ASYMMETRIC VARIATIONS OF THE CORONAL GREEN LINE INTENSITY

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(Received 5 August, 1987; in revised form 18 February, 1988)

Abstract. The analysis of the daily measurements of the coronal green line intensity, which have been extensively tested for homogeneity and freedom of trends observed at the Pic-du-Midi observatory during the period 1944–1974, has revealed some characteristic asymmetric variations. A north–south asymmetry of the green line intensity is the main feature of the period 1949–1971 while a south–north one is obvious within 1972–1974 and the minor statistical significance span 1944–1948. On the other hand a significant W–E asymmetry has been confirmed in the whole period 1944–1974. It is noteworthy that the period 1949–1971, where the N–S asymmetry takes place consists a 22-yr solar cycle which starts from the epoch of the solar magnetic field inversion of the solar cycle No. 18 and terminates in the relevant epoch of the cycle No. 20.

The combination of N–S and S–N asymmetry with a W–E one makes the NW solar-quarter to appear as the most active of all in the 22-yr cycle 1949–1971, while in the periods 1944–1948 and 1972–1974 the SW quarter is the most active. Finally, from the polar distribution of the green line intensity has been derived that the maximum values of the asymmetries occur in heliocentric sectors ±10°–20° far from the solar equator on both sides of the central meridian.

Physical mechanisms which could contribute to the creation of both N–S and E–W asymmetries of the solar activity and the green line intensity as an accompanied event, like different starting time of an 11-yr solar cycle in the two solar hemispheres, the motion of the Sun towards the Apex, and short-lived ‘active’ solar longitudes formed by temporal clustering of solar active centers, have been discussed.

1. Introduction

The extremely high temperature of the solar corona causes line radiation from highly ionized atoms the most important of which are in the visible wavelengths, the red (Fe XI λ6374 Å), the green (Fe XIV λ5303 Å) and the yellow (Ca X V λ5694 Å) lines.

Visual observations of the green line collected by a Lyot-type coronagraph and spectrograph during three solar cycles have revealed an extremely inhomogeneous corona with both low density regions known as ‘coronal holes’ where the green line intensity is especially weak (Waldmeier, 1981) and high density areas where the intensity increases (Leroy and Trellis, 1974). Useful information about the intensity of this line can be inferred by detailed observations of the electron density within coronal holes and dense coronal regions (Noëns and Leroy, 1981).

The green line intensity has been studied extensively in relation to various solar, interplanetary, and geophysical parameters while quantitative models have been presented.

Some interesting correlations of the green line intensity with sector boundaries of the

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heliospheric current sheet and the solar wind velocity have been reported by Antonucci (1974) and Pathak (1971), respectively. On the other hand Stenflo (1972), bearing in mind that the intensity of the green line increases with coronal temperature found that the latitudinal distribution of the green line intensity follows closely that of sunspots, the faculae and the strength of magnetic fields. Quantitative expressions of the green line intensity in relation to sunspots, faculae, the number of proton flares and the red emission line at 6374 Å have been also presented by Waldmeier (1971), Cuperman and Sternlieb (1972), Xanthakis, Petropoulos, and Mavromichalaki (1980, 1981).

Two prominent maxima of the green line intensity in every solar cycle have been denoted by Pathak (1972), while Xanthakis, Petropoulos, and Mavromichalaki (1981) have pointed out that the green line intensity can be considered as an integrated index of the solar activity.

One of the most interesting feature of the green line intensity is a north-south asymmetry which shows a negative correlation with the solar activity in the sense that it is small in the maxima and high in the minima (Pathak, 1972; Rušín, 1980). In the opposite, some investigations for a possible E-W asymmetry of the green line intensity or other solar activity manifestations were not able to come to significant conclusions (Růžičková-Topolová, 1974; Letfus and Růžičková-Topolová, 1980).

In the present study we analyze a long time series of green line intensity values which has been derived to be adequately homogeneous and reliable (see next paragraph), intending to result to confident conclusions about possible asymmetries of this line.

2. Data

Daily measurements of the absolute intensity of the coronal emission line 5303 Å taken from the Pic-du-Midi Observatory for the period 1944-1974 were used in this work. These measurements have been obtained by a classic Lyot-type coronagraph for all heliocentric sectors around the solar limb with a resolution of 5° and a distance of about 40” until 2” from the Sun’s edge. Hence, our data are obtained in a polar coordinate system defined by the central meridian passage. The unit of the measured intensity of this line is 10^{-6} times the intensity at a width 1 Å wavelength of the continuous photospheric spectrum (Rozelot and Fulconis, 1983; Dollfus, 1971). From the daily measurements of the green line intensity, yearly mean values in each heliocentric sector and in each north, south, east, west solar hemisphere have been calculated.

The number of days when observations have been obtained as well as the number of months where these measurements are distributed, have been entered in Table I. From the entries of this table, it is evident that the data of the years 1944 and 1945 do not offer sufficient statistical confidence because the mean values of these years have been calculated by 12 and 37 daily observations, respectively, which are distributed in only two months for each year.

In the opposite the measurements after 1971 are less significant than those of the previous years (1946-1971) but they do not lose their statistical confidence because they are distributed in 10-11 months for each year making a reliable representation of the