MOTION OF SMALL SUNSPOTS IN A CHANNEL

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ABSTRACT

In the old bipolar sunspot group in Hale region 17117 new fluxes emerged. Numerous small spots became settled to a curved shape channel around the old leader spot, and the channel was extended to eastwards and also to westwards. During 5 days (11-15 Sept. 1980) the spots were emerging and moving along this channel or joined to it, irrespective to their polarities. This channel of sunspot motion might be in connection with large-scale flows of photospheric or sub-photospheric layers, perhaps with supergranular flows.

ДВИЖЕНИЕ МАЛЕНКИХ СОЛНЕЧНЫХ ПЯТЕН В КАНАЛЕ: В старой биполярной группе в области HR 17117 появилось новое магнитное поле. Множество мелких пятен расположились в искривленном канале около старово патна-лидера, этот канал удлинялся и на восток, и на запад. В течение 5 дней (11-15 сент. 1980 г.) пятна появлялись и двигались вдоль этого канала, независимо от их полярностей. Этот канал движения пятен может быть связан с крупномасштабными фотосферными или подфотосферными течениями, возможно со супергрануляцией.

POHYB MALÝCH SLNEČNÝCH ŠKVŔN V KANALI: V starej bipolárnej skupine škvŕn HR 17117 vzniklo nové magnetické pole. Veľký počet malých škvŕn vytvoril okolo starej vedúcej škvrny pravidelnú štruktúru - kanál. Tento útvar smeroval od vedúcej škvrny tak na východ ako aj na západ. Počas 5 dní (od 11. do 15. sept. 1980) škvrny nielen vznikali, ale sa aj pohybovali pozdĺž tohto kanála a to nezávisle od ich magnetickej polarity. Tento kanál pohybu škvŕn môže súvisieť s veľkorozmernými fotosferickými, alebo podfotosferickými prúdmi, pravdepodobne súvisiacimi so supergranuláciou.

INTRODUCTION

Spiral-like structures in sunspot groups are specially interesting phenomena. In connection with these structures the first question is: are they accidental, aphemeral formations, or long-living, real paths of sunspot proper motions?

In Hale region 17117 a spiral-like structure appeared around an old spot, therefore the study of development and proper motions of this group provided an opportunity to answer the question at least in one particular case.

OBSERVATIONS

Between 9-15 September 1980 50 full-disc white light photoheliograms were taken at the observing station of the Debrecen Observatory in Gyula (Table 1). The majority of the observations were obtained by S. Rostár and L. Győri. The diameter of the Sun's image in the photoheliograms was about 10.5 cm. Generally the objective of 2 m focal length was stopped down to 9 cm and the photographs have been taken on Kodalith films of estar base, through a metal-interference filter of about 10 nm half-width centered at 554 nm.

The Carrington coordinates (L=longitude and B=latitude) were calculated from the measurements by means of an Ascorecord coordinate measuring instrument. The computer programs takes, by reduction, some corrections for the differential refraction into account and also some instrumental ones, particularly for optical distorsion of the enlarging system of the heliographs.

The relative coordinates refer to the main spot were calculated at Ondřejov Observatory.

TABLE 1. OBSERVATIONS

1980		UT	No.
Sept.	9	07:02-14:56	10
	10	08:47-12:23	4
	11	07:40-08:44	3
	12	05:57-15:33	12
	13	06:47-15:13	12
	14	08:50-11:39	6
	15	08:33-08:36	2

DEVELOPMENT OF THE SUNSPOT GROUP

Hale region 17117 rotated into the disc on 7 September 1980. Is was a developed bipolar group containing a circle-shape leader (N1) with a satellite spot in its penumbra (N2) and some tracer spots (S1, S2, S3 and S4 - see Fig.1.

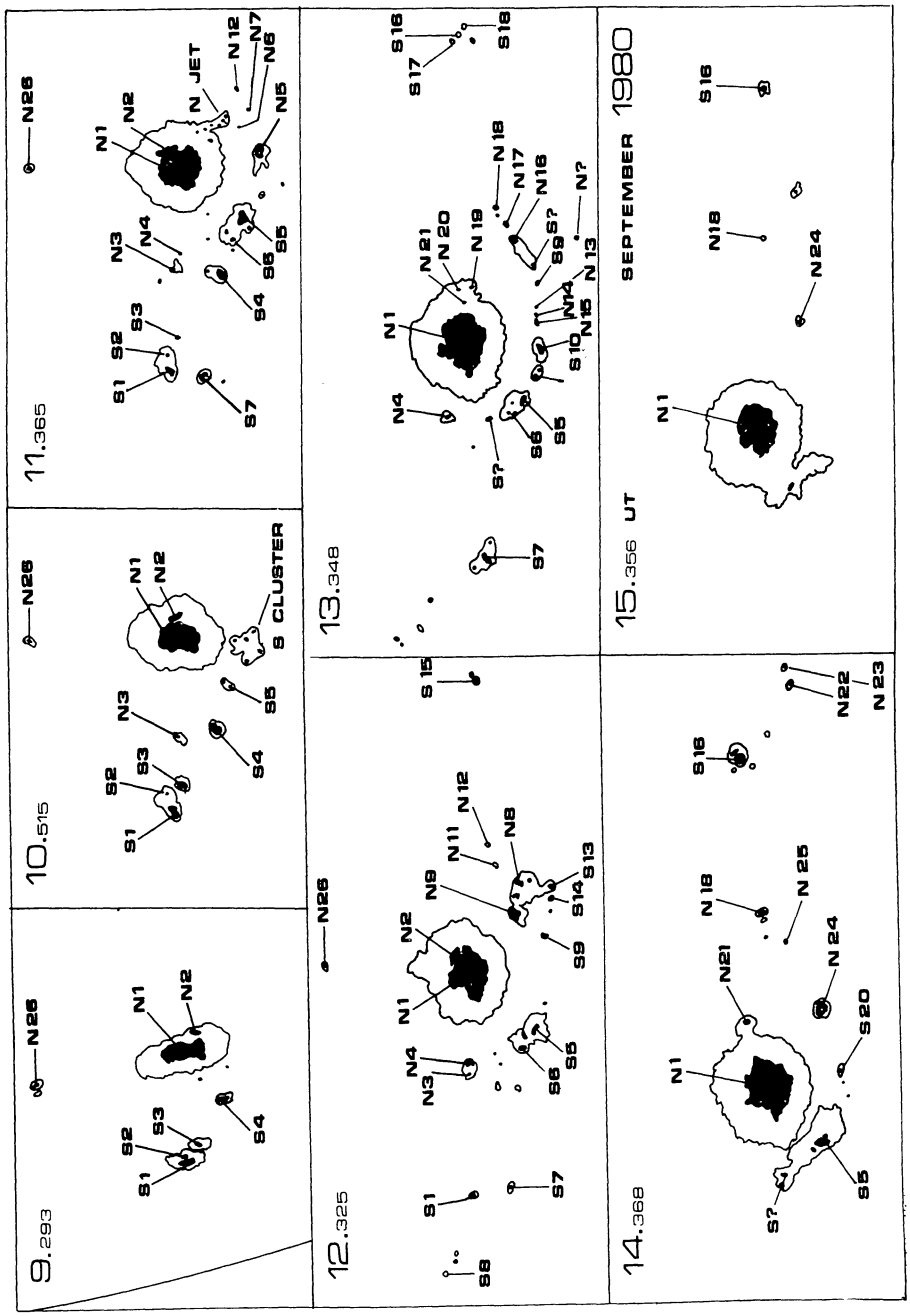

Fig. 1: Hale region 17117 between 9-15 September 1980 and Hale region 17116 (S15-19 and N22-23) between 12-15 September 1980. S and N indicate magnetic polarities on the basis of Mount Wilson sunspot polarity drawings (courtesy Dr. R. Howard).

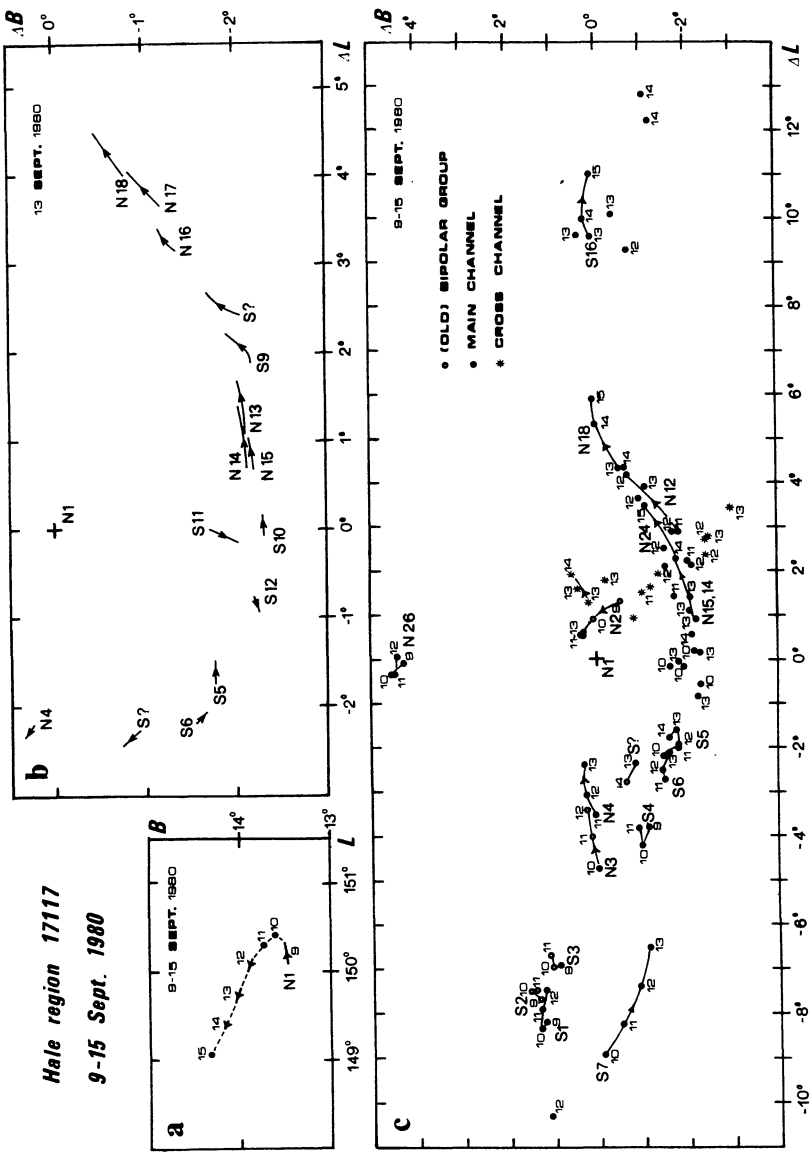

Fig. 2: a/ Proper motion of the main leader spot in Carrington coordinates between 9-15 Sept. 1980.
b/ Daily proper motions of the small umbrae in the spirallike part of the main channel on 13 Sept. between 13.252-13.634 UT relatively to the N1 spot.
c/ Proper motion map of the sunspot group in relative coordinates to the N1 spot between 9-15 Sept. 1980. Small numbers indicate the dates, larger letters and numbers the denotiations of longer-lived umbrae. The different symbols indicate different populations of umbrae.

There was also a small leader polarity spot nordwards to the leader (N26). On 10 Sept. new activity appeared in the region southwards to the leader. By 11 Sept. it became a bipolar group (main spots: N5 - S5). On the same day a jet of small spots appeared in the penumbra of the old leader spot, as a sign of its disintegration. The merged small spots joined to the new group (N9), then, by 13 Sept. spots became settled to a spiral-like structure around the old

leader spot. The daily motion of the small spots followed the spiral path (Fig. 2b) in relative coordinates to the main spot, and what is more, the remnants of this spot-chain were moving in the same path during the next days (Fig. 2c). The spots formed before 13 Sept. were also situated along this spot-channel, or converged to the channel. The channel was not really spiral-like, but it was only a curved shape line around the old N polarity spot. It extended from S8 spot to Hale region 17116 (S15, S16-18). Along, or in the vicinity of this channel the new spots emerged nearly in the same time. The direction of proper motions was the same along the channel. The small sunspot group in Hale region 17116 was f type, which is typical for a spotgroup developing westwards to an old active region (Martres, 1970) - this is an other sign of the influence of the old region.

The two new spots in the middle part of the old group (N3, N4) followed also a (sub)channel.

DISCUSSION

These channels of sunspot motions are not unusual events, one can see also a channel in the June 1974 group (Kovács, 1977), or also in the July 1982 group (Kálmán and Nagy, 1986). The existence of these channels might be in connection with large-scale flows of photospheric or sub-photospheric layers of the Sun. This assumption is supported by the fact, that the tracer polarity spots (S7, S8, S9 and S10) were moving along the channel in the same direction than the leader spots, also with the same velocities, although usually one can make easily difference between diferent polarity spots on the basis of the different directions and velocities of their proper motions (see e.g. Kovács and Dezso, 1986). In this case the small spots of the new activity had constrained motion, the trajectory of which was fixed to the old spot - the rotation rate was the same. The compelling large-scale flows perhaps are in connection with supergranular flows: Livingston and Orrall (1974) reported certain magnetic structures ("magnetic pukas") persisting for 4 to 7 days, which was explained as very stable convective cells (supergranules). Kubicela (1976) also found some long-lived supergranules having lifetimes more than three days. In this active region the lifetime of the sunspot-channel was 5 days, which is similar to the upper results. The most populated part of the main channel was about 6 heliographic degrees long (roughly 70.000 km) which is similar to the scale of a magnetic pukas.

It has been pointed out by Meyer et al. (1979), that new fluxes usually emerge in the centre of supergranulas, and this flux is disintegrating later. Flux is carried by "moving magnetic features" to the supergranula boundaries. In our case the old spot was in the centre of the curved main channel, the spots of the "jet" of 11 Sept. streamed to the main channel, chich perhaps represents the supergranula boundary. As Meyer et al. (1979) wrote, the motion of flux tubes is determined by the combined effects of large scale convection, magnetic buoyancy and the Lorentz force, acting together. I think, that in

concrete cases the role of the different effects may be different, chich can be seen in the proper motions of the spots. For example in the case of HR 18430 (Kovács and Dezso, 1986) the role of buoyancy seems to be most important, in our case the role of large scale flows apparently were acting more efficiently.

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COMMENT

A. Krüger
I would like to stress out that there are two different things properly to be distinguished, viz. "spiral" motions and the appearance of the structure of supergranular cells.