# SEQUENCES OF LARGE SUNSPOT GROUPS

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**Abstract.** The concept of a sequence of large sunspot groups is defined. From distribution functions of large groups from the period of sequences and that outside sequences it has been found that there are relatively more groups with a smaller maximum area in the period of sequences than in the period outside sequences. With an increased frequency of the occurrence of large sunspot groups on the solar disc their size decreases.

## 1. Introduction

Kopecký and Kotrč (1974, 1976) submitted that after time intervals in which the occurrence of large sunspot groups at a heliographic longitude is more or less fortuitous and in time sporadic, there is a sudden increase in the activity of large groups. Such periods were called by the authors 'outbursts of solar activity'. Among other things, they manifest themselves by an increased frequency of the occurrence of large groups appearing in such periods simultaneously on a large part of the solar surface, practically at all heliographic longitudes.

## 2. Sequences of Large Sunspot Groups

For large sunspot groups which during their passage across the solar disc have attained a mean area of at least 500 millionths of the solar hemisphere we determined according to *Greenwich Photoheliographic Results* the course of frequency of their occurrence in cycles 14 to 19.

An increase in the frequency of the occurrence of large groups high over a usual level given by the 11-year cycle phase takes place very quickly. As a rule, the state of an increased frequency of occurrence lasts for one to several rotations of the Sun. During such a period we observe an abnormally large number of large sunspot groups. In such periods large groups do not accumulate in short longitudinal intervals but are densely distributed in a long belt of heliographic longitudes. Such a trend in the occurrence of large groups was ascertained in the entire investigated period.

Figure 1 reflects a typical example of the described phenomenon from the first half of 1958. Even at a high level of activity (maximum of the 19th cycle) a dense series of large groups containing objects from both hemispheres is quite distinct. The distribution of groups in this zone exceeding one rotation of the Sun is very conspicuous in the diagram reflecting the heliographic longitude and the time of the first appearance and differs from the form of the occurrence of large groups in adjacent rotations.

For such a phenomenon the working term 'sequence of large sunspot groups' was selected. Figure 2 demonstrates the course of such a sequence in the first half of 1950. It is evident from Figures 1 and 2 that characteristic features of sequences in the period of lower solar activity and of those in the maximum phase are similar. The

*Bumba and Kleczek (eds.), Basic Mechanisms of Solar Activity*, 199–202. 

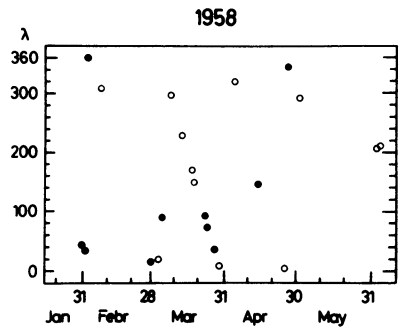


Fig. 1. A sequence of large sunspot groups from February to April 1958. On the vertical axis the Carrington heliographic longitude, on the horizontal one the time of the first appearance. Groups from the northern hemisphere of the Sun are represented by empty circles, those from the southern one by full circles.

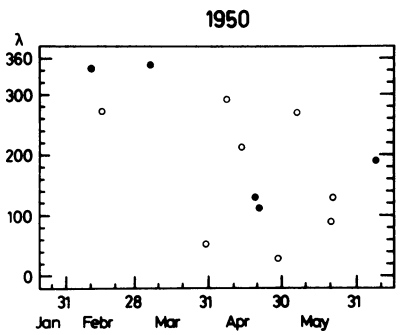


Fig. 2. A sequence of large sunspot groups from March to May 1950. Marking identical with Figure 1.

conclusion relating to common features verified on data obtained from cycles 18 and 19 was conducive to our efforts to delimit the term 'sequence of large sunspot groups'. We wish to define the above term mainly in order to establish a firm basis for the study of laws of spot-forming activity discovered from the course of the frequency of the occurrence of large sunspot groups.

Under a sequence of large sunspot groups we understand a formation of sunspot groups attaining, during their passage over the solar disc, an area of at least 500 millionths of the solar hemisphere and having the following features:

(1) at least six large sunspot groups appear during 27 subsequent days.*

(2) those large groups are distributed in a zone of heliographic longitudes at least 180 deg long.

(3) as border objects belonging to the respective sequence we consider those groups which from the neighbouring ones belonging to the respective sequence

* A minimum number of groups stipulated under item 1 is in another definition describing the above phenomenon inversely proportional to the magnitude of a mean area of the respective group or another criterion determining the border of the basic statistical set. It is also directly proportional to the total number of large groups of the basic set occurring during the 11-year cycle under consideration.

according to features (1) and (2) are distant not more than 150 deg of heliographic longitude.

In accordance with the above definition altogether six sequences of large groups in cycle 18 and ten sequences in cycle 19 were found and their main characteristics were also ascertained.

## 3. Some Characteristics of a Statistical Distribution of Large Sunspot Groups in Sequences and Outside Sequences

Characteristic features of the frequency distribution of sets of large sunspot groups from the period of sequences and from the period outside them both according to mean and maximum areas were found. It is evident from them that the relative number of large groups from sequences decreases with the growing mean area quicker than the relative number of groups not belonging to the sequences. See Figures 3a and 4a. This is interrelated also with the fact that the maximum of the distribution function of large groups according to maximum areas appears for groups in sequences already in an interval of areas from 700 to 900 millionths and is relatively narrow. However, for groups not belonging to sequences, the maximum of the distribution function according to maximum areas appears only in the interval of maximum areas around 1000 millionths and in cycle 19 even around 1200 millionths and is relatively wide. See Figures 3b and 4b.

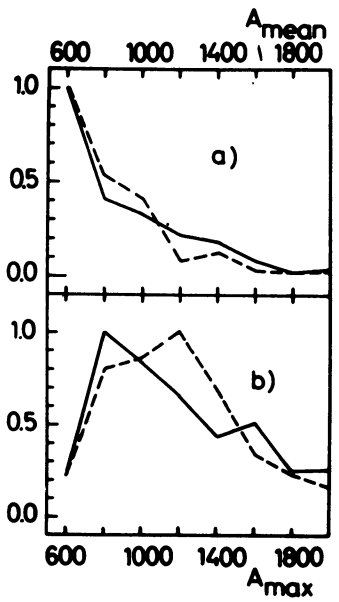


Fig. 3. Frequency distribution of large sunspot groups from cycle 18. In part (a) is the distribution according to area $A_{mean}$, in part (b) according to Area $A_{max}$. Full lines represent groups from sequences, dashed ones groups not belonging to sequences.

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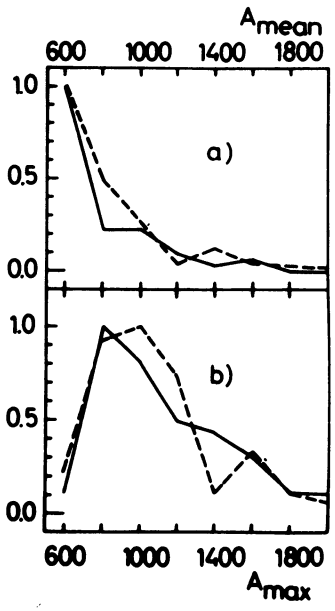


Fig. 4. Frequency distribution of large sunspot groups in cycle 19. Marking of individual curves the same as in Figure 3.

We may thus conclude that in the period of a high frequency of the occurrence of large sunspot groups, i.e. in the period of sequences there are relatively more groups with a smaller maximum and mean area than in the period outside sequences. With an increased frequency of the occurrence of large groups their size decreases. The hypothesis to the effect that in the period of high areal density of large sunspot groups, on the Sun are such conditions that cause a smaller probability of the formation of sizeable large groups, may serve for clarification. The search for interrelations of this kind which might clarify the substance of sequences of large groups will be the object of further investigations in this field.

The present paper is a brief summary of the article which will be published in *Bull. Astron. Inst. Czech.*

## References

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