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CONNECTION BETWEEN SUNSPOT PROPER MOTION AND FLARE FREQUENCY

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Abstract. Three adjacent sunspot groups were studied, using white-light heliograms and SGD. Flare activity showed close connection between proper motions and area development of the sunspots.

1. INTRODUCTION

Flare activity of solar active regions is generally believed to depend on sheared configuration of magnetic fields (Hagyard et al., 1984). There are cases when the shear necessary for flare can be attributed to the emergence of a new flux in the spot group (Wang, 1992). But, perhaps, a newly born active region can also influence the magnetic field configuration in a nearby active region (Poleto et al., 1993; Gesztelyi et al., 1993, Csepura 1994). In this paper we are interested primarily in the influence of a newly emerging spot group on a nearby one.

2. DATA

Proper motions of the spots and area development in three nearby active regions NOAA AR 6412(B,C), 6413(A) and 6415(D) have been studied between 13-22 December 1990. White-light full-disk photoheliograms for studying sunspot proper motion and area evolution have been taken at Gyula Observing Station (Hungary), Debrecen Heliophysical Observatory (Hungary) and Helwan Observatory (Egypt). Making use of SGD (No.558, part 1, February 1991), the daily flare frequency and positions have been also determined. Two days, December 16 and 18, have been found to include interesting events.

3. BRIEF HISTORY OF THE ACTIVE REGIONS

NOAA AR 6412 appeared at the east limb of the Sun on December 11, 1990 and disappeared over the west limb on December 24, 1990. It was a large bipolar spot group (Fig.1). NOAA AR 6415 emerged as a new active region on December 16, 1990. It had a fast development phase until December 18 and after this time a fast

declining phase (Fig.1). NOAA AR 6413 rotated on the sun disc on December 11 and disappeared on December 18, 1990. It was a roundish spot in its declining phase without any proper motion (Fig.1,2).

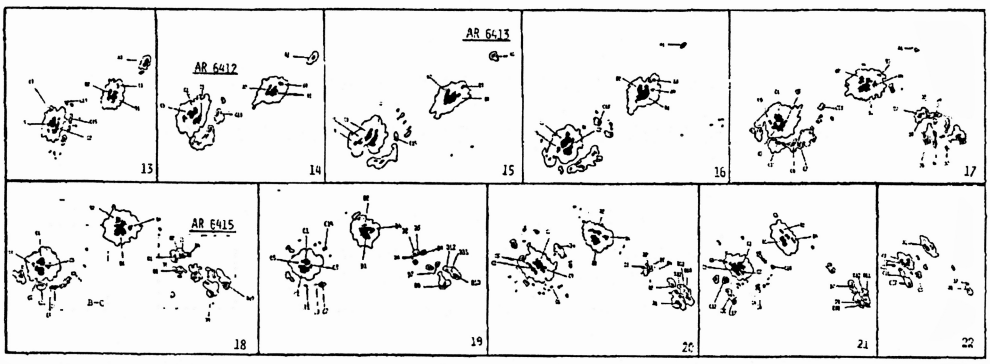

Fig. 1. Development of the sunspots groups in AR 6412(B,C), Ar 6413(A) and AR 6415(D) between 13-21 December 1990.

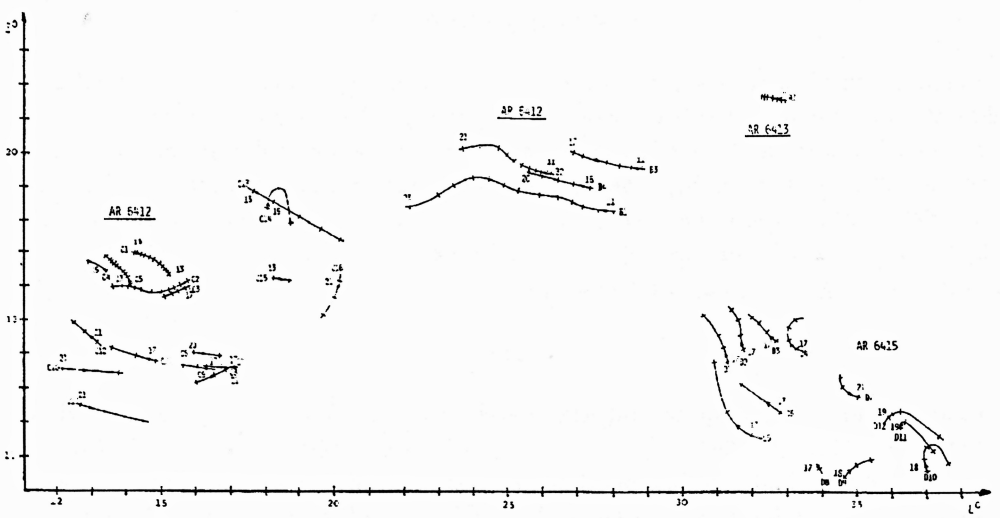

Fig. 2. Proper motions of umbrae in Group A, Group B, Group C and Group D between 11-23 December 1990.

4. EVENTS

a.) Events of December 16

This was the day when the emergence of the newly born region D began (Fig.1). Up to this day area of the active region B,C, continuously raised but from this day it began to decrease (Fig.1,3). From this day on, the spots B1 and B2 in active region

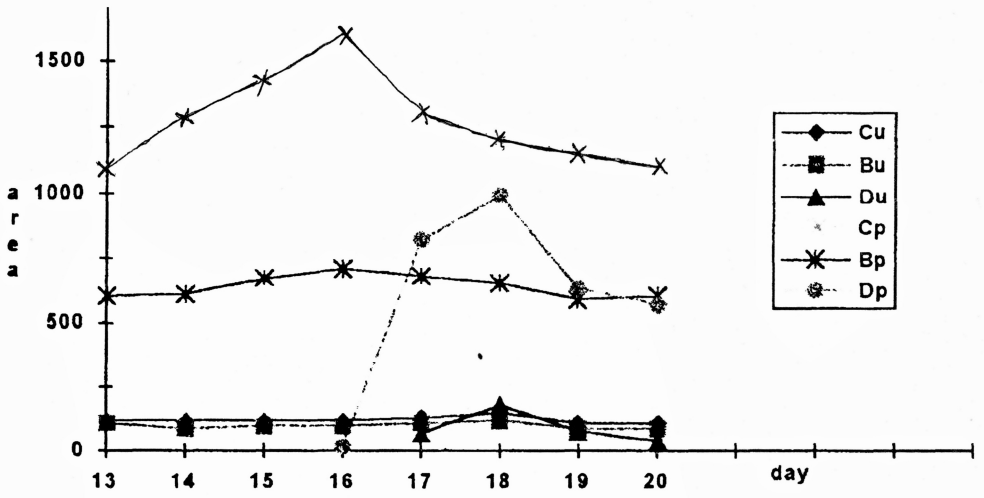

Fig. 3. Development of the total umbral (Cu,Bu,Du,) and whole spots area (Cp,Bp,Dp) of Group B, Group C and Group D between December 13-21, 1990. Expressed in millionths of the Sun's visible hemisphere.

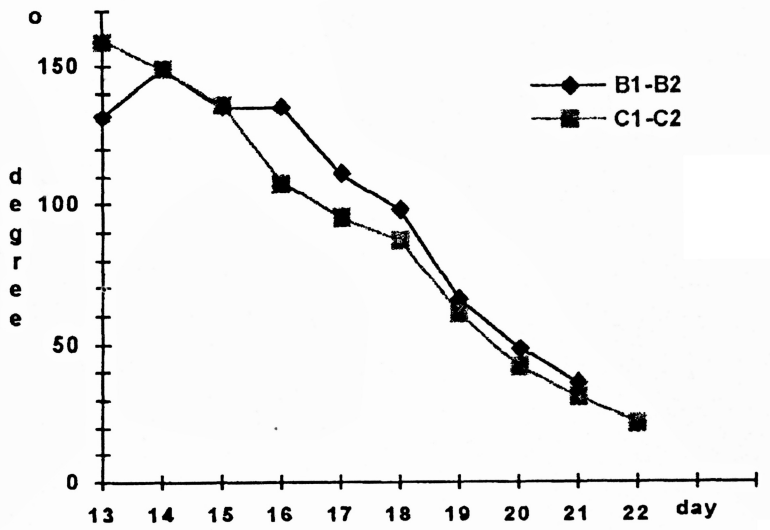

Fig. 4. The rate of daily relative revolution of spots B1-B2 and spots C1-C2.

B,C, began to a relative revolution around each other and in the same active region, there was a sudden increase in the relative revolution of spots C1 and C2. (Fig.1,4). Up to December 16, the occurrences of the flares in active region B,C were scattered over the whole region but on this day they were concentrated between B and C and increased, while, on the contrary, the daily flare frequency in these active regions was found to have a local minimum (Fig.1,5).

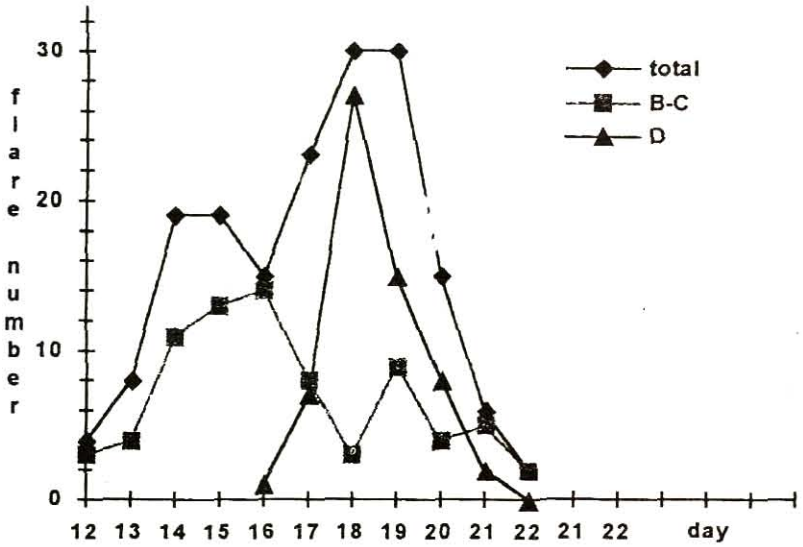

Fig. 5. "total" represent the total daily numbers flares. The ather two curves shows the daily number of flares in the two flares centrums (B-C and D) showns in Fig.1.

It is well known that the emergence of new spots inside in a spot group increase the flare frequency and causes changes in the proper motions of the spots (Schmieder, 1994). From the above facts, it seems that a spot group emerged close to an another one can have an influence on the proper motion and the flare frequency in the other spot group.

b.) Events of December 18

On this day, group D has reached its maximal area and at the same time, the total umbral area had its maximal value also (Fig.3). It is interesting that up to this time the umbral areas of the spots have practically not changed (except group D) but on this day there were a slight increase in their values and after this day the previous values were restored (Fig.3). The positions of the flares after this day is shifted to the group D (Fig.1,5). As it was found on December 16 the rate of the relative revolution of the spots C1 and C2 increased on this day also (Fig.1,4). The above events can probably be explained by the fact that this was the day when group D started declining.

5. DISCUSSION AND CONCLUSIONS

The emergence of new spots inside a pre-existing spot group usually increases the flare frequency and may alter the proper motion pattern of the spots in the AR. In general, young spots show fast proper motions : the faster the emergence, the higher their velocity. An approaching motion between opposite polarity spots of different flux system induces magnetic reconnection : the new emerging magnetic flux is bound to interact (reconnect) with the pre-exiting overlying field leading to flare activity (Heyvaerts, 1977). In case of flux emergence occurring not inside an exiting active

region, but relatively close-by, the mechanism of a possible interaction seems less clear, although observations of the solar corona by the Yohkoh X-ray satellite showed that solar Active Regions are inter-connected by huge coronal loops (see e.g. Porter et al.,1994). Fast appearance and disappearance of a region may lead to re-organization of those interconnecting loops, therefore enhanced flare activity of the pre-exiting region(s). Among adjacent Active Regions the possibility of an under-photospheric connection can not be entirely excluded either (see e.g.van Driel-Gesztelyi et al., 1993), since those regions are members of an active nest (Gaizauskas et. al, 1983). From the coincidences found above the hint can be drawn that quickly evolving sunspot groups might have an influence on the flare activity or even on the pattern of proper motions of other, adjacent groups, although we can not exclude the possibility that the relationship among events of those nearby sunspot groups was not causal, but only pure coincidence.

Acknowledgements

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