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DETECTION POSSIBILITY OF THE GIANT ROLLS IN THE SUN

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ABSTRACT The expected giant convection pattern has been studied by using its probable twisting influence on the emerging magnetic fields. The studies carried out on extended computations and material have confirmed the previously found evidence for a pattern with longitudinal wavenumber l=11 in the year 1977.

INTRODUCTION

The present work is the extended version of the study (Baranyi and Ludmány, 1992) which will be referred to as Paper I henceforth. As is described therein the work is based on the assumptions that (1) the internal magnetic field is basically toroidal and (2) the diverging and converging parts of the giant convection cell system can twist the azimuthally directed emerging magnetic fluxes on account of the Coriolis-force. The orientation data of the emerging active regions were used to look for the mentioned distributions in the year 1977 using Debrecen photoheliograms (Dezső et al., 1987). Clear spatial separation of positive (equatorward) and negative (poleward) tilts was searched.

SEARCH FOR DISTRIBUTION PATTERNS

The possible longitudinal patterns are considered to be columnar giant convection cell systems expected by the theory (Glatzmaier, 1984; Gilman and Miller, 1986). Many possibilities have been examined by varying the following parameters: the longitudinal wavenumber (l), difference of the internal and outer (Carrington) rotation rates ($\Delta\omega$) and curvature of the rolls. The search means a procedure for finding high coincidence of positive (negative) tilts with diverging (converging) fields respectively in the possible configurations.

The coincidence is described by a suitable parameter. Each sunspot group is characterized by a W weight. Consider various

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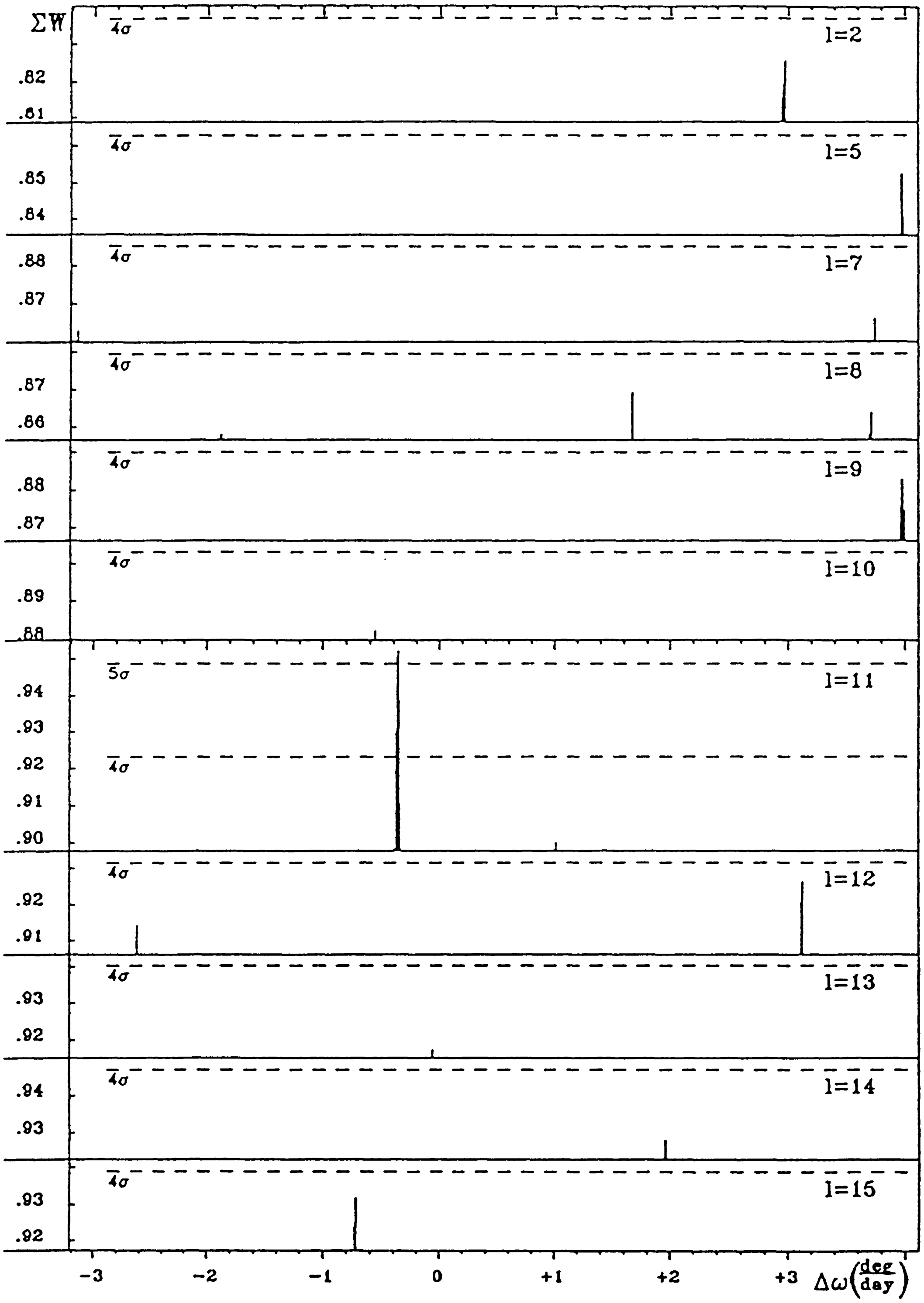

Fig. 1. Normalized sums of orientation weights (ΣW) characterizing the coincidence of the sunspot group tilts with various supposed internal sector structures as functions of the longitudinal wavenumber (l) and the difference of the internal-outer rotation rates (Δω). Only the values above the 3σ level are displayed. The band of high values at l=11 and Δω=-0.37 deg/day implies a probable internal structure.

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hypothetical sector structures with alternating positive-negative sectors. If the sign of the W corresponds to the sign of the sector in which the given sunspot group emerges then the W is added to a sum of weights (ΣW), if not, it is omitted. Three kinds of definition were used and averaged for the W.

Definition 1. (used also in Paper I, allowing 76 groups):

$$W = \Sigma\, \alpha_i (A_i)^{0.5} \qquad i=1,2,3$$

α_i: tilt of the sunspot group dipole to the azimuth (degrees), A_i: area of the spots of the group (millionths of the solar hemisphere) on the i-th day of its existence. Tolerance strips of 2.5 degrees are allowed beyond either sector borders.

Definition 2. The W is the same as in definition 1, but only for the first bipolar day. This allows 88 sunspot groups.

Definition 3. corresponds to the definition 2, but the strip of tolerance is equal to one sixth of the sector width.

Two sector parameters (difference of internal-outer rotation rates (Δω), and sector curvature) have been computed for the same values as in the Paper I, but the wavenumbers (l) were varied from 2 (instead of 9) through 15. The highest values of ΣW have been chosen for all l and Δω values, they have been normalized to the highest achievable ΣW values and averaged for the three definitions.

The Fig. 1 shows only the ΣW values exceeding the 3σ level (no such cases for l=3,4,6). The band of high maxima at l=11 and Δω=-0.37 degrees/day makes probable an internal sector structure characterized by these parameters and slight curvature in the given year and confirms the results and conclusions of Paper I which is based on more restricted data.

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