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V.M. Efimenko, V.G. Lozitsky

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# Essential features of long-term changes of areas and diameters of sunspot groups in solar activity cycles 12-24

V.M. Efimenko, V.G. Lozitsky\*

*Astronomical Observatory of the Taras Shevchenko National University of Kyiv,  
Observatorna St. 3, Kyiv 04053, Ukraine*

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## Abstract

We analyze the Greenwich catalog data on areas of sunspot groups of last thirteen solar cycles. Various parameters of sunspots are considered, namely: average monthly smoothed areas, maximum area for each year and equivalent diameters of groups of sunspots. The first parameter shows an exceptional power of the 19th cycle of solar activity, which appears here more contrastively than in the numbers of spots (that is, in Wolf's numbers). It was found that in the maximum areas of sunspot groups for a year there is a unique phenomenon: a short and high jump in the 18th cycle (in 1946-1947) that has no analogues in other cycles. We also studied the integral distributions for equivalent diameters and found the following: (a) the average value of the index of power-law approximation is 5.4 for the last 13 cycles and (b) there is reliable evidence of Hale's double cycle (about 44 years). Since this indicator reflects the dispersion of sunspot group diameters, the results obtained show that the convective zone of the Sun generates embryos of active regions in different statistical regimes which change with a cycle of about 44 years.

*Keywords:* Sun; Solar activity; Sunspots; Indexes of activity; Areas and diameters of sunspot groups; 44-years cycle.

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## 1. Introduction

A characteristic feature of solar activity is its 11-year cycle. Essential features of this cycle were discussed in detail by many authors, e.g. Gnevyshev (1977). However, the 11-year cycle is only most obvious and intense solar activity cycle, a kind of its "pulse". A more detailed analysis shows that the spectrum of fluctuations of solar activity has about 20 less intensive but reliable cycles, including cycles lasting 11.89 and 9.97 years (Tsirulnik et al., 1997). These cycles are close to the period of rotation of Jupiter around Sun (11.86 years) and the repetition of orbital quadratures for the system "Saturn-Jupiter" (9.90 years). Also shorter periods (less than 5 years) were found in the solar cycle data (Lean and Brueckner, 1989; Krivova and Solanki, 2002).

For a further more detailed study of cyclicity of solar activity, a long series of homogeneous observations should be used. Recall that telescopic observations of sunspots have been carried out for more than 400 years, since their first observations by Galileo, Scheiner and Fabricius.

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\*Corresponding author. Address: Astronomical Observatory of Taras Shevchenko National University of Kyiv, 3, Observatorna str., Kyiv 01053, Ukraine.

Tel.: +380 44 486 0906; fax: +380 44 481 4478.

*E-mail addresses:* [lozitsky\\_v@ukr.net](mailto:lozitsky_v@ukr.net), or [lozitsky@observ.univ.kiev.ua](mailto:lozitsky@observ.univ.kiev.ua) (Lozitsky V.G.), [efim@observ.univ.kiev.ua](mailto:efim@observ.univ.kiev.ua) (Efimenko V.M.)

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