SIXTY SIX DAY PERIODICITY OF POLAR CORONAL HOLES

(Research Note)

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Abstract. Fourier analysis of the coronal hole size distribution shows sixty six day periodicity in respect of the time of advancement of solar cycle which is presumed to be due to the differential rotation of solar envelope.

1. Introduction

In an earlier paper it has been shown that the size of the polar coronal holes decreases with the increase of solar cycle activity. At the time of evaluation of the variation of polar coronal hole size with the time of advancement of solar cycle, we observed a periodicity in the hole size with respect to time. In this note this finding has been established after computing the Fourier coefficients of the time series of the polar coronal hole size.

The coronal hole data that were observed in the Helium D chromosphere by the Big Bear Solar observatory during the period from January, 1976 to December, 1981 and published in the Solar Geophysical Data bulletins by NOAA, U.S. Department of Commerce, have been analysed in this research note. The sizes of all coronal holes that occurred in the northern solar hemisphere have been added together and were termed as north polar holes and a similar technique was adopted for south polar holes.

2. Results and Discussion

We have assumed that the coronal hole size is represented by a periodic function $f(t)$ which can be expanded in a Fourier series in complex form with respect to the time (t) in days. After choosing several arbitrary time periods for the aforesaid Fourier series we have found out the Fourier coefficients (not normalised) for the hole size distribution. The results are shown in Figure 1a and 1b for the north polar holes and south polar holes respectively. It is observed from both figures that the Fourier coefficients for hole size vary with chosen time periods in an oscillatory manner and the values of the coefficients decrease with the increase of time periods. Although several peaks are obtained in the same graph, the most prominent peak has been found to occur at around 66 days, which holds good for the northern as well as the southern polar holes.

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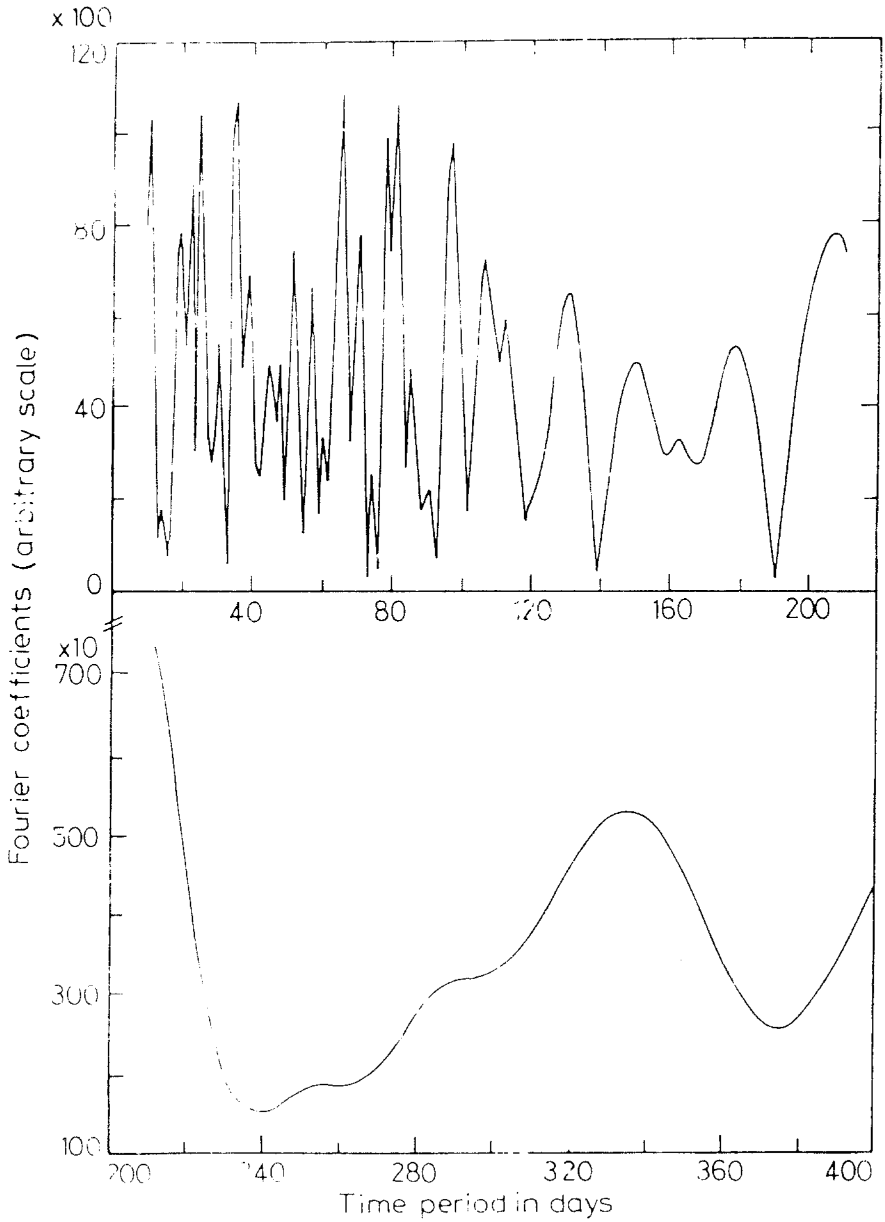

Fig. 1a. Curves showing the variation of Fourier coefficients of the periodic function $f(t)$ representing coronal hole size with the chosen time periods in days at the North pole.

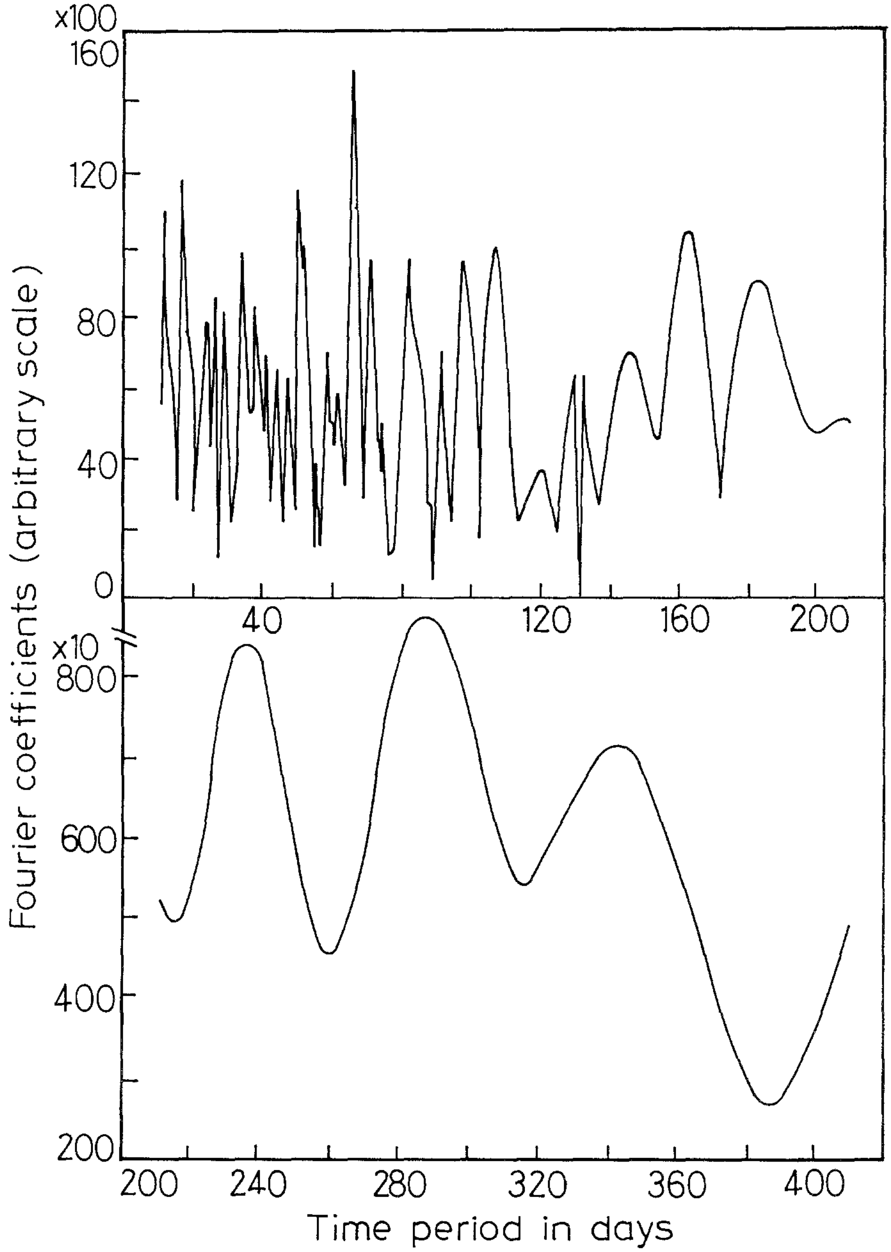

Fig. 1b. Curves showing the variation of Fourier coefficients of the periodic function $f(t)$ representing coronal hole size with the chosen time periods in days at the South pole.

TABLE I
Statistical significance of the sixty-six day peak

Polarity	Mean	Standard Deviation	3-sigma level
North	3854.00	104.42	4167.29
South	5963.07	109.00	6292.47

The significance of this peak has been studied quantitatively and the results are shown in Table I.

It is observed from this table that the peak rises far above three sigma level for the coronal holes of both north and south polarities individually. Moreover, the function representing the Fourier coefficients diverges as the time period increases.

The periodicity of about 66 days in the coronal hole size with respect to the time of advancement of solar cycle coincides miraculously with that of differential rotation of solar envelope. In considering the mechanisms for the formation of coronal holes Frankenthal and Krieger (1977) suggested that the interaction between the rigidly rotating field and the differentially rotating, diffusive solar envelope produces a fore aft asymmetry in the distribution of fields which emerge to the photosphere. As the coronal holes are assumed to be permeated by the rigidly rotating fields, there is a possibility that coronal hole size will have a periodicity equal to the period of differential rotation.

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References

Frankenthal, S. and Krieger, A.S.: 1977, *Solar Phys.* **55**, 83–97.