The Rotational Modulation of Ca II K in the Sun

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The most widely used indicator of the stellar magnetic activity is the flux in the CaII K-line core (K-index) (Baliunas and Vaughan, 1985). The K-index data have also been used for measuring the rotation of stars. But using the method for the Sun gives different results (Keil and Worden, 1984; Singh and Livingston, 1987). The reason for the observed differences, besides those indicated by Singh and Livingston, may be the character of the distribution of active regions. This study is based on observations made at Tashkent Astronomical Observatory and the data published in SGD for solar cycle 21. We study the longitudional distribution of sunspots and plages. Some intervals of active longitudes (IAL) were selected and the evolution of them was studied. Active regions were found to concentrate in certain longitude intervals which are in nearly rigid rotation. Fig. 1 shows the longitudinal distribution of sunspots areas for 1983–84, as an example.

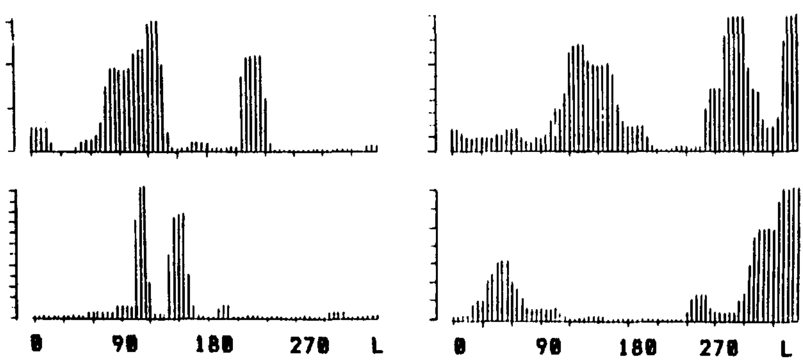

Fig. 1. Longitudinal distribution of sunspot areas for north (left) and south (right) and for 1987 (above) and 1984 (below).

The activity in the southern hemisphere was predominant in 1983 and had three IAL (in the northern hemisphere there were two). Under poor spatial resolution (the Sun as a star) the intervals merge and can form the homogeneous background. In such cases the rotational modulation of the K-index gives a poor result. In 1984 both hemispheres showed nearly equal activity, but in the north the

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activity was concentrated in a comparatively narrow interval of longitudes (90°–140°). Therefore the rotational modulation analysis (RMA) of the K-index from Tucson (Singh and Livingston, 1987) and Sacramento Peak (Keil and Worden, 1984) obtained in 1983 may give inexact, different results and exact, equal ones in 1984. The first groups started to form close to the eastern border of the above narrow interval and the site of formation of further new active regions is gradually shifted more and more westwards (Sattarov and Bumba, 1990). The velocity of the westward shift of the centre of activity is in the range of 40 m/sec. The rotational rate obtained from the K-index at Tucson for 1984 has an excess of 100 m/sec.

The evolution of the active regions in the narrow interval leads to the formation of large-scale magnetic fields (LMF) with a line of polarity reversal, which rotates around the pivot point anticlockwise (Fig. 2). Such a LMF rotates nearly rigidly and perhaps influences the surface rotation. So the solar rotation during summer 1982, observed earlier by Howard (1984), may be connected with the LMF on longitudes 300°–360°.

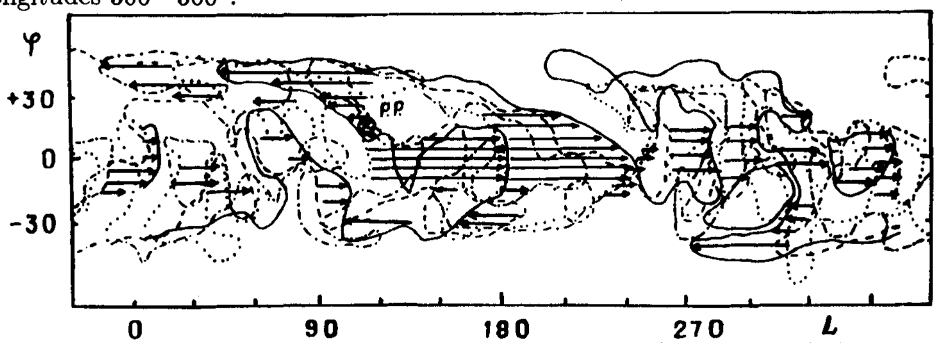

Fig. 2. Motion of the line of polarity reversal in February (...)–August (—) 1984.

Study of the evolution of active regions on the ascending phase of cycle 21 (Gaizauskas *et al.*, 1983) and the longitudinal distribution of sunspots in the whole cycle (Sattarov *et al.*, 1990) shows that there are 7–8 IAL on the Sun. Sometimes a complex of activity is formed. In the solar maximum the magnetic fields (calcium plages) of the IAL cover the entire solar surface. If the signal to noise ratio is poor, the RMA of the K-index will be inexact. The isolated and powerful complexes of activity usually appear in the ascending and particularly the descending phase of cycle. In such periods the K-index data analysis gives exact results.

References

Baliunas, S.L., Vaughan, A.H.: 1985, *Ann. Rev. Astron. Astrophys.* **23**, 379
Keil, S.L., Worden, S.P.: 1984, *Astrophys. J.* **276**, 766
Singh, J. and Livingston, W.S.: 1987, *Solar Phys.* **109**, 387
Sattarov, I., Bumba, V.: 1990, in *The Dynamic Sun*, ed. L. Dezsõ, Debrecen, p. 48
Howard, R.: 1984, *Ann. Rev. Astron. Astrophys.* **22**, 131
Gaizauskas, V., Harvey, J., Harvey, K. and Zwaan, C.: 1983, *Astrophys. J.* **265**, 1056
Sattarov, I., Mustaeva, F.G., Litvinov, O.V.: 1990, *Issledovaniya solnechnoj activnosty*, eds. Yuldashbaev, T.S., Korobova, Z.B., in press