Multi-Wavelength Investigations of Solar Activity
Proceedings IAU Symposium No. 223, 2004
A.V. Stepanov, E.E. Benevolenskaya & A.G. Kosovichev, eds.

DOI: 10.1017/S1743921304006854

Evidence of the fundamental periodicity in the flare index between the years 1966-2002†

A. Özgüç[1] T. Ataç[1] and J. Rybák[2]

[1]Kandilli Observatory and E. R. I., Boğaziçi University, Istanbul, Turkey email: ozguc@boun.edu.tr

[2]Astronomical Institute, Slovak Academy of Sciences, 05960 Tatranská Lomnica, Slovak Republic email: choc@astro.sk

1. Extended abstract

The short-term periodicities of the flare index (FI) which is roughly proportional to the total energy emitted by the flare, are investigated in detail using Fourier transform (FT) for the full-disc and for the northern and the southern hemispheres of the Sun separately over the epoch of almost 4 cycles (1966-2002) which covers 13392 days. Figure 1 shows the power spectra of the three time series of FI calculated for the 289-771 nHz (15-40 days) range with 0.24 nHz interval. The uncertainty in each frequency is $\pm$ 0.4 nHz due to the 36.5-year data length. The dashed lines indicate the false alarm probability significance levels. In this figure, there are several pronounced power peaks whose significances are enough high. These are at 25.6, 27.0, 30.2 days for the full-disc, 27.0 days for the northern hemisphere and 27.5 and 33.8 days for the southern hemisphere. Since commonly used FT is not able to disclose the possible changes in the periodicities over the period studied, the wavelet transform (WT) was applied to search for temporal variability. The wavelet transform results show that the occurence of periodicities of flare index power is highly intermittent in time. All three FI time series show that the major periods, obtained by Fourier transform are localised in short time intervals (typically up to half of a year).

A comparison of the results of the FT and the time-period WT of the flare index time series has clarified the importance of different periodicities, whether they are or are not the harmonics of the basic ones, as well as the temporal location of their occurrence. Because we found that the modulation of the flare index due to the 27-day solar rotation is more pronounced during the declining portion of solar cycle than during the rising portion. Our results show that 27-day modulation seems 27.5-day in the southern hemisphere of the Sun. There is a possibility that some parts of an active region move rapidly forward or backward with respect to the mean rotation rate of the Sun, to give spacings different from 27 days. This can be checked only by an actual image comparison.

The fundamental period proposed by Bai and Sturrock (1991) was reported as 25.5-day. In our analysis, we found this value as 25.6 days. This periodicity operates mainly during maximum phases of solar cycles only short time intervals. However, Zięba *et al.* (2001) found the rotation rate of the "active longitudes" in the rising phase of cycle 23 as equal to 26.0$\pm$0.3 days. Recently, Bai (2003) studied longitude distributions of major flares in a coordinate system rotating about the solar axis, using the rotation period as a free parameter. And he concluded that, the idea of 25.5 days is a fundamental period of the Sun is well supported by data. However, its clock mechanism is still unknown. The differences between the results of the different authors can be explain that because of the non-sinusoidal nature of the variation of some activities (e.g., square waveform shape

† The complete version of this paper to be published in Solar Physics

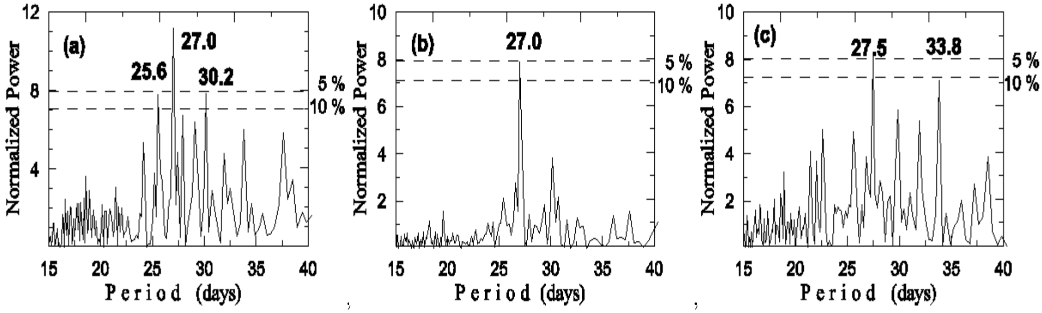

Figure 1. Normalized power spectra of the flare index of the (a) full-disc, (b) northern hemisphere, and (c) southern hemisphere of the Sun for time interval of 13392 days and for period interval of 15-40 days. The dashed lines indicate the false alarm probability significance levels.

of an X-ray source), a broad fundamental frequency will appear in the power spectra (Bouwer, Pap, and Donnelly, 1990).

To conclude that the problem of solar periodicities is still open and needs new observational data. Therefore, the solution of the observed solar periodicities should be sought in a complicated Sun's magnetic system which generates in the different solar data the compound set of solar periodicities.

Acknowledgements

One of the authors (A. Ö) is very thankful to the organizers of the IAUS 223 for providing financial support. This work was supported by Boğaziçi University Research Fund by the project of 00T101 and by the Slovak grant agency VEGA by the grant 2/3015/23. This research is part of the European Solar Magnetism Network (EC/RTN contract HPRN-CT-2002-00313).

References

Bai, T. 2003 *Astrophys. J.* **585**, 1114–1123.

Bai, T. & Sturrock, P. A. 1991 *Nature* **350**, 141–143.

Bouwer, S. D., Pap, J. & Donnelly, R. F. 1990 in *Climate Impact of Solar Variability* (ed. K. H. Schatten & A. Arking). NASA Conf. Proc. 3086, NASA, Greenbelt, MD, pp. 125–132.

Zięba, S., Maslowski, J., Michalec, A., & Kulak, A. 2001 *Astron. Astrophys.* **377**, 297–311.

https://doi.org/10.1017/S1743921304006854 Published online by Cambridge University Press