CHANGE OF FLARE ACTIVITY A FEW DAYS BEFORE PROTON FLARES, ESPECIALLY FOR THE EVENT OF NOV. 5, 1970

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Abstract: The development of the activity in the regions, where a cosmic or proton flare occurred, is represented with the method of summation curves (Křivský, 1969). This method, which fundamentally gives the trends in the release of energy of active regions for flares and X-ray bursts, can be used to characterize typical intervals in development, which display the same trend of development over a number of days. It has also been found in the proton region with the P-flare of 5 Nov. 1970 that a few days before the occurrence of the P-flare a steep trend of flare and X-ray burst activity set in. The onset of this steep trend is associated with the origin of the interaction of a few sunspot groups and magnetic systems within one complex.

Introduction

The development of the activity in the region where a proton flare occurred, is represented with the help of the method of summation curves like with some of the proton regions in the past (Křivský and Nestorov, 1968; Křivský, 1969, 1973a,b). This method, which fundamentally gives the trends in the release of energy of active regions for flares and X-ray bursts, can be used to characterize typical intervals in development, which display the same trend of development over a number of days. The occurrence of an individual flare in an active region appears to be random, however, the occurrence of flares (according to their importance and duration) over an interval of several days (their time distribution of occurrence) appears to be a non-random process. This process is apparently connected with and conditioned by the special development of the active complex and by a certain configuration of the magnetic fields (Bumba et al., 1968; Bumba, 1973).

The method used is also practical as one of the factors in forecasting the occurrence of flares with emissions of fast particles. If a steep trend, e. g., of the flare parameter F, is in evidence (this is the flare index $Q = I \times D$, introduced earlier, where I is the importance and D is the duration of the flare in minutes; Kleczek, 1952), one may expect the proton flare to occur a few days later.

The type of sunspot groups in the active region is also given for the individual days and the method of summation curves was used to treat the reduced area of the spots and the number of spots in the active region.

Method of Treatment and Initial Data

The flare parameter F represents solar flares inclusive of subflares observed in H-alpha in the world station network (Solar-Geophysical Data, Boulder), defined by the product $I \times D$ (importance times duration). The existing importance scale was transformed to the importance scale used earlier, so that $1- = 0.5$, $1 = 1.0 \ldots 3+ = 3.5$. The vertical section ("step") on the summation curve corresponds to the value of this parameter for each individual flare and is fixed in time to the beginning of the flare. The horizontal section (not interrupted by the "step") indicates the time during which no flare was observed. The parameter F was, of course, only compiled from flares which belonged to the region with the proton flare.

The parameter X represents the rough value of the energy of the X-ray burst in the 1—8 Å interval, observed by the Solrad 9 satellite (Solar-Geophysical Data, Boulder), which was determined as follows: a) the bursts on the X-ray records due exlusively to flares from the region investigated, were identified; b) the maximum amplitude of the bursts E was determined (i. e. the difference between the mean undisturbed level of the X-ray flux and the level reached at the time of the

maximum of the burst) in terms of the tenth-order energy scale, e. g., 20.0 = an increase of the emission at the time of the burst maximum by 2 orders of magnitude; c) the duration of the burst D was determined roughly in minutes; d) the parameter $X = 1/2\ (E \times D)$ was calculated, i. e. a roughly triangular shape of the burst is assumed. The value of X determined in this way was used to construct the summation curves in the same way as with parameter F.

The summation curve for the X-ray bursts is not as representative as the F-curve constructed from flares. The reason for this is that the Solrad 9 satellite was not able to record all X-ray bursts at the time of the solar flares when it was temporarily located in the Earth's shadow.

Parameters Characterizing Spot Groups

S_A — *reduced spot-group area* (daily values) adopted from Solnechnye Dannye, Moscow. The daily summation values of studied group were fitted with a continuous curve.

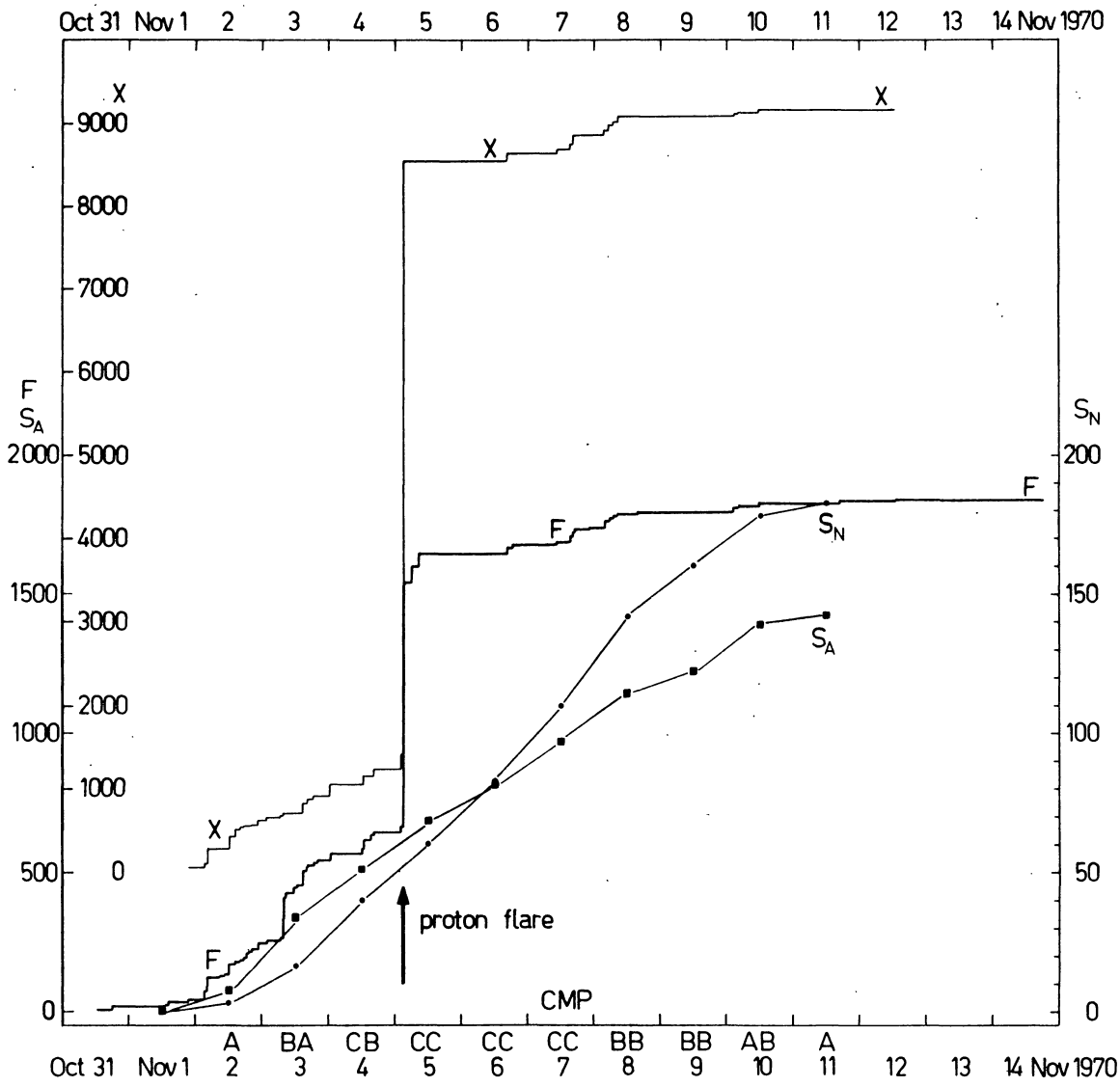

Fig. 1. Cumulative summation curves of the flare index F and the flare X-emission index X of the proton region 14 °S, CMP 7 Nov., 1970; the onset of the proton flare on 5 Nov., 1970 is marked with an arrow. The summation curve of the area of sunspot groups is marked with squares, the number of spots with points. The spot group types of the active complex after the Map of the Sun (Freiburg) are given with the dates.

S_N — *number of spots in the group* (daily values) was determined by drawing on the following data sources: Solnechnye Dannye, Moscow; Map of the Sun, Fraunhofer Institute—Freiburg. The daily summation values were also fitted with a continuous curve.

The type of group according to the Zürich classification was determined for each day, drawing on the Map of the Sun, Fraunhofer Institute—Freiburg, and the data concerning the type were given for the individual days on the time scale with the dates.

Results

The method described above was used to investigate the trends of the said parameters of the proton complex during one disk passage (31 Oct., 1970 — 14 Nov., 1970). The area of the complex of activity (McMath region 11019) with CMP 7 Nov., 1970 had the location: $14 \pm 6°$ S, $0 \pm 10°$. Photospheric pictures of this region from 5 Nov., 1970 are in the paper Fárník et al. in this publication.

The probable beginning of the development of the proton group set up on 2 Nov., 1970. The initial phase of the development was characterized by a weak trend of activity ($F = 22$ per day). The steep trend of activity set in on 2 Nov., 1970 ($F = 200$ per day). It is probable that this new trend is associated with the evolution of three sunspot groups in one complex of activity (Solnechnye Dannye, No. 11, 1970; as regards the meaning of "satellite groups" for flare activity see papers: Křivský and Obridko, 1969; Kasinskii, 1972).

A few days before the beginning of the proton flare on 5 Nov., 1970 (03 07 UT) the trend reached the value of $F = 206$ per day.

Beginning with 6 Nov., 1970 the complex of activity experienced a change in the trend of activity again to weak activity ($F = 21$ per day). The dissolution of the sunspot groups occurred on 12 Nov. 1970.

It has again been shown that the trend of the flare index F changed its value from a few tens to a few hundred units per day before the onset of a proton flare.

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