SOLAR DIVISION Bulletin

AUG 5 1954

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

Editorial Advisory Committee: Neal J. Heines - Margaret W. Mayall - William A. Reid
David W. Rosebrugh - Alan H. Shapley (CRPL)

JUNE-JULY 1954 Number 94-95

Editorial note:

Due to my vacation and other personal obligations I was forced to combine the June and July issues of our Solar Division BULLETIN into one copy. This will also apply to our August and September issues. These two issues will have an additional page. I hope that this will not inconvenience our readers too much. After the summer the BULLETIN will again appear on a monthly basis. Sincerely yours, H.L.Bondy

ECLIPSE REPORTS wanted

Members who were fortunate to observe the June 30th TOTAL ECLIPSE and who wish to have their observations and experiences published in our BULLETIN should kindly mail their report to the Editor before September 1st. We intend to devote our October BULLETIN to this year's solar eclipse. Any and all reports will be highly appreciated. H.L.B.

* * * * * * * * * *

BOOK REVIEW:

THE SUN: edited by Gerard P. Kuiper; University of Chicago Press 1953; 745 pages; $ 12.50 .

In the preview Gerard P. Kuiper writes:"This volume is the first of four intended to give a systematic and comprehensive account of our present knowledge concerning the sun and the other three volumes are 2: The Earth as a planet; 3: Planets and Comets Part I: Planets and Satellites; 4: Planets and Comets Part II: Asteroids, Meteorites and Meteors, Comets, Problems of Origin". This series on the Solar System follows in the footsteps of the "Handbuch der Astrophysic" volume 4 (1929).

The first volume,"The Sun",is dedicated to the memory of Bernard Lyot, who was originally intended to be one of the co-authors in Volume 1 and 3. It was Lyot's genius that permitted one of the greatest advances in solar astronomy.

For an amateur to review this monumental work may be almost sacrilegious, but than we have to help ourselves. I tried to stick to the very text, limiting myself to a minimum of personal comments.

Chapter 1, called INTRODUCTION, was written by Leo Goldberg, University of Michigan. It presents the historical background of modern solar research and what the author calls "The Hale-Mount Wilson Era". The most recent developments are briefly sketched and the fundamental solar constants are given. A brief outline of the problems of solar physics concludes this chapter. A thoroughly excellent list of references follows this as well as all other chapters. (unfortunately a few references in certain chapters are missing in the accompanying reference lists.)

The second chapter, THE SUN AS A STAR, was written by Bengt Strömgren, Yerkes and Mc Donald Observatories. It deals with the fundamental aspects of astrophysics. The basic equations concerning stellar structure are given and developed in great detail. The most advanced solar models are presented. It may be of interest to note that since Eddington's first attempts to give us an actual stellar model, the central temperature of the sun "fell" from about 26 million degrees to almost half this value; namely to about 13½ million degrees K. On the other hand the Hydrogen content steadily "grew" until now (X) proportion to Helium (Y) and all other elements (Z) is 76:23: 1.

THE PHOTOSPHERE by M. Minnaert, Utrecht Observatory, forms chapter 3. The radiation coming from the photosphere and its constitution is dealt with herein in detail. The careful study of the socalled Fraunhofer Spectrum (dark absoption lines in the solar spectrum which form the basis of stellar spectroscopy) illustrates the complex nature of spectral lines of a stellar body. The various line broadening effects permit the astrophysicist to detect physical properties which otherwise cannot be recorded and thus to check and improve his theoretical model of the solar interior. The socalled curves of growth (meaning curves illustrating the rate of increased width of a spectral line depending on the number of elements) are discussed. The last part deals with theoretical considerations of turbulence as evidenced in granulation, and its effect on the shape of spectral lines.

Chapter 4 concerns the IDENTIFICATION OF SOLAR LINES by Charlotte E. Moore of the National Bureau of Standards. Some 67 elements are known to be present in the solar spectrum, 4 of which are indeterminate or insufficiently known. Of 15 elements absent from the solar spectrum, 6 are technically accessible. Another 12 are not expected due to the intrinsic nature these elements. Spectra obtained with rockets in the ultraviolet region will further extend the list of identified elements. Some elements are in evidence only in the sunspot spectrum (where also the molecular bands appear) and Argon is known only from the corona, where it appears stripped of 9 electrons.

THE CHROMOSPHERE AND THE CORONA by H.C.Van de Hulst, University of Leiden, is chapter 5. A detailed study of the chromosphere and corona is most difficult even though the former is regularly observed since 1868 and the latter since 1930. Even so records made during the fleeting moments of total eclipses are eagerly studied for very fine details otherwise not yet accessible. One of the most complex and not fully solved problems is the temperature gradient from the photosphere through the lower and upper chromosphere and inner and outer corona. Table I. in Van de Hulst's chapter gives these interesting data: Photosphere with a temperature of 6400°K

lower chromosphere (1000km above the solar limb) T= 5300°K
upper chromosphere (most uncertain-7000-14000km) T= 25000-300000°K
inner corona (21000-140000km) T= 1,000,000°-1,500,000°K
outer corona (some 1,400,000km above the limb) T= 1,500,000°K

The problem of heating and support of the chromosphere is one of the great solar riddles. Van de Hulst's chapter about the corona is by far the most concise writing about this most recent advance in solar astronomy. It contains material scattered in numerous publications all over the world and yet presents as concise a picture of the corona as is possible today. Undoubtedly however it is destined for the greatest additions and revisions in the progress due in the next decade.

Chapter 6 is about SOLAR ACTIVITY and was written by K.O.Kiepenheuer of the Fraunhofer Institute and Yerkes Observatory. This by far longest chapter of 143 pages contains the heart of solar astronomy which permits us to learn more about the all important solar-terrestrial relationship. Sunspots, faculae, flares and prominence activity, their incidence and distribution is described in great detail with many excellent graphs and photographs. Their behavoir as well as that of the inner emission regions of the corona during a solar cycle is documented. Solar corpuscular radiation, the 27-day geomagnetic activity, as well as the recent progress made in the study of the solar component of cosmic radiation conclude this fine chapter. To one who is most keenly interested in this field of solar astronomy somehow even this wealth of information seems insufficient, and it becomes clear that only the actual sources of research must be sought for more information.

J.L.Pawsey and S.F.Smerd of the Radio Physics Laboratory-CSIRO-Sidney, wrote chater 7 on SOLAR RADIO EMISSION. One of the rosier sides of the Second World War was the great progress made from radar studies particularly in Australia. The theory of the origin of solar radio waves and the general features of this radiation from 8mm waves to more than 15m are presented. The shortest waves come from the lowest chromosphere, the longest exclusively from the corona. Radio noise is understood to be essentially of two basic kinds: a) of thermal origin, b) of non-thermal origin due to the interaction of immense electromagnetic forces in disturbed solar regions.

Chapter 8, SOLAR ELECTRODYNAMICS by T.G.Cowling, University of Leeds. Without solar electromagnetics the modern astrophysicist could not possibly hope to explain the nature of sunspots, of flares, the motions of prominences, the heating of the corona or for that matter the overall solar cycle. This is possibly the most difficult part of this book but its importance cannot be overrated.

Chapter 9 called EMPIRICAL PROBLEMS AND EQUIPMENT acquaints us with some of the most modern tools used in solar astronomy. It contains the following papers: 1)"Measurement of the solar constant" by C.W.Allen; 2)"Photography of the sun's disc in integrated light" by Phillip C. Keenan /concerning photospheric granulation/; 3)Coronal Photographs" by G. Van Biesbroek; 4)"Tower Telescopes and Accessories" by R.R.Mc Math /giving us an insight into the Mc Math-Hulbert Observatory/; 5)"Birefringent Filters" by J.W.Evans; 8)"The Coronagraph" by J.W.Evans; 7)"eclipse Problems and Methods" by C.W.Allen;8)"Continuous Solar Survey, Cinematography and Electronic Sunfollower"by Walter Orr Roberts. Parts 5,6,8 give us some idea of the instruments and work done at the High Altitude Observatories here in the U.S. 9)"Solar Work at High Altitudes from Rockets" by R. Tousey. This paper describes the most up-to-date method in solar research; 10)"Techniques for Observation of Radio Frequency Radiation from the Sun" by J.P.Wild; 11)"Solar Flares, Photometry and 200Mc/sec Radiation" by Helen Dodson. The study of flares, the most violent solar phenomena affecting geophysical conditions, now combines both photo-visual and radio observations; 12)"Mapping the Magnetic Field of the Sun" by Horace W. Babcock and Harold D. Babcock. Until this remarkable instrument ("Gauss-grapher") went into action the reality of a general solar magnetic field was subject to many conflicting reports. Magnetograms now clearly illustrate the "dipolar field" of the sun, as well as the variable magnetic regions in disturbed areas (at the most recent AAS meeting it was disclosed that the mysterious-because otherwise invisible- socalled M-regions were detected on such magnetograms having a distinct pattern); 13)"The Sun and Cosmic Rays" by A.Ehmert and J.A.Simpson.The great puzzle of cosmic rays is at last partly being resolved through the study of that variable component coming from the sun. The appendix to chapter 3 on "The Radiation of Sunspots and the Sunspot Model"by M. Minnaert concludes this part.

Two tables list the names, instruments and briefly outline the programs of both types of solar observatories, optical and radio. A very brief Subject Index and a welcome Index of Definitions conclude this encyclopedic volume on the sun.

There is little I may add except that I wish everyone who reads this review to own this"Well of Knowledge".

Harry L. Bondy

* * * * * * * * *

DID YOU KNOW?

"The American Physical Society at an annual meeting was informed that the National Bureau of Standards, using new calculations and a "radio interferometer," had clocked the speed of light at 299,795.1 kilometers a second."

"That's 19.1 kilometers,or some twelve miles, faster than the velocity generally accepted until recently, and quoted in the textbooks as the equivalent of 186,324 miles a second".

(from The New York Times)

Concerning "A Study of Bartlett's Granulation Program (1950-1953)".

Harry L. Bondy

Note: The above-named study was written last December as an analysis of granulation data collected by Dr. James C. Bartlett, Jr. Only a few typewritten copies and photostats of five pages of graphs were availible. Since however this study concerns observations made by our members, it was therefore felt desirable to present here at least the main results. This is also intended as a basis for a discussion of the problem of granulation observation in general. Your opinions, criticism and suggestions will be appreciated.

- - - - -

Introduction: In August 1947 Dr. James C. Bartlett, Jr. published in POPULAR ASTRONOMY (LV-No.7, pp 367-375) a lenghty paper called : "A New Aspect of the Sun as a Variable Star". This paper dealt with solar granulation and Bartlett's own observations thereof. Giving a thorough historical background, Bartlett pointed to the meager, often contradictory reports that astronomers made concerning this phenomenon Bartlett's observations suggested to him that..."the curve of granulation visibility did follow the curve of spot activity, though not precisely".(p.370). Bartlett thus suspected that solar granulation took part in the fundamental process of the Solar Cycle. To prove this conclusively a practical method to "detect gross variation in the visibility of the phenomenon" /i.e.granulation/ was needed. Bartlett reasoned.."if 2 inches /objective aperture/ would just show this granulation, a level of visibility would thus be established...a sort of optical barometer".

With this in mind, Bartlett proceeded to organize a small group of observers in the Solar Division-AAVSO, which with personel changes is active to this day.

The observed phenomenon: Since the 19th century, the mottled appearence of the solar disc has been described by various observers in many different ways. The variety of descriptive terms used such as "nodules" "grains","rice grains", "willow leaves","photospheric network" etc testifies to the difficulty of discribing this elusive phenomenon. Mr. David W. Rosebrugh, by far the most active granulation observer, describes this phenomenon very aptly as "a lemon-peel finish".

Bartlett's Program: The basic feature of this program concerns estimates of the apparent variation in contrast of brighter and darker flecks accross the solar disc, ranging from a smudgy to an almost "engraved""lemon-peel finish". Originally this apparent variability was classified in several terms from "positively present" to "positively absent". However since 1950, for sound statistical reasons, an arbitrary scale was adopted. This scale was 0 for absent and 5 at maximal contrast, very similar to the socalled character figures used for chromospheric flocculi (except that of course no photographic standards were availible). These"granulation character figures" form the basis of Bartlett's granulation index. Simple monthly and yearly means called "granulation numbers" by Bartlett, were intended to reveal the existence of an overall granulation cycle within the solar cycle.

Unfortunately, such an elusive phenomenon is far from readily indexed. Besides this, a whole conglomeration of detrimental statistical factors and erroneous conclusions were involved in this program. The following points will illustrate clearly the fatal defects of Bartlett's index.

Bartlett's reduction formula for monthly mean "granulation numbers" may be expressed as follows: $G = dm(\bar{A}+\bar{B}+\bar{C}+...)/ N$

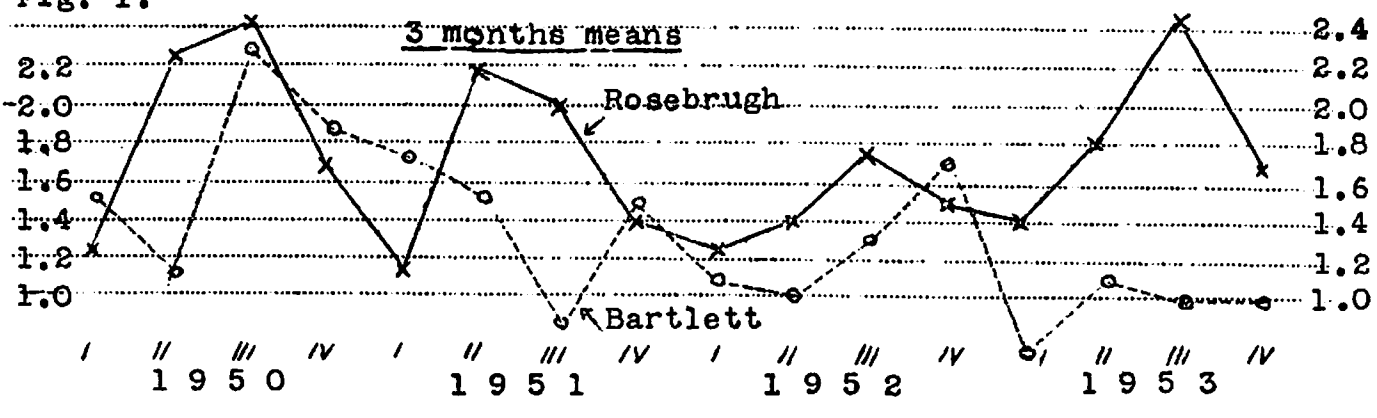
where G is Bartlett's granulation number; dm is the number of days per particular month; $\bar{A},\bar{B}...$ is the mean granulation figure per individual observer; N is the number of participating observers.

Thus reductions are made of data a) from 4 to 8 observers, b) the individual's reprts may cover data collected on 4, 6, 15, 22 or any other number of days; c) while old observers drop out, new ones are added immediately to the reduction work; d) the original plan to standardize all instruments with a 2" diaphragm was never in force-thus the actual instruments range in size from 2" to 12", whereby even individual observers may use different telescopes; e) observations made under the whole range of visibility conditions-from excellent to poor- were entered indiscriminately to the reduction work; f) since the very inception, it was known that estimates of this granular appearence varied considerably from observer to observer. This was disregarded because Bartlett reasoned that eventually there would be "more agreement than disagreement" which, in spite of all, would reveal the granulation cycle.

Thus all basic precautions of objective statistics were violated under the pretext of only determining the "relative trend". Need more be added to show that any numerical values of "granulation numbers" thus arrived at cannot reflect a single phenomenon? This index is useless and missleading.

<u>A different approach: Individuals' averages:</u> Since evidence of the existence of a "granulation cycle" was Bartlett's primary goal, other methods may be applied to the raw data without neglecting basic statistical precautions. The simplest way perhaps-though far from perfact-is to compute simple averages for individual observers. Thus <u>monthly, 3-months, semiannual and annual averages</u> were computed for Bartlett, Rosebrugh, Beardsleay and Pierson for the years 1950-1951-1952-1953. The results fail to show any agreement, while large differences are strikingly apparent. One thing is clear; there is <u>no evidence</u> in Bartlett's program <u>of any "granulation cycle"</u>.

Fig. 1.



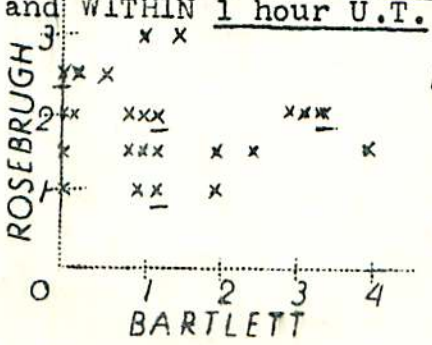
The nature of granulation character figures: The perplexing differences in the individual daily estimates and in the averages require a closer inquiry into the very nature of the observed phenomenon. A correlation analysis was therefore undertaken. This was first attempted with 71 parallel observations of Bartlett and Rosebrugh /covering 16 different months in 1950,51,52 and 1953/. (These data from Bartlett's summaries were kindly supplied by Mr. Herbert A. Luft, while the detailed data for the remaining months of 1950,51,52 were specially copied for this study by Dr. Bartlett, Jr-for which I am greatly indebted). No correlation at all was found for the said 71 parallel dates. Nor was it any different for data by Thrussell and Rosebrugh or Bartlett and Thrussell. A more restricted selection of parallel observations was therefore made from Bartlett's detailed data. Data of observations made only under Excellent and Good seeing were used in the second attempt, without any improved correlation. Thirdly, data of observations made under E and G seeing and WITHIN ONE HOUR of U.T.. While there were far fewer availible data (see Fig.2) the lack of correlation is clearcut. Similarly data for Luft and Pierson /who live only 15 miles apart/ were analysed without any better results.

Bartlett's hypothesis that "there is more agreement than disagreement" in these granulation observations, requires a correlation coefficient of better than 0.71 to give a better than 50% agreement /i.e. determination/. This is not the case at all. This lack of correlation forces one to conclude that local conditions overwhelmingly influence the apparent granular appearence of the sun. It seems clear now, as Janssen claimed already, that only near perfact seeing conditions will reveal the true solar granulation.

Other considerations: To what extend do seeing conditions influence these granulation estimates? The coarsest granulation estimates (≥4) were made by all observers in over 90% of all cases when seeing was excellent or good. (see Fig.3) Rosebrugh's observations, by far most numerous and complete, suggest that coarser granulation comes with better seeing. Furthermore a most careful set of observations made by Rosebrugh on five days shows that short period changes are related to seeing. His observations made in short intervals /as short as 10min. apart/ indicate this, so that Rosebrugh concluded: "In general the readings made under good seeing are lower than those under excellent seeing." Thus these difficult observations of Rosebrugh's confirm independently what the statistical analysis revealed.

Fig.2

Parallel observations ONLY under E and G seeing and WITHIN 1 hour U.T.



× within 10min.

Fig.3

Granulation ≥4

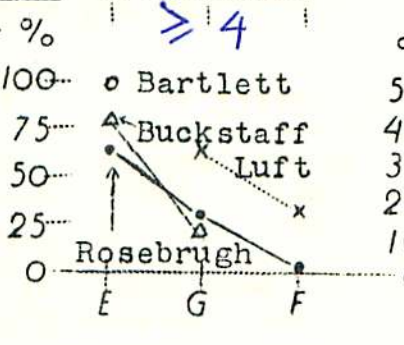
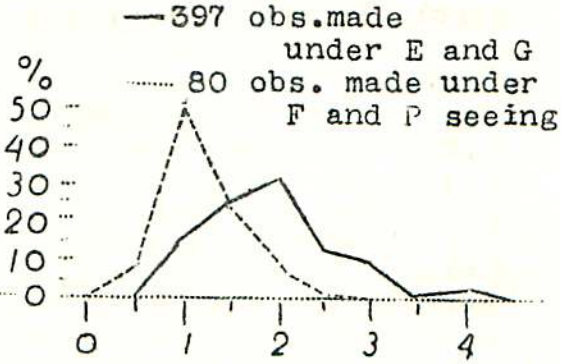


Fig.4

Rosebrugh
— 397 obs. made under E and G
..... 80 obs. made under F and P seeing



Conclusions: 1) Bartlett's granulation-number index is meaningless, since it eroneously reduces statistically incompatable data.

2) Averages of individual observers' estimates of this granular appearence fail to indicate any trace of a common cycle.

3) The absence of correlation in the observations indicates that atmospheric conditions overwhelmingly influence this granular appearence.

4) There are valid indications that the more pronounced granular appearence depends on better seeing.

5) Turbulence in the upper atmosphere in the form of scintillation may be responsible for generally mottled appearence of the sun, permitting only rare views of the proper granulation.

- - - - - - - - - - - -

Addendum: While the negative results of Bartlett's granulation program point to the futility to continue along the very same path as heretofor, I personally am not ready to accept the view that serious amateurs cannot contribute to the study of the overall problem of granulation. For one the turbulent nature of granulation (of large and small cellular structure?) is far from resolved. This also applies to what may be called "granulation patches" (local areas on the solar disc which appear to show a more pronounced granular pattern) or what has been described also as 'granulation"crowded together in the neibourhood of sunspots"/see F.J.Fellers, F.R.A.S. in his chapter on "The Sun" in "Astronomy for Everyman"p.28; or also as referred to by H.J.Nitschman in "Die Sterne"-1953-Heft 1-2 p.23-28 in the form of "Granulationsherden"/. While professional astronomers seek the typical granulation, we may be able to establish what the granulation looks like in active regions, its relation to pores, sunspots, faculae and plages. It must be clear by now, that whatever is attempted in a granulation study, reliable observations can only be made under superior seeing conditions and with first class telescopes by experienced people. The cooperation of a group of observers, both geographically very close as well as far apart for purposes of careful correlation study, with a definite program is of cardinal importance if the limited instrument resolutions of our telescopes is to be succesfully minimized. Such a program should be worked out by those most interested. Later on the guidence and advise of professional men might be secured. I am eager to hear what you think about all this.

Footnotes: I am convinced that the interests of amateur astronomy are best served when our work is subjected to constructive scrutiny without personal bias. I asked Dr. Bartlett,Jr, whose interests,cooperation and devotion to astronomy I highly esteem in the most friendly manner, to state his views on my study. The following was written in answer to my request on May 24th: "Now as to a reply to your report on the granulation program, there is very little I care to say at this time. As I told you some time ago, I think it is a good paper; that it is objective; and that your point of view is worthy of serious consideration so far as it goes. However as I see it, the time is not yet at hand for any final judgements. My point would be that while your analysis should be considered carefully by all concerned, it is, in my opinion, premature. Whether others will agree I do not know. However, I promise you that at the proper time-which is not going to be soon- I shall publish a rather more comprehensive report in which I shall attempt to meet each and every one of your objections with complete honesty if with nothing else." signed: James C. Bartlett, Jr.

AMERICAN RELATIVE SUNSPOT NUMBERS FOR MAY AND JUNE 1954:

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

Monthly Mean: RA' 0.2 .. 0.2

****

ZURICH PROVISIONAL SUNSPOT NUMBERS FOR MAY AND JUNE 1954.
Dependent on observations at Zurich Observatory and its stations in Locarno and Arosa:

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

Monthly mean RZ: 0.7 .. 0.2

****

Mr. William A. Reid, 167 South Avenue, Hawthorne, New Jersey, has a few REDUCTION CHARTS available for any interested member. Anyone interested in obtaining these charts, please write to Mr. Reid directly.

****