RIGID AND DIFFERENTIAL ROTATION OF THE SOLAR CORONA

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(Received 14 September; in revised form 5 November, 1973)

Abstract. The rotation of the solar corona has been studied using recurrence properties of the green coronal line (5303 Å) for the interval 1947–1970. Short-lived coronal activity is found to show the same differential rotation as short-lived photospheric magnetic field features. Long-lived recurrences show rigid rotation in the latitude interval ± 57°.5. It is proposed that at least part of the variability of rotational properties of the solar atmosphere may be understood as a consequence of coexistence of differential and rigid solar rotation.

This study of coronal rotation uses synoptic tables of the intensity of the green coronal line (5303 Å) for the years 1947–1970. These tables were prepared by Sýkora (1973, personal communication) on the basis of intensity measurements published in Quarterly Bulletin on Solar Activity. The intensity is expressed in the Pic du Midi photometric scale. The coronal intensity for the central meridian was calculated as an average of intensities measured at the limbs 7 days before and 7 days later respectively. In the table Sýkora gives the intensity as 3-day averages every third day for six latitudinal zones 20° wide. The zones are centered at 47°5N, 27°5N, 7°5N, 7°5S, 27°5S, and 47°5S respectively. We have interpolated one day values from the tables.

It is clear that the resulting data sets have been extensively smoothed so that only long-lived and large-scale coronal features are left. However, for an investigation of coronal rotation this property of the data seems to be an advantage. On the other hand, very long period variations (such as the 11 yr sunspot cycle) are not desirable and have been removed by subtracting a running 27-day average from the data. The six time series (one for each latitude zone) were then autocorrelated with a lag varying from 0 to 60 days or more, to investigate the recurrence tendency and recurrence period which we interpret as the synodic rotation period for the coronal features. This implies that we assume that any systematic coronal movements in longitude during one rotation are negligible.

Figure 1 shows the autocorrelations out to a lag of 60 days for two 3-yr intervals centered on 1951 and 1968, corresponding to years in the declining portion and to years in the rising portion of the sunspot cycle. The recurrence tendency is equally marked; the autocorrelation coefficient is of the order +0.5 for the peaks near 27 days. This indicates that stable coronal features do exist and may be traced using the green line intensity. We intend to use these features as tracers to determine the solar rotation period for each of the six latitude zones. Generally the peaks are well formed so that

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Fig. 1. Autocorrelation functions for lags varying from 0 to 60 days of the intensity of the coronal green line (5303 Å) for two intervals 1950-52 and 1967-69. The vertical distance between the lines labeled 0.0 corresponds to an ordinate difference of 1.0. Six latitudinal zones have been examined: the zone limits are given on the figure. Vertical lines are drawn corresponding to recurrence periods of 27 and 54 days respectively.