ROTATIONAL CHARACTERISTICS OF THE GREEN SOLAR CORONA : 1947-1991

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Abstract. Fe XIV 530.3 nm coronal emission line observations have been used for the estimation of the green solar corona rotation. A homogeneous data set, created from measurements of the world-wide coronagraphic network, has been examinated with a help of correlation analysis to reveal the averaged synodic rotation period as a function of latitude and time over the epoch from 1947 to 1991.

The values of the synodic rotation period obtained for this epoch for the whole range of latitudes and a latitude band $\pm30^0$ are 27.52±0.12 days and 26.95±0.21 days, resp. A differential rotation of green solar corona, with local period maxima around $\pm60^0$ and minimum of the rotation period at the equator, was confirmed . No clear cyclic variation of the rotation has been found for examinated epoch but some monotonic trends for some time intervals are presented.

A detail investigation of the original data and their correlation functions has shown that an existence of sufficinetly reliable tracers is not evident for the whole set of examinated data. This should be taken into account in future more precise estimations of the green corona rotation period.

Key words: Sun – corona – green emission line – rotation

1. Introduction

Besides other parts of solar body, also the solar emission corona has been studied with aim of the synodic rotation period determination on the base of Fe XIV 530.3 nm line measurements from patrol observations. After papers of Antonucci and Svalgaard (1974) /an investigated epoch of 1947-1970/, paper of Sime, Fisher and Altrock (1989) /1974-1985/, Rušin and Zverko (1990) /21st cycle/ and at last, paper of Rybák (1993) /1964-1989/, we try to prolong investigated epochs up to the whole period of the green emission line measurements.

2. Data and methodology

'The homogeneous data set of coronal green line intensities' (HDS) over the period 1939-1991, prepared by Rybanský et al. (1993), has been used in the present study. It

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was created following the method of Rybanský (1975), on the base of measurements from different coronal stations. HDS represents 53 years of daily records, each of 72 data with a position angle lag of 5^0, where days of no available measurements have been interpolated.

Following main steps of the data evaluation have been used for the estimation of the synodic rotation period in selected time and latitude intervals of the green line measurements : 1/ only east limb data have been used, 2/ a data division to yearly intervals and sumation in 15^0 latitude bins, 3/ for each yearly latitude bin an autocorrelation function (ACF) was computed for lag interval from 0 to 90 days (Press et al., 1986). 4/ the center of mass of ACF was estimated with help of 13 points of the highest correlation coefficient around local maximum in the lag interval from 21 to 35 days (see Hansen et al. (1969) for the core of their method) 5/ this estimation of the ACF center of mass was taken to be the synodic rotation period, 6/ latitude and temporal averages of the rotation period together with their standard deviations have been computed for the whole epoch.

3. Results and discussion

When only years with less than 200 interpolated days have been used (1947-1991), the following results were obtained : 1/ the average synodic rotation period of the green corona for the whole range of latitudes and the latitude band $\pm 30^0$ are 27.52 ± 0.12 days and 26.95 ± 0.21 days, resp., 2/ applying the same procedure for western limb data almost the same results have been obtained.

'Differential rotation' - Fig. 1 shows the synodic rotation period for latitudes from -80^0 to 80^0, when the time-averaging over the whole epoch is applied. Results are in a good agreement with results of Sime et al. (1989) and the nothern heliosphere clearly rotates with greater velocity than the southern one. Comparing the whole corona and the $\pm 30^0$ latitude bin, the possitive difference of 0.5 day is obtained. Therefore, the clear differential rotation of the green corona is without doubt as an whole epoch average.

'Cyclic time behaviour' - even with relatively large standard errors, some trends of data behaviour can be seen /1960-1964, 1971-1974/ in Fig.2 but no cyclic dependence of the rotational period was obtained.

Trying to find the reason for so large scatter of the rotational period estimations, we have found that for the investigated part of ACFs, there are very low ACF maxima values typically of only 0.3 ! We can conclude, that it is very important to look carefuly for the existence of real tracers in emission data. Usual methodology for the rotational period estimation should be applied only when the inevitable conditions for this method are fulfiled. This type of analysis will be done in the near future.

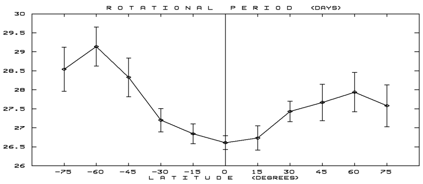

Figure 1. The time-averaged synodic rotation period for the epoch 1947-1991 as a function of latitude. Error bars displayed are one standard deviations.

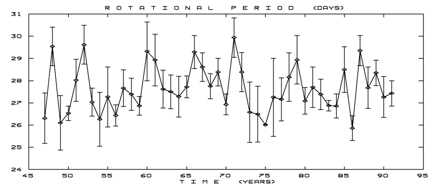

Figure 2. The yearly averages of the synodic rotation period over the latitude interval $\pm 80^0$.

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