Rotation of the Solar Green Corona - Tracer Results and their Reliability

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The determination of coronal rotation has a specific place in the field of the solar rotation investigation due to limited possibilities for observations of tracers in these solar atmospheric layers. The most extensively studied tracers are the solar coronal features in the FeXIV 530.3 nm green emission line intensity. Generally, the green corona rotates more rigidly than the photosphere - only a little faster on the equator but more rapidly at higher heliographic latitudes. The cycle dependence was detected as more differential rotation after beginnings of new solar cycles and during their maxima (e.g. Sime et al., 1989).

However, the existence of sufficiently reliable tracers is not evident for the whole available time-latitude domain of coronal measurements and this should be taken into account in estimates of overall rotational characteristics of the emission-line corona (Rybák et al. 1994). Therefore, the reliability of the green coronal emission line rotational results in the relation to the tracer expressiveness and stability as like as possible consequences of a selection of the best tracers on the rotation period results are briefly presented in this work.

'The Homogeneous Data Set of Coronal Green Line Intensities over the Period 1939-1991' has been used for computations (Rybanský and Rušin 1992, 1994). The rotation period results and the estimates of their reliability have been calculated by Spearman's rank-order autocorrelation function (ACF) applied to yearly data subsets with steps of 0.1 year and 5°. The center of mass near the first ACF rotational maximum was taken to be a synodic rotation period. The tracer quality was estimated from the ACF local maximum value (ACFM). The most real tracers were selected in each calendar year for every latitude bin. East and west limb data sets have been used separately. It was found reasonable to compare only the results with ACFM higher than the limit level of 0.2. The results bellow this level show too pronounced scatter and it is of no use dealing with them even in the case that part of the time-latitude domain is lost.

Applied reliability test of results - comparison of results obtained from east and west limbs - shows that in the 1-day difference range there is 68% and in the range of 2 days 88% of results with ACFM higher than 0.2. At the same time, only 76% of the whole time-latitude domain is covered with ACFMs above the limit level of 0.2 for both limbs. This is, to our knowledge, the first test of green corona rotation results quality.

The map of the synodic rotation period is obtained as a mean of corresponding east and west limb results. The mentioned latitude and cycle dependencies of the coronal rotation are presented together with isolated events of a non-typical rotation. Generally, the rotation period of green corona is less than photospheric one. The cycle dependence of coronal rotation is represented by two qualitatively different types of latitudinal behaviour. During the enhanced solar activity existence the rotation of the corona is characterized by a greater degree of differential rotation close to the magnetic rotation of the photosphere whereas solar activity minima exhibit rather rigid rotation with the period roughly equal its equatorial value.

Overall latitude behaviour of the coronal rotation is, unfortunately, influenced by the selection of the best pronounced tracers using different ACFM levels because of time-latitude distribution of tracer quality. It was found that no clear trend of overall rotation latitudinal dependence is detectable for latitudes higher than 60° where selection of different quality of tracers has important effect and can produce opposite trends in latitude behaviour of rotation period. An attempt to approximate the overall latitude behaviour of the coronal rotation at least within the ±50° range from both limb results with ACFM level above 0.2 was done. The rotation period approximation $P(\beta)[\mathrm{days}] = 26.773 + 3.530.\sin^2(\beta) - 0.569.\sin^4(\beta)$ was obtained (β=latitude [°]). Due to contradictory influence of the ACFM level on results it seems that there is no possibility of getting a better overall latitude approximation of the emission-line corona rotation.

It can be concluded that performed reliability test has shown that with moderate quality of tracers, which are sometimes available only in the time-latitude domain, the tracer method can give only very approximative individual results. This fact is caused by absence of well pronounced and more stable emission tracers mainly at higher latitudes. Nevertheless, some coronal emission events lasting for longer time can provide realistic information about the rotation of green corona.

From above it follows that it is worth trying to compare the rotation information inferred from the time-latitude subsets with the best tracers in the lower emission corona with that characterizing another layers of the solar outer atmosphere related to them in time and space. X-ray observations of coronal holes from *Skylab* or *YOHKOH*, while-light corona measurements of *SOLWIND* or HAO K-coronameters as well as potential coronal magnetic field extrapolation results can be ranked among candidates for such work. In this way more information about the behaviour of the coronal material rotation can be inferred over time (cycle), latitude and height above solar surface.

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