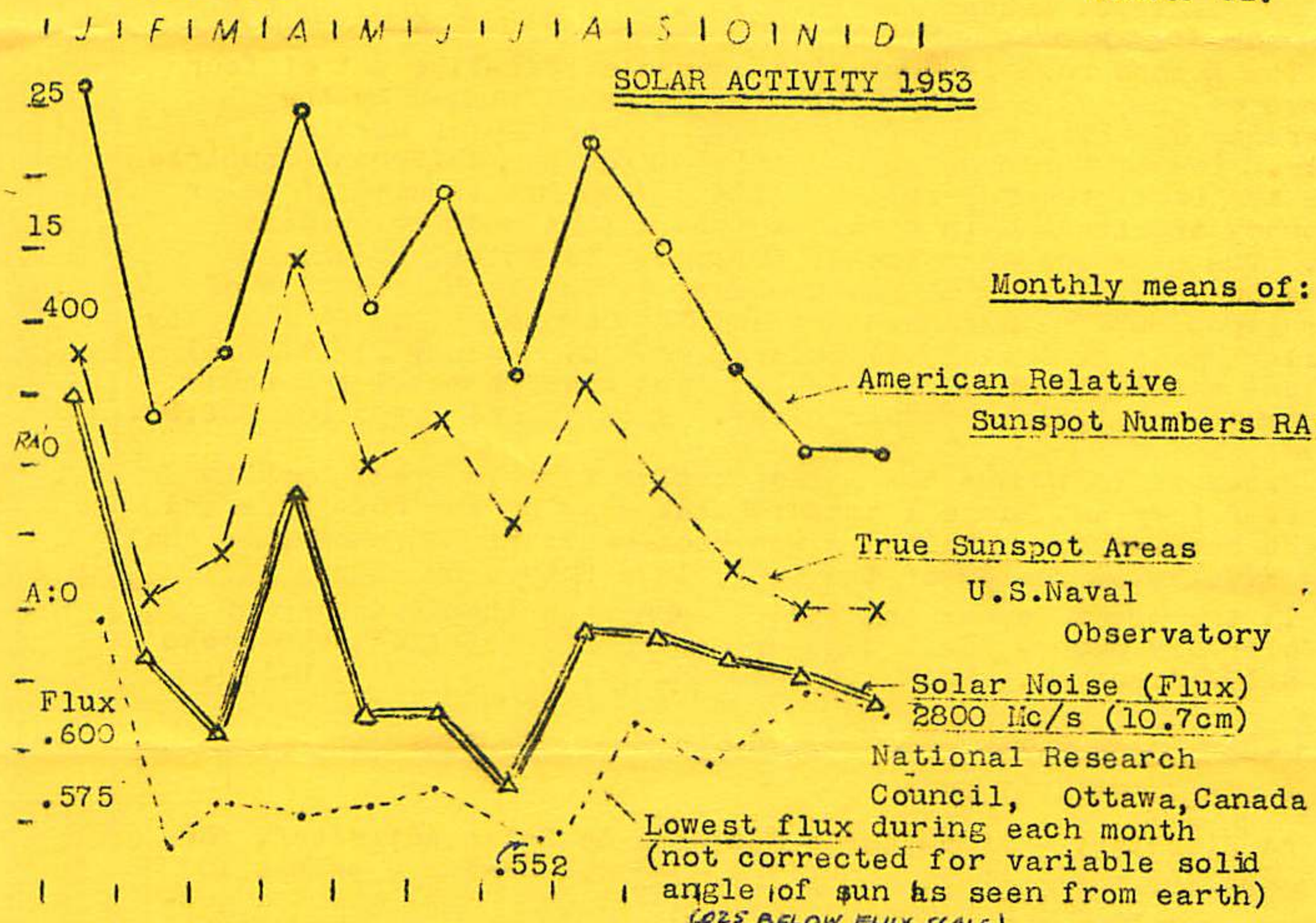

Note: The absence of a "parallel" decrease in solar radio noise at 2800 Mc/s (which usually follows closely spot activity) and the increase in the lowest flux value after August is puzzling. Dr. A.E. Covington explains, that about 5% in the increased low in November could be due to the increased solid angle of the sun as compared to July and the remaining 5% may be the new cycle increase. Records show no point-like source (radio spot), but only a broad source. In the past there were similarly unexplained increases (late in 1948)/see Bulletin No.87 Supplement-June 1953/.

NEW BOOKS

The year 1953 will be a memorable one to students of Solar Astronomy. This is so, because two excellent books about the sun have been published here. The first book was written by LAWRENCE H. ALLER and is called, "ASTROPHYSICS - THE ATMOSPHERES OF THE SUN AND [redacted] STARS", published by Ronald Press Co., New York. This book is addressed primarily to students of Astrophysics and to professional physicists. Eight chapters of this book deal in great detail with spectroscopic studies and problems. The ninth chapter presents in a condensed, but lucid way, what is known as "Solar Phenomena". One is almost tempted to recommend this twelve-dollar book for this chapter alone, since most advanced amateurs may study it without great difficulty. The book is well illustrated with many diagrams and photographic reproductions. The September, 1953 issue of "Sky and Telescope" carried a brief review of this book by Philip C. Keenan.

The second book is part of an encyclopedia-like set of four volumes called, "The Solar System". It is published by the University of Chicago Press under the editorship of Gerald P. Kuiper. Twenty three solar physicists from six different countries wrote the first volume, called, "THE SUN". All aspects of solar Astronomy are treated in nine chapters with almost up-to-date data. The nine chapters are as follows: 1) Introduction, 2) The Sun As a Star , 3) Photosphere, 4) The Identification of Solar Lines, 5) The Chromosphere and The Corona, 6) Solar Activity 7) Solar Radio Emmission, 8) Solar Electrodynamics, 9) Empirical Problems and Equipment. Two tables list solar optical and radio equipment in all parts of our globe. This Volume lists for $12.50.

Since it is impossible to do justice to this great book in any brief form and since I am sure that many of our observers and readers have eagerly awaited a new book on Solar Astronomy, we shall carry a detailed review of "The Sun", in a future BULLETIN.

In the meantime, we are glad to announce that a member of the Solar Division - AAVSO may purchase either of these two books with a 10% discount. Write to this editor. H.L.B.

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OUT OF OTHER PUBLICATIONS:

"A Planetary - Atmospheric Response to Solar Activity". Mr. Ralph Shapiro - Air Force Cambridge Research Center - writes in the JOURNAL of Meteorology" (Vol. 10, #5; Oct. '53) about a possible relationship between overall solar activity and the brightness of Jupiter. The following is the abstract of his article: "The brightness of the Planet Jupiter is found to be related to mean annual and monthly relative sunspot numbers, which are used to indicate the general level of solar activity. The evidence for the relationship is presented and is examined for possible meteorological implications."

"Sun Throws Out Particles at One-Fifth of Light Speed" Science News Letter, Jan. 23, '54. Visual observations of eruptive prominences have long ago indicated that solar matter is occasionally ejected at such speed as to escape solar gravitation. Thus velocities up to 700 km/sec. have been recorded. From geomagnetic storms due to solar flares, velocities of solar corpuscles of the order of 2500 km./sec. have been deduced. Recently Paul Wild of the Radiophysics Division of the Commonwealth Scientific and Industrial Research Organization in Sydney, Australia, found evidence from solar radio frequency emmission storms, that particles are ejected from the sun with speeds up to 37,000 km./sec. These velocities are of the order of magnitude of cosmic-ray type particles, which crash into our atmosphere, and further support the theory that cosmic rays actually originate in the sun. Until recently, there has been only a very meager evidence of increased cosmic ray incidence following solar flares and even this increase has been explained by some physicists as a secondary effect. Australian scientists are now able to study the sun with a radio telescope, which does not record solar noise of one frequency only, but instead in a wide range from 40 to 240 Mc/sec. ten times each sec.

There is an excellent article in The Journal of the Royal Astronomical Society of Canada - Vol.XLVII, No. 4 - July-August, '53; by J.L. Pawsey, describing extensively "Radio Astronomy in Australia". This fine article can hardly be sufficiently recommended.

"The Zodiacal Light and the Solar Corona". Sky and Telescope, March, 1954, carries an article by F.E. Roach and G. Van Biesbroeck, who present evidence that the outer, so-called false corona and the zodiacal light may be part of a dust cloud surrounding the sun and extending far into planetary space. The nrightness decrease with distance of this corona and the brightness decrease of the zodiacal light may both be expressed in one logarithmic equasion. Since it is impossible to measure the brightness of the zodiacal light closer than 25 degrees from the sun, (because of the twilight), the June 30th eclipse will give astronomers an opportunity to study the zodiacal light from certain parts of the U.S., where the sun will be eclipsed just below the horizon and thus some of the twilight should be diminished.

NOTES:

Mr. Wm. A. Reid, 167 South Ave., Hawthorne, N.J.; has completed the regular Reduction Charts giving all individual sunspot observations made by members of the Solar Division - AAVSO. Copies may be obtained directly from Mr. Reid for twelve cents, plus postage.

Our Chairman, Mr. Neal J. Heines, wishes to thank all members who wrote to him. He regrets that he is unable to answer these letters, for lack of time, and sends his best regards to all.

Mr. Russell C. Maag, 816 1/2 So. Massachusettes Ave., Sedalia, Missouri, informed us that he still has copies of the Astronomical League's Convention proceedings. These may be obtained directly from Mr. Maag for $1.50 per copy.

An unusual flare was reported in the Ionospheric Data, Nov.'53 as observed at Sacramento Peak on Oct. 31. This flare was recorded at S08 and E69, of importance 1- from 1600 to 1800 U.T. (2hours). According to the U.S. Naval Observatory, there was a small group at S05 and E65 with 4 spots. Usually only flares of 2 plus and 3 importance last for such a long time. No S.I.D. was reported.

MOST RECENT ADVANCES IN THE STUDY OF PHOTOSPHERIC GRANULATION

For more than a hundred years, solar astronomers have been puzzled and deluded in their study of the very surface of the sun, called photosphere. The photosphere is a gaseous barrier beyond which we cannot see any more interior solar regions. At about 6,000 degrees K it is hotter than any temperature reached in man-made furnaces. The problem is what happens to the photosphere when on one side it is subjected to the great heat and ionization of the solar interior, and when, on the other side, it comes practically in contact with the cold of cosmic space? What happens is granulation.

Since J.C. Janssen of Meudon, France was able to photograph the sun in great detail in 1878, it was clear that to observe this fine structure nearly perfect seeing conditions are required. As a result, there may be fewer satisfactory photographs of this fine granulation than there are of the sun during total eclipses. Since the pioneer work of Janssen in France and Hansky in Russia, different methods have been applied in the study of granulation and oddly, quite different results have been obtained. To add to this confusion, a rather distinctly new granular structure was discovered in faculae. Thus granule dimensions varied from one second of arc to more than a dozen with lives of one minute to an hour depending on the authors. It is difficult to understand such discrepancies obtained by professional astronomers with first-class instruments. Where then is the source of this confusion? The main villain is the turbulence of our earth's atmosphere and the very nature of solar granulation; namely, its own turbulence.

I shall first attempt to describe a process of turbulence in our own atmosphere. Let us take two parcels of air under different conditions. (The data used here are from Dr. Max Waldmeier's book, "Sonne und Erde"). The first case: On a clear autumn morning, the temperature at 500 meters above sea level is 10 degrees C, and the overall temperature decreases slowly with height at a rate of ½ degree C for each 100 m. Now suppose a certain parcel of air at 500 m level rises an additional 10 m. Its own temperature will decrease to 9.90 degrees C, due to the cooling effect of expansion under lower atmospheric pressure. Such a change in temperature, is called <u>adiabatic</u>. Our atmosphere's adiabatic gradient is about 1 deg. C per 100 m. Now since the atmosphere on this day is warmer at 510 m, namely 9.95 deg. C, the parcel of air we permitted to rise, is actually heavier / because cooler/ than the surrounding air. Consequently it will sink back to its original level. Such an atmosphere is called stratisfied and is stable.

Second case: An altogether different process will occur on a hot summer afternoon. Suppose on such a day, the temperature decreases by 2 deg. C for each 100 m in height. Now, if a parcel of air at 500 m and of 20 deg. C were to rise 10 m, its own temperature would drop to 19.90 deg. C (same atmosphere, same adiabatic gradient of 1 deg. C per 100m). However, the surrounding air at 510 m is only 19.80 deg. C according to our assumed temperature gradient. As a consequence now our parcel of air being lighter /warmer/, will continue to rise. Such a process of vertical up and down motion is called convection and is one of the main causes of atmospheric turbulence.

Going back to the sun. The photosphere is opaque because of the high degree of ionization in the underlying Hydrogen Convection Zone. Though the outer photosphere is stable, there is great turbulence underneath. Let's assume that a parcel of the photospheric gas is descending. In this process it is not only warmed up due to adiabatic compression, but it is also subjected to ionization. The energy for ionization is taken from this gas in form of temperature. In consequence, since its temperature increases at a lower rate, it continues the downward motion. Finally, when the ionization increases to such a degree that the adiabatic gradient becomes smaller than the temperature gradient, convection currents arise in the lower and middle regions of the photosphere. In other words, the temperature of lower regions increases at a far greater rate than the pressure.

In March, 1950, R.S. Richardson and M.Schwartzschild published in the Astrophysical Journal (111, 351) a study of remarkable observations performed with the 150' telescope at Mt. Wilson. They were not only able to get fine photographs of granulation, but were also able to record the line of sight motion of granules as seen in the Doppler shifts in the spectrum. From comparison with undistorted lines of our own atmosphere (superimposed on the solar spectrum) they measure the velocity of individual granules. Then they proceeded to correlate these velocities with the brightness of the very same granules. They concluded ..... "the correlation between brightness fluctuations and the velocities is rather weak; only the narrow regions of high upward velocities appear to have systematically higher brightness than average".

The 1950 data were subjected to another statistical analysis by F.E. Stuart and J.H. Rush of the High Altitude Observatory. The raw velocity and brightness data were smoothed by running means and thereby large-scale fluctuations were eliminated. The resulting data brought about a significantly higher correlation between velocity and brightness of granules, revealing more clearly that the brighter granules were associated with outward moving material. In 1952, F.W. Frenkiel and M. Schwartzschild published in the Ap. J. 116, 422 - another study on the fine granulation. They determined the so-called "turbulence spectrum of granulation". A turbulent gas is composed of a great number of individual cells, which again contain smaller cells and so on, they make up a hiearchy of cells. Such a hiearchy, though having cells of all dimensions, will also have cells which occur far more frequently than others. The 1952 study confirmed the granular structure centered about an average size of 2,300 km and also predicted cells of about 15,000 km. A superfine structure of only 200km was also predicted. Now F.E. Stuart and J.H. Rush analyze 8 photometrically calibrated white light photographs taken by W.A. Miller of RCA Lab. at Rocky Pt., L.I.,N.Y. From these they were able to find evidence of the large-scale granular structure. Their results are published in: Research Report #2, High Altitude Observatory "correlation analyses of turbulent velocities and brightness of the photospheric granulation". They conclude: "The fluctuations in brightness that define the 14,000 km structure, are not nearly so marked as those of the small granules. On the plates we analyzed, r.m.s. deviation from the mean averaged about 1% of the mean surface brightness. This quantity is not constant from one plate to the next, but varies between the limits of ½% to 2%. Some of this variation, however, must be attributed to differences in seeing effects from one plate to another. The dimension of the large structure is by no means constant either, but varies from 10,000 to 17,000 km. Comparisons of the results from the 2 traces at right angles on each plate revealed no consistent orientation effects."

H.L. Bondy

American Relative Sunspot Numbers -RA'- for January 1954

Jan.: 1...0	11...2	21...0
2...0	12...0	22...0
3...0	13...0	23...0
4...0	14...0	24...0
5...0	15...0	25...0
6...0	16...0	26...0
7...0	17...0	27...0
8...0	18...0	28...0
9...0	19...0	29...0
10...0	20...0	30...0
		31...0

Mean RA': 0.1

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Zurich Provisional Relative Sunspot Numbers RZ for January '54 all zero. Mean RZ: 0.0

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Zurich Definitive Sunspot Numbers for 1953 were published by Dr. Max Waldmeier. The monthly means follow:

I...26.5	IV...27.8	VII... 8.6	X... 8.2	Yearly
II... 3.9	V...12.5	VIII...23.5	XI... 1.6	Mean: 13.9
III...10.0	VI...21.8	IX...19.3	XII... 2.5	

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True Sunspot Areas during 1953

The United States Naval Observatory Circular No. 48 carries the "Solar Summary for 1953". Among others it also gives the Monthly mean Sunspot Areas corrected for the foreshortening effect and expressed in millionths of the solar hemisphere:

I...356	IV...490	VII...122	X... 66	
II... 16	V...290	VIII...324	XI... 12	Yearly mean: 178
III... 81	VI...272	IX...184	XII... 11	

Only six sunspot groups lived through two rotations in 1953 as against twelve in 1952 of which two lived for three rotations. This also compares 33 in 1951 (of which ten lived through three rotations, four through four, two through five and one through six rotations. In 1950 there were 47 groups living through two rotations, 12 through three, 2 through four and one through five rotations. Clearly the longevity of sunspot groups is closely related to the solar cycle's phase.

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Mean monthly values of solar flux at 2800 Mc/s (10.7cm) as recorded at National Research Council Ottawa, Canada
Flux in watts/m²/cycles/sec bandwidth (x10^{-20}) - 2 polarizations:
(month; number of observations; flux)

I(22)..0.724	IV(23)..0.691	VII(29)..0.592	X(27)..0.634
II(20)..0.633	V(23)..0.615	VIII(25)..0.645	XI(26)..0.629
III(19)..0.607	VI(25)..0.617	IX(26)..0.642	XII(23)..0.621

Yearly mean: 0.638