INTERACTION BETWEEN BIPOLAR SUNSPOT GROUPS

G. Csepura[1], L. van Driel-Gesztelyi[1,2], I. Nagy[1], O. Gerlei[1], B. Schmieder[3], and J. Rayrole[3]

[1] Heliophysical Observatory of the Hungarian Academy of Sciences, P.O. Box 30, H-4010 Debrecen, Hungary
[2] Sterrenkundig Instituut, Rijksuniversiteit te Utrecht, Postbus 80.000, 3508 TA Utrecht, The Netherlands
[3] Observatoire de Paris, Section d'Astrophysique, 92195 Meudon, France

Abstract

We find some evidence for the interaction of two close-by developing sunspot groups: (i) the proper motions of the principal preceding spots of both groups show quite similar patterns; although they had different ages, they moved almost parallel and changed the direction of their motion on the same day at almost the same heliographic longitude; (ii) after the emergence and fast divergence (shearing motions) of new spots in both groups, a filament formed between them; (iii) the fast development of the new group was followed by new flux appearance (faster area increase) in the older, larger one; two periods in which the area of the larger sunspot group increased were followed by periods in which the area of the smaller group decreased.

Introduction

Solar active regions tend to appear near other active region(s) (see e.g. Zwaan, 1990), and the question arises if there is any sign of a possible link between sunspot groups developing close to each other. This question was investigated by Martres (1970), who found some effects of a possible interaction in the area development and proper motions of the involved sunspot groups. In connection with the lifetime of active regions, Sheeley (1981) stated that bipolar magnetic regions might annihilate one another within a few days if they emerged in a suitable configuration.

In the period of 11-18 June 1980 we observed two bipolar sunspot groups of different ages developing very close to each other. Their longitudes were almost identical ($L \approx 280°$) and their separation in latitude was only 5° (N17.5° and N12.5°). These active regions gave an excellent opportunity to study the characterictics of a possibly disturbed sunspot group development, and to search for any sign of interaction between these sunspot groups.

Observations

At the Heliophysical Observatory of the Hungarian Academy of Sciences in Debrecen (Gyula Observing Station) 387 white-light full-disk photoheliograms were obtained between 9-20 June 1980, which we could use for a study of the motion and evolution of the sunspot groups in this period. The method of observation, position measurements and computation of heliographic coordinates is described in detail in the Introduction to the "Debrecen Photoheliographic Results" by Dezső *et al.* (1988).

For this study we also used a few Hα filtergrams which were obtained in Debrecen with a 53 cm Nikolsky-type coronograph, equipped with a 0.5 Å Halle filter.

Between 13-15 June 1980, 8 magnetic maps were taken at the Observatoire de Meudon. The data processing of the Meudon magnetograph is described in a previous paper (Rayrole, 1981).

Signs of Interaction in the Development of the Active Regions

Hale region 16898 rotated onto the disk on 8 June 1980 as an older-looking bipolar sunspot group (Mt.W. 21517), hereafter referred to as Group 1 in this paper (Fig. 1). On 11 June new flux emerged 5 heliographic degrees south of it, which had formed a smaller bipolar group by the next morning (Mt.W. 21526), named Group 2 (Fig. 1).

In the middle part of Group 1 new activity emerged in several waves: on 11, 13 and 16 June. At first in both sunspot groups the p (N polarity) spots moved westward (towards the

W-SW) faster than the f (S polarity) spots moved eastward (to the E-NE), showing the ordinary behaviour of a young, developing bipolar active region (Fig. 2). Then the principal p umbrae of Group 1 and Group 2 stopped on 15 June and changed the direction of their motion, and both moved towards the NE till the end of the observing period, 20 June (or in case of Group 2 till 18 June, when it died out, see Fig. 2). Taking into account their different ages, this parallel proper motion and the subsequent simultaneous change in the direction of the motion of the main p spots can be a sign of some kind of connection between the sunspot groups, or perhaps of the mutual influence of the sunspot groups on each other. It may be that these sunspot groups are different branches of the same flux tube, and that the behaviour of the common flux tube root is displayed in the common features of their proper motions. But on the other hand we can not exclude the possibility that the simultaneous turn of the principal preceding spots could also be an indication of the existence of large-scale flows in the vicinity of the close-by developing active regions, which influence the motion of these spots. A possible influence of large-scale flows on sunspot motions was described previously by Marquette and Martin (1988).

A pair of young opposite polarity spots (N2, S3, S4 and S5) produced a sheared velocity field in the centre of Group 2 on 13 June (c.f. Figs. 1 and 2). The velocity of their divergence was 350 m s^{-1}. The location of this sheared velocity field became the end-point of a new filament

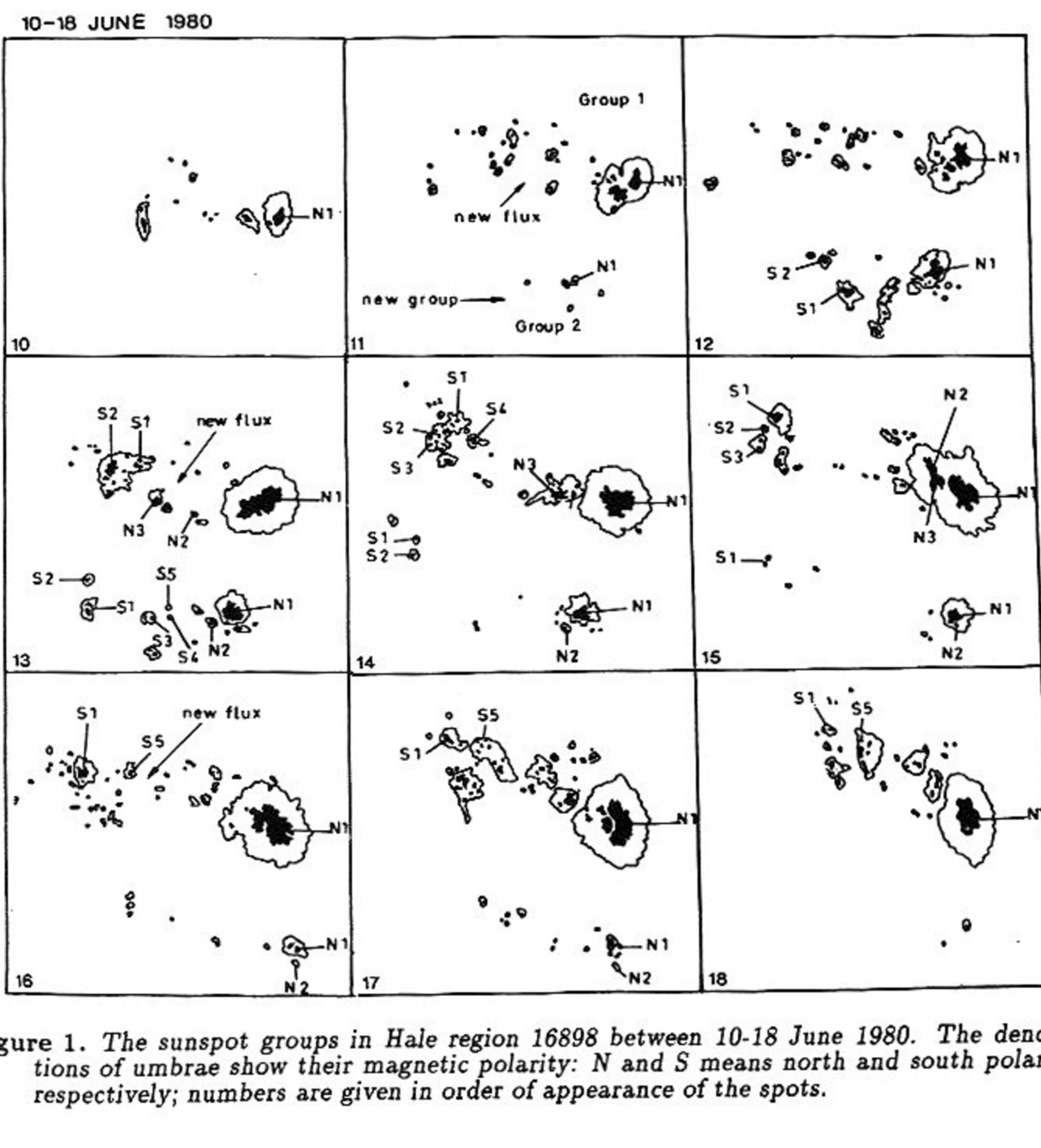

Figure 1. *The sunspot groups in Hale region 16898 between 10-18 June 1980. The denotations of umbrae show their magnetic polarity: N and S means north and south polarity, respectively; numbers are given in order of appearance of the spots.*

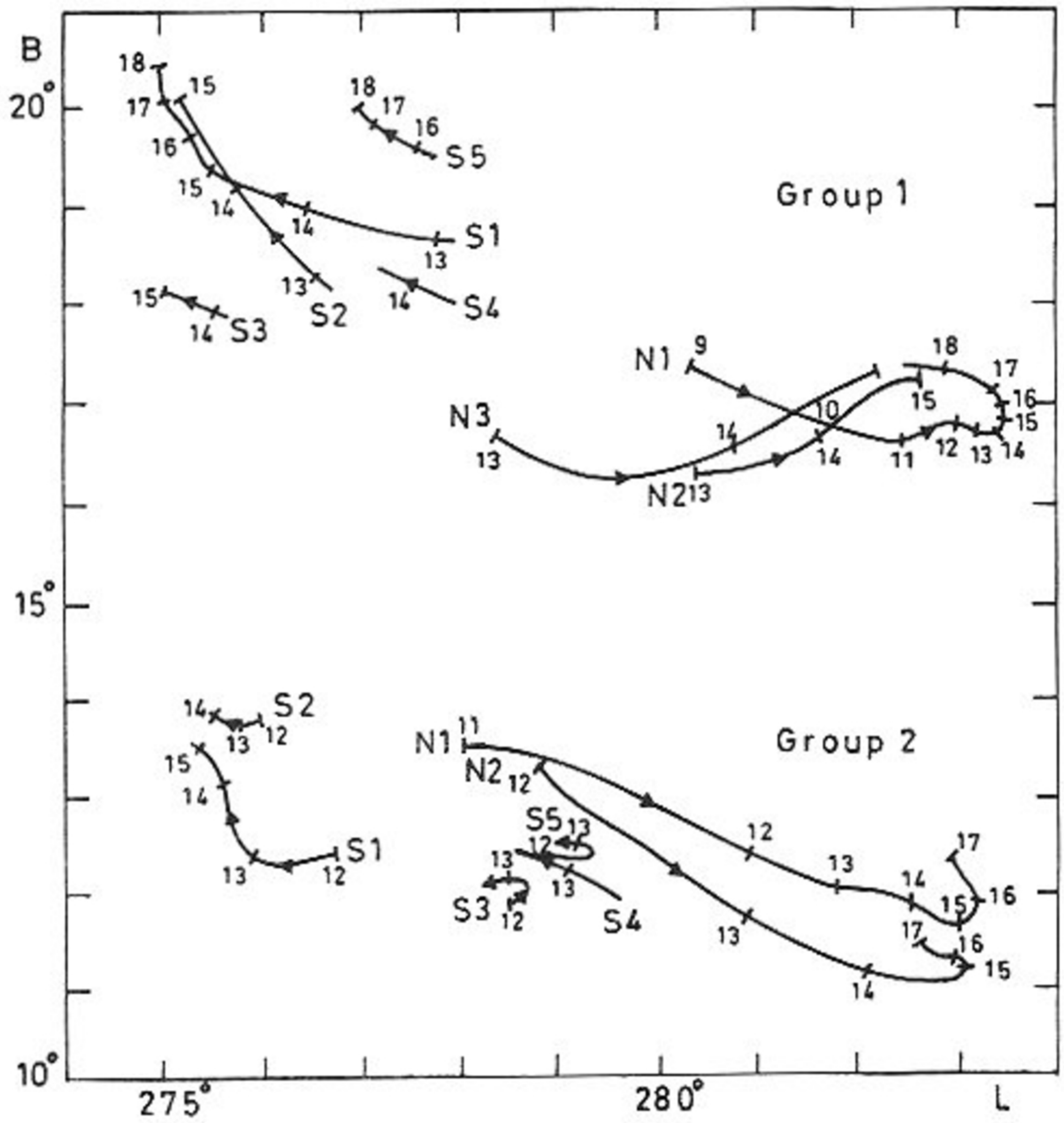

Figure 2. *Proper motions of umbrae in Group 1 and in Group 2 between 9-20 June 1980. The preceding umbrae are marked with the letter N and the following umbrae with the letter S, showing their magnetic polarity, and also with different numbers in order of appearance (c.f. Fig. 1)*

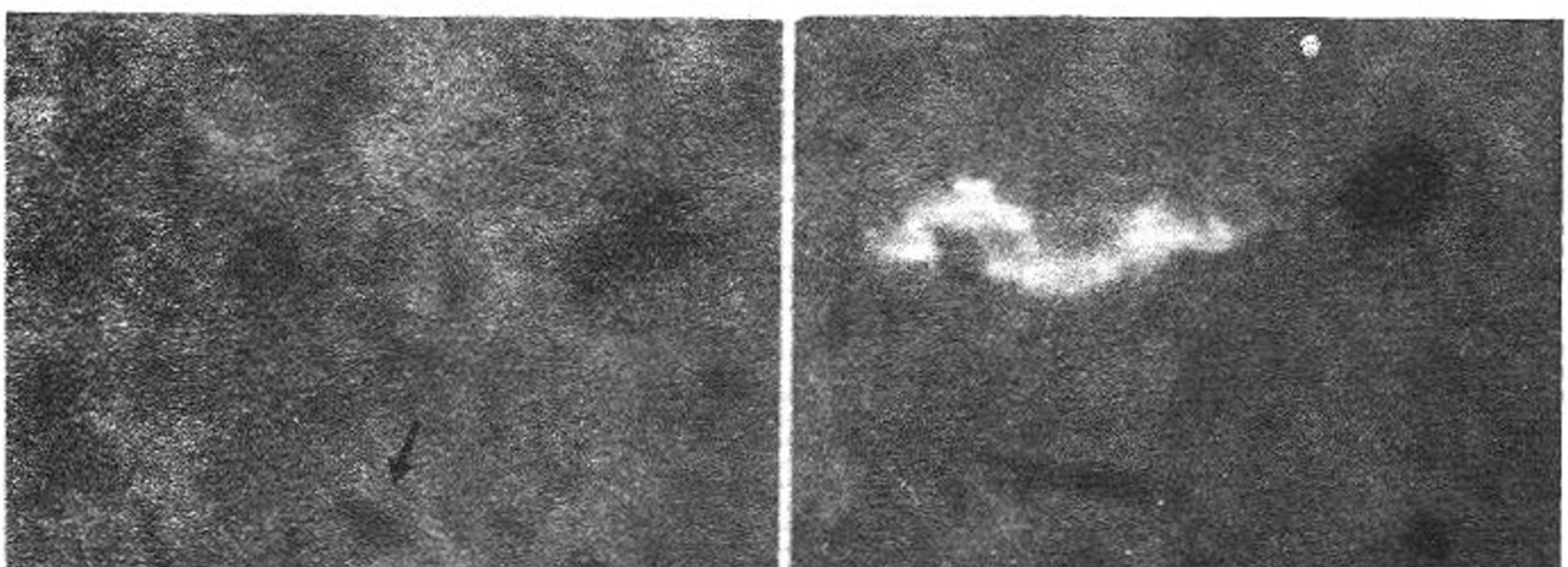

Figure 3. *Formation of a filament observed in the channel between Group 1 and Group 2 on 13 June 1980 at 14:10 UT in Hα -0.5 Å and on 14 June at 06:32 UT in Hα+0.5 Å.*

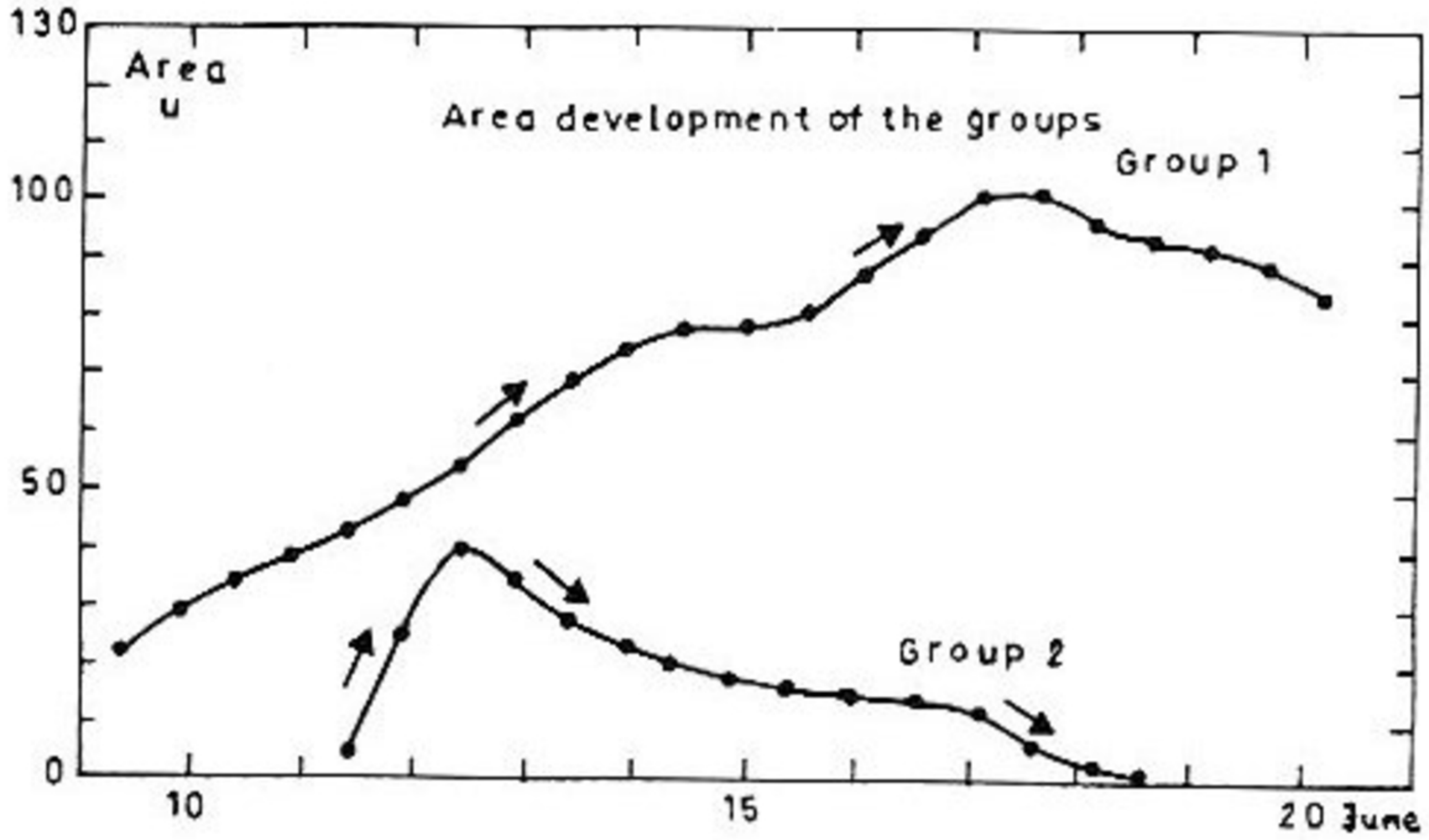

Figure 4. *Development of the global umbral area of Group 1 and Group 2 between 9-20 June 1980.*

which formed in the channel between Group 1 and Group 2 in the afternoon of 13 June (Fig. 3). At the same time there were also fast moving, diverging spots in Group 1 (Fig. 2), which were associated with the most intense (non-thermal) radio source of the whole region (Chiuderi-Drago *et al.*, 1987). These shearing motions could create favourable conditions for the formation of a filament, as proposed by Rompolt and Bogdan (1986).

A third possible sign of the interaction of the sunspot groups can be found in the development of their area (Fig. 4). The fast development of the new Group 2 was followed by the appearance of flux (faster increase in area) in the older, larger Group 1. Two periods in which the area of the larger Group 1 increased were followed by periods of decreasing area of Group 2. When Group 2 disappeared, Group 1 showed a "resurgence" of activity, and flares were again observed in it at the west limb. The disappearance of Group 2 seemed to lead to an instability of Group 1. This sign of interaction of sunspot groups developing close-by was already mentioned by Martres (1970), Sheeley (1981), and Martres *et al.*, (1986).

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